CLIM 2.0 User Guide

Version 8.1

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Preface

0.0 About the User Guide

The Common Lisp Interface Manager (CLIM) is a powerful Lisp-based toolkit that provides a layered set of portable facilities for constructing user interfaces. The **Common Lisp Interface Manager User Guide** is intended for CLIM programmers who are looking for material arranged by concept. The Guide, based on the CLIM II Specification, is a complete reference for the LispWorks version of CLIM. Each chapter of the *User Guide* explains a key aspect of CLIM and includes summaries of conditions, constants, functions, macros, and presentation types that pertain to the particular topic, as well as many code examples. For a detailed syntactic description of a particular CLIM construct, refer to the on-line CLIM manual pages.

0.1 Notational Conventions

The *User Guide* employs the following conventions to distinguish different types of text.

`construct`	Lisp and CLIM constructs, such as functions or classes.
significant term	Significant terms introduced for the first time. These terms appear in the glossary.
`code examples`	Computer-generated text, prompts, and messages, as well as code examples and user entries.
`KEYSTROKES`	References to keystrokes, as in **`META`** or **`SHIFT`**. Logical keystrokes are enclosed in angle brackets. Thus for **`<ABORT>`**, you might type **`CONTROL-z`**; for **`<END>`**, **`CONTROL-]`**; and for **`<HELP>`**, **`META-?`**.
function arguments	Arguments to functions.
`specified arguments`	Specific values for arguments within code examples.
unspecified arguments	Arguments within code examples for which the user must supply a value.
`Menu Item`	Menu items, as in **`Exit`** or **`File>Save`** or **`Up`**.

Please note that **<release-directory>** refers to the location of CLIM in the LispWorks library. **<release-directory>/demo/puzzle.lisp** should be interpreted as **<lispworks-directory>/lib/<version-number>/clim2/demo/puzzle.lisp**.

Mouse pointer gestures are capitalized, as in Left or **`SHIFT`**-Middle.

1 Using CLIM

1.1 Conceptual Overview

The Common Lisp Interface Manager (CLIM) is a powerful Lisp-based toolkit that provides a layered set of portable facilities for constructing user interfaces. These include application building facilities; basic windowing, input, output, and graphics services; stream-oriented input and output augmented by facilities such as output recording, presentations, and context sensitive input; high-level "formatted output" facilities; command processing; and a compositional toolkit similar to those found in the X world that supports look-and-feel independence.

CLIM does not compete with the window system or toolkits of the host machine (such as Motif or OpenLook), but rather uses their services, to the extent that it makes sense, to integrate Lisp applications into the host's window environment. For example, CLIM "windows" are mapped onto one or more host windows, and input and output operations performed on the CLIM window are ultimately carried out by the host window system.

The CLIM programmer is insulated from most of the complexities of portability. Regardless of the operating platform (that is, the combination of Lisp system, host computer, and host window environment), applications only need deal with CLIM objects and functions. CLIM makes abstractions out of many of the concepts common to all window environments. The programmer is encouraged to think in terms of these abstractions, rather than in the specific capabilities of a particular host system. For example, using CLIM, the programmer can specify the appearance of output in high-level terms and those high-level descriptions are then turned into the appropriate appearance for the given host. Thus, the application has the same fundamental interface across multiple environments, although the details will differ from system to system.

CLIM provides a spectrum of user interface building options, all the way from detailed, low-level specification of "what goes where," to high-level specifications in which the programmer leaves all of the details up to CLIM. This allows CLIM to balance ease of use on the one hand and versatility on the other. By using high-level facilities, a programmer can build portable user interfaces quickly, whereas by utilizing lower-level facilities, she can customize her programming and user interfaces according to her specific needs or requirements. For example, CLIM supports the development of applications that are independent of look and feel, as well as the portable development of toolkit libraries that define and implement a particular look and feel.

The CLIM architecture is divided into several layers, each with an explicitly-defined protocol. These protocols allow the programmer to customize or re-implement various parts of CLIM.

1.2 Highlights of Tools and Techniques

The facilities provided by CLIM include:

Graphics CLIM offers a rich set of drawing functions, a wide variety of drawing options (such as line thickness), a sophisticated inking model, and color. CLIM provides full affine transformations, so that a drawing may be arbitrarily translated, rotated, and scaled to the extent that the underlying window system is capable of rendering such objects.

Windowing CLIM provides a portable layer for implementing window-like objects known as sheets that are suited to support particular high-level facilities or interfaces. The windowing module of CLIM defines a uniform interface for creating and managing hierarchies of these objects. This layer also provides event management.

Output Recording CLIM offers a facility for capturing all output done to a window. This facility provides the support for automatic window repainting and scrollable windows. In addition, this facility serves as the foundation for a variety of interesting high-level tools, including incremental redisplay.

Formatted Output CLIM provides a set of macros and functions that enable programs to produce neatly formatted tabular and graphical displays with very little effort.

Context Sensitive Input

The presentation type facility of CLIM links textual or graphical output on a window with the underlying Lisp object that it represents, so that objects may be retrieved later by selecting their displayed representation with the pointer. This "semantic typing" of output allows the application builder to separate the semantics of the application from the appearance and interaction style.

Application Building CLIM provides an application framework for organizing an application's top-level user interface and command processing loops. This framework provides support for laying out application windows under arbitrary constraints, managing command menus and/or menu bars, and associating user interface gestures with application commands. Using these tools, application writers can easily and quickly construct user interfaces that can grow flexibly from prototype to delivery.

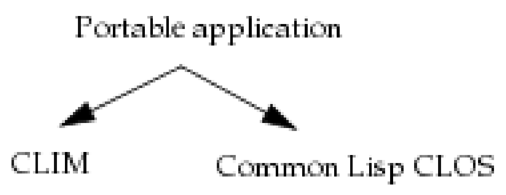
Adaptive Toolkit CLIM provides a uniform interface to the standard compositional toolkits available in many commercial computer environments. CLIM defines abstract classes that are analogous to the gadgets or widgets of toolkits such as Motif or OpenLook. CLIM fosters look-and-feel independence by defining these gadgets in terms of their function, without respect to the details of their appearance or operation. If an application uses these gadgets, its user interface will ultimately draw upon whatever toolkit is available in the host environment. This facility lets programmers easily construct applications that automatically conform to a variety of user interface standards. In addition, a portable CLIM-based implementation of these gadgets is provided.

1.3 How CLIM Helps You Achieve a Portable User Interface

Portability is one of the features that sets CLIM apart from other interface managers.

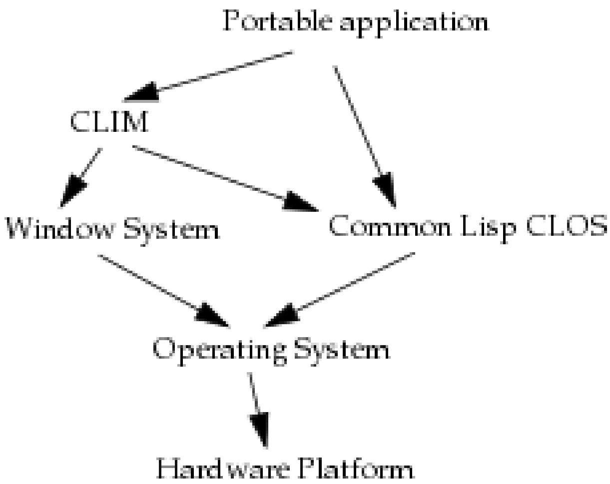
CLIM provides a uniform interface to the standard compositional toolkits available in many environments. By defining user interfaces in terms of CLIM objects rather than by accessing windows and widgets of a given windowing system directly, you are able to achieve a highly portable interface. In addition to CLIM functionality, you may also incorporate aspects of Common Lisp and CLOS into your program. The dependencies of your application are outlined in **The Foundation of a Portable Application**.

The Foundation of a Portable Application



The portability of your code comes from the fact that it is written in terms of standardized packages: Common Lisp, CLOS, and CLIM. From the perspective of your application, the details of the host windowing system, host operating system, and host computer should be invisible. CLIM handles the interaction with the underlying windowing system. **How CLIM Is Layered Over the Host System** shows the elements of the host environment from which CLIM insulates your application.

How CLIM Is Layered Over the Host System



CLIM shields you from the details of any one window system by making abstractions of the concepts that many window systems have in common. In using CLIM, you specify the appearance of your application's interface in general, high-level terms. CLIM then turns your high-level description into the appearance appropriate for a given host environment. For example, a request for a scroll bar pane would be interpreted as a request for the scroll bar widget in the current windowing system.

In some cases, you may prefer to have more explicit control over the appearance of your application. At the expense of portability, you may, at any time, bypass CLIM abstract interface objects and directly use functions provided by the underlying windowing system.

1.4 What Is CLIM?

In the first three sections you have been given a brief introduction to CLIM and some of its features. This section addresses the nature of CLIM in a more concrete and tangible fashion by defining important CLIM terms and discussing the fundamental elements of CLIM, as well as higher-level facilities that have been built from this core.

1.4.1 The Core of CLIM

1.4.1.1 Application Frames

An ***application frame***, or simply a ***frame***, is the locus of all application-specific knowledge. It is a physical, bordered object that is composed of smaller, individually functioning parts, called ***panes***. The frame maintains information regarding the layout of these components, keeps track of the Lisp state variables that contain the state of the application, and optionally has an interface to the window manager.

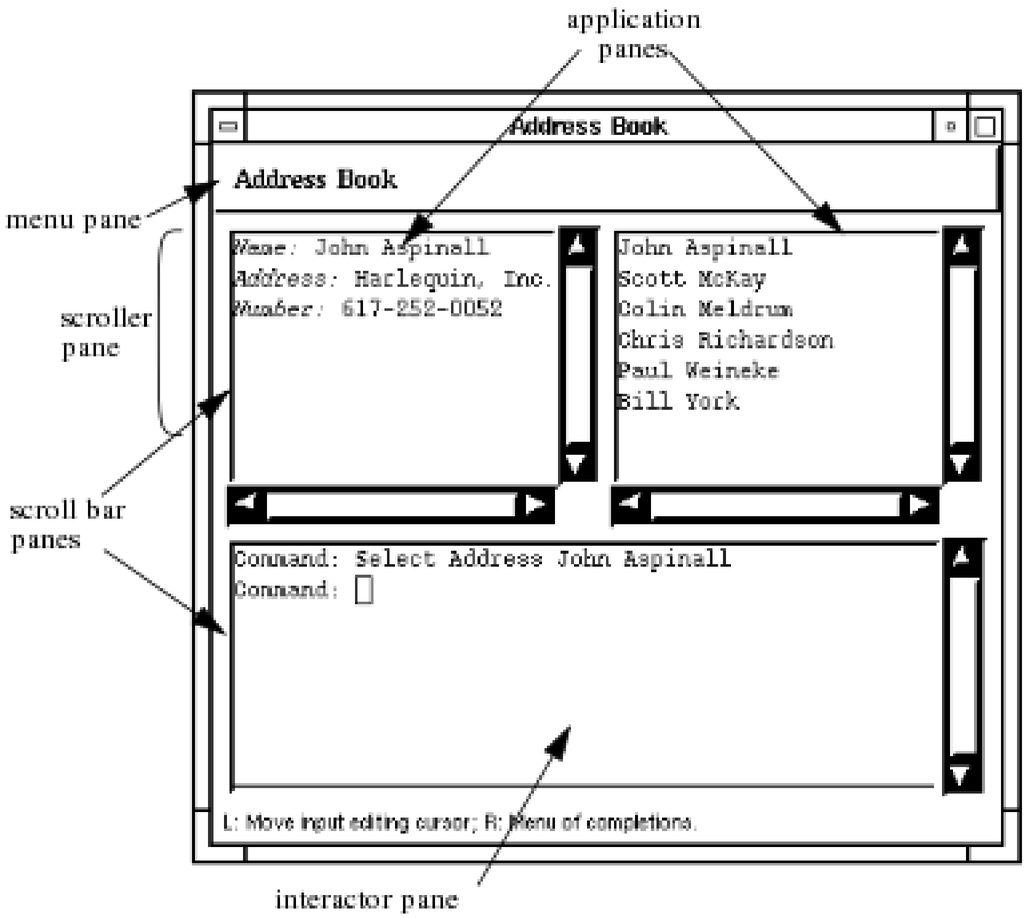
In developing a simple application such as an on-line address book, the application frame could be divided into several units to accomplish various tasks, as you can see in **1.4.1.2 Panes**. One pane could be used to accept commands; another section of the screen could provide an index of names in the address book; another portion could be used to display a specific address entry. We might also choose to have a general menu and a few conveniently placed scroll bars. Each of these components of the application frame is a pane.

1.4.1.2 Panes

A pane is a window-like object that knows how to behave as a component of an application frame. That is, it supports the pane protocol operations for layout.

Panes come in many different varieties. For example, gadget panes include such things as buttons and scroll bars. Stream panes deal specifically with text. Some panes are defined only in terms of their functionality, without regard to their specific appearance or implementation. These panes are called abstract panes. The abstract definition allows various instances of the pane class to take on a platform-dependent look and feel. Panes can also be classified according to their role in pane hierarchies. Panes that can have child panes are called composite panes; those that cannot are called leaf panes. Composite panes that are in charge of spatially organizing their children are called layout panes.

An Example of Panes Within an Application Frame



The address book application frame shows a typical pane hierarchy. There are three instances of text panes that have associated scroll bars. For every extended stream pane, or text field, with affiliated scroll bar panes there is an "invisible" parent pane, known as a scroller pane, which does such things as control the layout of the child panes and ensure that its children are given the space they need.

The ability to address space allocation and composition concerns is the primary characteristic that sets panes apart from their superclass, sheets, to be discussed in **1.4.1.3 Sheets**. Panes, therefore, understand how much screen space they want and need. For instance, the menu pane in the address book application has a static height, so that if the window is resized, the menu pane will not be scaled vertically. On the other hand, the scroller pane labeled in **1.4.1.2 Panes** (the pane controlling the application pane for the address book index and the gadget panes for the two associated scroll bars) can be resized as long as the scroll bars are granted enough screen space to function, that is to say, to display the minimum graphics necessary to implement scrolling.

1.4.1.3 Sheets

Panes are built from more general objects called ***sheets***. Sheets are the fundamental "window-like" entities that specify the areas of the screen to be used for input and output interactions. Sheets consist of, in part, a region on the screen, a coordinate system, and optionally a parent and/or child sheets. For a complete discussion on sheets, refer to **18 Sheets**. CLIM programmers will typically not need to deal with sheets directly, but instead will use the higher-level pane objects.

1.4.1.4 Enabling Input and Output

A pane hierarchy must be attached to a display server so as to permit input and output. This is handled by the use of ***ports*** and ***grafts***. A port specifies the device acting as the display server, whereas grafts are special sheets, typically representing the root window, which are directly connected to the display server. (The term ***graft*** is derived from the horticultural practice of grafting, in which the trunk of one tree is joined onto the rootstock of another.) Again, a CLIM application programmer will not normally deal with these objects directly. A call to **`make-application-frame`** automatically results in a port specification and graft instantiation. Refer to **9.2 Defining CLIM Application Frames** for details.

1.4.1.5 Graphics

Once your panes are ready to accept output, you may be interested in creating graphics. CLIM provides elementary graphic functions such as **`draw-point`** and **`draw-circle`** as well as higher-level graphic functions such as **`draw-arrow`** and **`make-elliptical-arc`** (see **3.2 Using CLIM Drawing Options**). CLIM also supports region operations such as **`region-intersection`** and **`region-difference`** (see **2.5 General Geometric Objects in CLIM**).

1.4.1.6 Text

The fundamental function for displaying text is **`draw-text`**. In addition to many of the graphic drawing options, text functions take a text-style argument that controls the font, face, and size.

1.4.1.7 Events

An ***event*** is a CLIM object that represents some sort of user gesture (such as moving the pointer or pressing a key on the keyboard) or that corresponds to some sort of notification from the display server. Event objects store such things as the sheet associated with the event, the **x** and **y** position of the pointer within that sheet, the key name or character corresponding to a key on the keyboard, and so forth.

1.4.1.8 Mediums

Graphical operations performed on panes must ultimately be carried out by the window system of the underlying host computer. This is accomplished primarily via communication with an underlying object called a ***medium***. A medium understands how to implement CLIM graphics operations, such as **`draw-line`**, by calling the underlying host window system's graphics functions. A medium also contains default drawing options, such as foreground and background colors, clipping region, transformations, line thickness, and fonts. There are different medium classes to support different windowing systems; thus, there is one medium class for the X Window System and a different one for the Macintosh Common Lisp environment.

This host-specific behavior is kept in a separate medium so that the pane classes themselves will be host-independent. Thus, when you build a new pane class, you do not have to build one version with X graphics mixed in, another one for the Mac, and so forth.

CLIM application programmers will not usually deal with mediums directly. In most cases, panes will automatically be allocated a medium upon creation, and output directed to the pane will be appropriately forwarded to the medium. In situations where efficiency is a concern, you may choose to send graphical output directly to the underlying medium. There are also situations, particularly when a pane has infrequent output, when you may wish to have many "light-weight" panes that share a medium.

1.4.2 CLIM Facilities

CLIM provides many higher-level facilities that are built from the fundamental CLIM elements.

1.4.2.1 Look and Feel

CLIM offers a variety of tools and features for creating portable Lisp applications. One of these techniques, made possible by the adaptive toolkit, is the ability to transform the look and feel of a given application easily. Thus, an application can take on Motif characteristics when running on a Unix workstation, can have a Microsoft Windows look and feel when running on that platform, or can be presented in a different customized manner.

1.4.2.2 Controlling Look and Feel

Frame managers are responsible for controlling the look and feel of an application frame. Each different kind of appearance, whether it be Motif or Microsoft Windows, is expressed by a different frame manager. CLIM provides frame managers that interface to a large number of host environments, including X Windows. There is also a "generic" frame manager that allows applications to maintain a "CLIM look and feel" across all platforms, rather than adopting the style of the underlying windowing system. Existing frame managers can be customized, or entirely new frame managers can be created to give your application the look and feel you desire.

A frame manager is responsible for interpreting the portable, window-system-independent layout specification of an application frame in the context of the look and feel supported by the frame manager. The abstract gadget panes, such as the scroll bars and buttons, will be mapped into specific pane classes that implement the gadget in terms of the native gadget of the host window system. For example, **`scroll-bar`** is mapped onto internal classes which use the **`SCROLLBAR`** control on Microsoft Windows and the **`ScrollBar`** widget on Motif.

1.4.2.3 Streams

Because Common Lisp performs its input and output on objects called ***streams***, CLIM does, too. In CLIM, streams are specialized sheets that implement the sheet and stream protocols. The basic stream protocols for input and output provide fundamental functionality such as reading and writing characters and flushing the output. Stream input is provided by low-level events; stream output is accomplished through low-level graphics.

1.4.2.4 Extended Input and Output

Streams in CLIM also support extended input and output protocols. The extended input stream protocol handles issues pertaining to, in part, non-character input such as mouse clicks. The extended output stream protocol addresses advanced issues such as text cursors, margins, text styles, inter-line spacing, and ***output recording***.

Output recording is a facility CLIM offers for capturing all output done to an extended stream. This information is stored in structures called output records. Output recording is used in the implementation of scrollable windows and incremental redisplay. See **14 Output Recording and Redisplay** and **15 Extended Stream Input Facilities** for more details.

1.4.2.5 Presentations

The presentation facility extends output recording to remember the semantics of output displayed in a CLIM window. ***Presentations*** are specialized output records that remember not only output, but also the Lisp object associated with the output and the semantic type affiliated with that object. This semantic type, called the ***presentation type***, allows display objects to be classified. Such semantic tagging allows the user to re-use existing output on the window to satisfy future input requests.

When a CLIM application is expecting input, an ***input context*** is established, which means the application is awaiting input of a certain semantic type. Presentations with an appropriate presentation type for the input context become sensitive; that is to say, clicking on them with the mouse will cause some action to happen. For instance, in the previous address book application example, when entering a new address, a user could type in an address or could specify input by clicking on any sensitive presentation. Addresses would be the only logical entry in this case, so only address presentation types will be sensitive. Nothing would happen if you clicked on a name or a phone number.

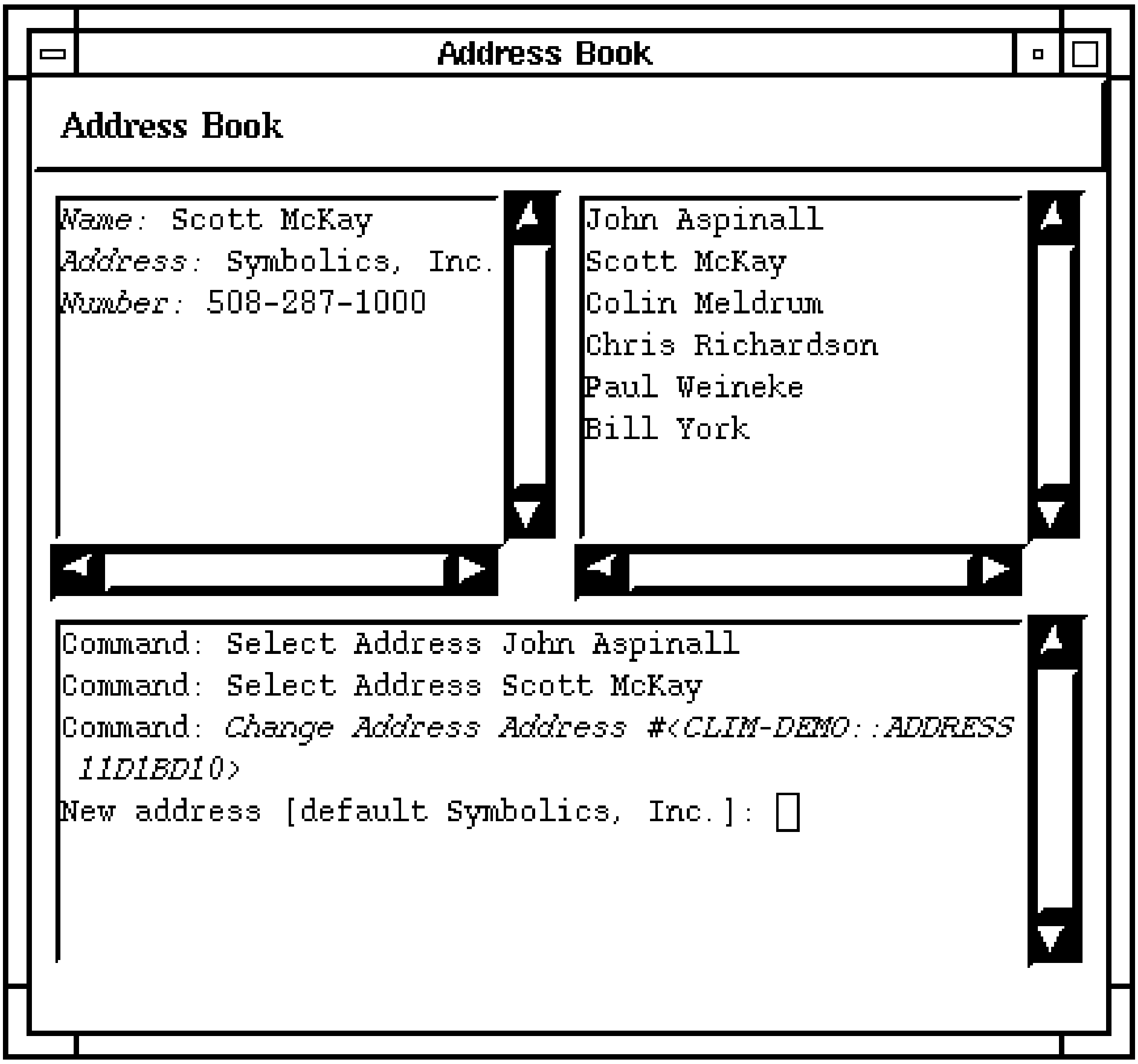
In a specific input context, when a given presentation type is valid input, all of the subclasses of this type are also acceptable. There are many cases, however, in which you may wish to expand the list of valid presentation types for a given input context. This is possible by the use of ***presentation translators***.

1.4.2.6 Command Loop

The outermost level of an application is an infinite interaction processing loop, similar to the Lisp **`read-eval-print`** loop, called a ***command loop***. The arguments to commands are defined in terms of the presentation type facility, so that command arguments can be specified via keyboard or mouse input.

It is also possible to map presentation types to commands that operate on arguments of those types. Thus you can invoke commands by clicking on displayed data. For example, in the address book example, as the command loop awaits commands, any command display objects would be sensitive. By using the **`define-presentation-to-command-translator`** macro, however, many other presentation types can in effect be turned into commands. A click on a name in the index could represent the "Select Address" command. Similarly, clicking on a field in the displayed address, such as the "Number:" field, could be translated into the "Change Address Number" command, as illustrated in **Using Presentation-to-Command Translators**.

Using Presentation-to-Command Translators



1.4.3 Summary

The CLIM core, comprising of sheets, mediums, graphics, and input and output, serves as the foundation for higher-level functionality. CLIM itself provides many advanced capabilities that have been developed from this kernel. Presentations, streams, and gadgets are all descendants of the fundamental CLIM kernel. This resulting hierarchy of objects and functionality gives CLIM a layered structure. For instance, we notice that streams and gadgets are specialized panes that are themselves specialized sheets. Similarly, presentations are customized output records. At any point in these hierarchies, one may customize and specialize objects by making subclasses of existing objects and adding the desired functionality. Although CLIM provides many advanced facilities, it is always possible to return to the fundamental CLIM building blocks and start creating anew.

1.5 Loading CLIM

To load CLIM into your LispWorks image, call:

```
(require "clim").
```

To load the PostScript functionality, call:

```
(require "clim-postscript")
```

To load the CLIM demos, call:

```
(require "clim-demo")
```

See **1.7 The CLIM demos**, for information about running the demos.

Note that module names are case-sensitive. For example **`(require "CLIM")`** will not work.

Note that the appearance of CLIM windows can be configured on some systems. See **1.7.1 Changing the appearance of CLIM windows**.

1.6 Testing Code Examples

These instructions assume that a CLIM image has already been built, or that CLIM has been loaded. Load CLIM via **`(require "clim")`**. See the *Release Notes and Installation Guide* for instructions on saving an image.

Below, '**>**' represents the Listener prompt which may appear differently in your Lisp image.

Load the sample file provided which contains CLIM code that defines an application frame:

```
> (load "<library-directory>/clim2/test/template.lisp")
```

Next, enter the following at the Lisp prompt:

```
> (run-frame-top-level
    (make-application-frame 'test :width 400 :height 500))
```

To exit the application and return to the Lisp top level, left-click on the **Exit** menu item. Enter **`(quit)`** at the Lisp prompt to quit Lisp.

1.7 The CLIM demos

To load the demo software, enter the following in a listener:

```
(require "clim-demo")
```

To run it, enter:

```
(clim-demo:start-demo)
```

This creates a new window, containing a menu listing all the demos. Choose the demo you wish to see. The CLIM demos are quick sketches of possible applications which demonstrate a variety of CLIM programming techniques. They are not robust, production-quality applications with complete error checking, but they can provide you with some ideas.

Note that the appearance of CLIM windows can be configured on some systems. See **1.7.1 Changing the appearance of CLIM windows**.

The sources for all the demos are included. The test suite is a collection of examples of CLIM's capabilities. The test suite examples are simple and succinct, so we recommend examining their sources for examples of CLIM's functionality that you may want to employ.

You can also run the demos directly, rather than using the menu, with the following function calls:

Function calls running each of the CLIM demos

Demo	Call
Bicycle gearing	**(clim-user::do-bicycle-gearing)**
Custom output records	**(clim-user::do-scigraph)**
Peek	**(clim-user::do-peek)**
Browser	**(clim-demo::do-ico)**
Ico demo	**(clim-browser::do-browser)**
Bitmap editor	**(clim-demo::do-bitmap-editor)**
Graphics editor	**(clim-graphics-editor::do-graphics-editor)**
Color chooser	**(clim-demo::do-color-chooser)**
Plotting demo	**(clim-demo::do-plot-demo)**
Thinkadot	**(clim-demo::do-thinkadot)**
Address book	**(clim-demo::do-address-book)**
15 puzzle	**(clim-demo::do-puzzle)**
Flight planner	**(clim-demo::do-flight-planner)**
CAD demo	**(clim-demo::do-cad-demo)**
Graphics demos	**(clim-demo::do-graphics-demo)**
Lisp listener	**(clim-demo::do-lisp-listener)**
Test suite	**(clim-test::do-test-suite)**

1.7.1 Changing the appearance of CLIM windows

This section describes how you can configure the fonts, colors and so on used in CLIM windows on some systems.

For more information see the section "Properties of the host window system" in the *CAPI User Guide and Reference Manual*.

1.7.1.1 Changing the appearance on Microsoft Windows

LispWorks (version 5.0 and greater) is a "themed" application on Microsoft Windows XP and later versions. Themes alter the appearance of some CLIM panes.

To make CLIM appear as on earlier versions of Windows and in LispWorks 4.x, call:

```
(win32:set-application-themed nil)
```

before creating any CLIM windows.

1.7.1.2 Changing the appearance on X11/Motif

You can change CLIM's color scheme and default fonts with X resources. Place your X resources in a file called **CLIM port** (that is, nine characters including the space) on your resource lookup path.

These are the default resources:

```
*buttonFontList:                            *times-bold-r-normal--14*
```

```
*labelFontList:                           *times-bold-r-normal--14*
CLIM port*CLIM-menu-bar*foreground:       #000080
CLIM port*CLIM-menu-bar*background:       #b3e6fd
CLIM port*CLIMprogressbar.foreground:     Red
CLIM port*CLIMpointerdoctext*foreground:  #000080
CLIM port*CLIMpointerdoc*background:      #b3e6fd
CLIM port*foreground:                     Black
CLIM port*background:                     White
```

By default, CLIM windows are mostly white. This is specified in the last line above.

2 Drawing Graphics

2.1 Conceptual Overview of Drawing Graphics

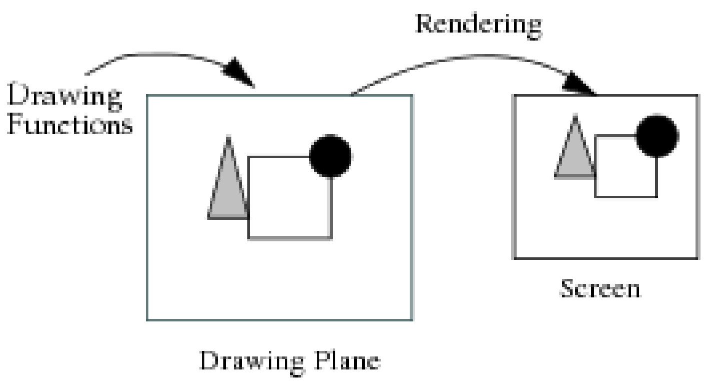
2.1.1 Drawing Functions and Options

CLIM offers a set of drawing functions that enable you to draw points, lines, polygons, rectangles, ellipses, circles, and text. You can affect the way the geometric objects are drawn by supplying options to the drawing functions. The drawing options specify clipping, transformation, line style, text style, ink, and other aspects of the graphic to be drawn. See **3.2 Using CLIM Drawing Options**.

2.1.2 The Drawing Plane

When drawing graphics in CLIM, you imagine that they appear on a drawing plane. The drawing plane extends infinitely in four directions and has infinite resolution (no pixels). The drawing plane has no material existence and cannot be viewed directly. The drawing plane provides an idealized version of the graphics you draw. A line that you draw on the drawing plane is infinitely thin.

Rendering from Drawing Plane to Window



Of course, you intend that the graphics should be visible to the user, so they must be presented on a real display device. CLIM transfers the graphics from the drawing plane to the window via the ***rendering*** process. Because the window lives on hardware that has physical constraints, the rendering process is forced to compromise when it draws the graphics on the window. The actual visual appearance of the window is only an approximation of the idealized drawing plane.

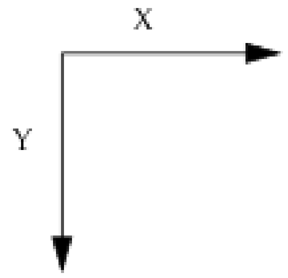
Rendering from Drawing Plane to Window shows the conceptual model of the drawing functions sending graphical output to the drawing plane, and the graphics being transferred to a screen by rendering. The distinction between the idealized drawing plane and the real window enables you to develop programs without considering the constraints of a real window or other specific output device. This distinction makes CLIM's drawing model highly portable.

CLIM application programs can inquire about the constraints of a device, such as its resolution and other characteristics, and modify the desired visual appearance on that basis. This practice trades portability for a finer degree of control of the appearance on a given device.

2.1.3 Coordinates

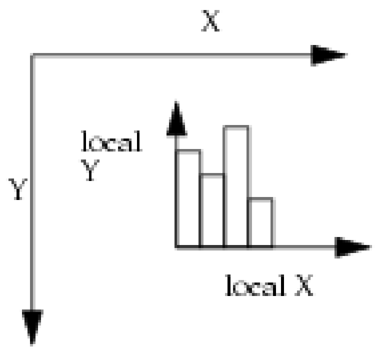
When producing graphic output on the drawing plane, you indicate where to place the output with coordinates. ***Coordinates*** are a pair of numbers that specify the **x** and **y** placement of a point. When a window is first created, the origin (that is, **x** = 0, **y** = 0) of the drawing plane is positioned at the top-left corner of the window. **X and Y Axes of the Drawing Plane** shows the orientation of the drawing plane. X extends toward the right, and Y extends downward.

X and Y Axes of the Drawing Plane



Each window looks into some rectangular area of its drawing plane. The specific area of the drawing plane that is visible is determined by the window's region and coordinate transformation. As the window scrolls downward, the origin of the drawing plane moves above the top edge of the window. Because windows can be located anywhere in the drawing plane, it may be inconvenient to keep track of the coordinates of the drawing plane, and it can be easier to think in terms of a ***local coordinate system***.

Using a Local Coordinate System



For example, you might want to draw some business graphics as shown in **Using a Local Coordinate System**. For these graphics, it is more natural to think in terms of the Y axis growing upwards, and to have an origin other than the origin of the drawing plane, which might be very far from where you want the graphics to appear. You can create a local coordinate system in which to produce your graphics. The way you do this is to define a transformation that informs CLIM how to map from the local coordinate system to the coordinates of the drawing plane. For more information, see **`with-room-for-graphics`**.

2.1.4 Mediums, Sheets, and Streams

Mediums, sheets, and streams are classes of primary importance in the creation of graphics in CLIM.

One of the arguments taken by drawing functions is a ***medium***. A medium keeps track of device-specific information necessary for creating graphics. There are different medium classes to support different devices; thus, there is one medium class for the X Window System and a different one for the Macintosh Common Lisp environment. A medium implements the low-level graphic functions such as drawing a line or displaying a color. A medium also keeps track of its drawing environment, which includes such things as the current transformation, text style, line style, and foreground and background inks.

A ***sheet*** specifies the destination for the graphical output of a medium.Whereas mediums are device-specific, sheets are completely portable. Sheets are visible objects that have properties such as a position, a region, a parent, and children. Interface elements such as scrollbars and pushbuttons are subclasses of sheets. For convenience, sheets have also been made to support the graphics protocol. A graphics function call to a sheet object, however, simply results in the same graphics function call being made to the medium object.

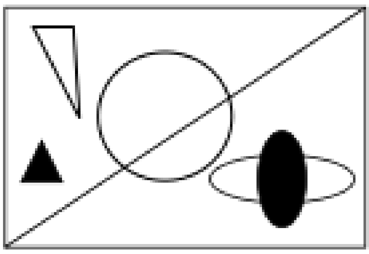
Streams are specialized sheets that implement the sheet and stream protocols. A stream is thus a sheet that supports stream methods like **`write-string`** and keeps track of additional stream-related state information, such as current cursor position.

2.2 Examples of Using CLIM Drawing Functions

Simple Use of the Drawing Functions shows the result of evaluating the following forms:

```
(clim:draw-rectangle* *my-sheet* 10 10 200 150 :filled nil
                      :line-thickness 2)
(clim:draw-line* *my-sheet* 200 10 10 150)
(clim:draw-point* *my-sheet* 180 25)
(clim:draw-circle* *my-sheet* 100 75 40 :filled nil)
(clim:draw-ellipse* *my-sheet* 160 110 30 0 0 10 :filled nil)
(clim:draw-ellipse* *my-sheet* 160 110 10 0 0 30)
(clim:draw-polygon* *my-sheet* '(20 20 50 80 40 20) :filled nil)
(clim:draw-polygon* *my-sheet* '(30 90 40 110 20 110))
```

Simple Use of the Drawing Functions



2.3 CLIM Drawing Functions

Many of the drawing functions come in pairs. One function in the pair takes two arguments to specify a point by its **x** and **y** coordinates; the other function takes one argument, a point object. The function accepting coordinates of the point has a name with an asterisk (*) appended to it, and the function accepting a point object has the same name without an asterisk. For example, **`draw-point`** accepts a point object, and **`draw-point*`** accepts coordinates of a point. We expect that using the starred functions and specifying points by their coordinates will be more convenient in most cases.

Any drawing functions may create an output record that corresponds to the figure being drawn. **15 Extended Stream Input Facilities** for a complete discussion of output recording. During output recording, none of these functions capture any arguments that are points, point sequences, coordinate sequences, or text strings. Line styles, text styles, transformations, and clipping regions may be captured.

The drawing functions are all specified as ordinary functions, not as generic functions. This is intended to ease the task of writing compile-time optimizations that avoid keyword argument taking, check for such things as constant drawing options, and so forth. If you need to specialize any of the drawing methods, use **`define-graphics-method`**.

Although the functions in this section are specified to be called on sheets, they can also be called on streams and mediums.

2.3.1 Arguments

- *point-seq* is a sequence of point objects.
- *coord-seq* is a sequence of coordinate pairs, which are real numbers. It is an error if *coord-seq* does not contain an even number of elements.
- The drawing functions take keyword arguments specifying drawing options. For information on the drawing options, see **3.2 Using CLIM Drawing Options**. If you prefer to create and use point objects, see **2.5.2 CLIM Point Objects**.

2.3.2 Basic Drawing Functions

draw-point *Function*

`draw-point` *sheet point* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit*

draw-point* *Function*

`draw-point*` *sheet x y* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit*

Summary: These functions (structured and spread arguments, respectively) draw a single point on the sheet *sheet* at the point *point*, or the position (*x*, *y*).

The unit and thickness components of the current line style (see **3.2 Using CLIM Drawing Options**) affect the drawing of the point by controlling the number of pixels used to render the point on the display device.

draw-points *Function*

`draw-points` *sheet point-seq* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit*

draw-points* *Function*

`draw-points*` *sheet coord-seq* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit*

Summary: These functions (structured and spread arguments, respectively) draw a set of points on the sheet *sheet*.

For convenience and efficiency, these functions exist as equivalents to:

```
(map nil #'(lambda (point) (draw-point sheet point)) point-seq)
```

and:

```
(do ((i 0 (+ i 2)))
    ((= i (length coord-seq)))
  (draw-point* sheet (elt coord-seq i) (elt coord-seq (+ i 1))))
```

draw-line *Function*

`draw-line` *sheet point1 point2* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

draw-line* *Function*

`draw-line*` *sheet x1 y1 x2 y2* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

Summary: These functions (structured and spread arguments, respectively) draw a line segment on the sheet *sheet* from the point *point1* to *point2*, or from the position (*x1*, *y1*) to (*x2*, *y2*).

The current line style (see **3.2 Using CLIM Drawing Options**) affects the drawing of the line in the obvious way, except that the joint shape has no effect. Dashed lines start dashing at *point1*.

draw-lines *Function*

`draw-lines` *sheet point-seq* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

draw-lines* *Function*

`draw-lines*` *sheet coord-seq* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

Summary: These functions (structured and spread arguments, respectively) draw a set of disconnected line segments. These functions are equivalent to:

```
(do ((i 0 (+ i 2)))
    ((= i (length point-seq)))
  (draw-line sheet (elt point-seq i) (elt point-seq (1+ i))))
```

and:

```
(do ((i 0 (+ i 4)))
    ((= i (length coord-seq)))
  (draw-line* sheet
              (elt coord-seq i) (elt coord-seq (+ i 1))
              (elt coord-seq (+ i 2))
              (elt coord-seq (+ i 3))))
```

draw-polygon *Function*

`draw-polygon` *sheet point-seq* **`&key`** **`(`***filled* **`t)`** **`(`***closed* **`t)`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-joint-shape line-cap-shape*

draw-polygon* *Function*

`draw-polygon*` *sheet coord-seq* **`&key`** **`(`***filled* **`t)`** **`(`***closed* **`t)`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-joint-shape line-cap-shape*

Summary: Draws a polygon or polyline on the sheet *sheet*. When *filled* is **`nil`**, this draws a set of connected lines; otherwise, it draws a filled polygon. If *closed* is **`t`** (the default) and *filled* is **`nil`**, it ensures that a segment is drawn that connects the ending point of the last segment to the starting point of the first segment. The current line style (see **3.3 CLIM Line Styles** for details) affects the drawing of unfilled polygons in the obvious way. The cap shape affects only the "open" vertices in the case when *closed* is **`nil`**. Dashed lines start dashing at the starting point of the first segment, and may or may not continue dashing across vertices, depending on the window system.

If *filled* is **`t`**, a closed polygon is drawn and filled in. In this case, *closed* is assumed to be **`t`** as well.

draw-rectangle *Function*

`draw-rectangle` *sheet point1 point2* **`&key`** **`(`***filled* **`t)`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-joint-shape*

draw-rectangle* *Function*

`draw-rectangle*` *sheet x1 y1 x2 y2* **`&key`** **`(`***filled* **`t)`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-joint-shape*

Summary: Draws either a filled or unfilled rectangle on the sheet *sheet* that has its sides aligned with the coordinate axes of the native coordinate system. One corner of the rectangle is at the position (*x1*, *y1*) or *point1* and the opposite corner is at (*x2*, *y2*) or *point2*. The arguments *x1*, *y1*, *x2*, and *y1* are real numbers that are canonicalized in the same way as for **`make-bounding-rectangle`**. *filled* is as for **`draw-polygon*`**.

The current line style (see **3.2 Using CLIM Drawing Options**) affects the drawing of unfilled rectangles in the obvious way, except that the cap shape has no effect.

draw-rectangles *Function*

`draw-rectangles` *sheet points* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-joint-shape*

draw-rectangles* *Function*

`draw-rectangles*` *sheet position-seq* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-joint-shape*

Summary: These functions (structured and spread arguments, respectively) draw a set of rectangles on the sheet *sheet*. *points* is a sequence of point objects; *position-seq* is a sequence of coordinate pairs. It is an error if *position-seq* does not contain an even number of elements.

Ignoring the drawing options, these functions are equivalent to:

```
(do ((i 0 (+ i 2)))
    ((= i (length points)))
  (draw-rectangle sheet (elt points i) (elt points (1+ i))))
```

and:

```
(do ((i 0 (+ i 4)))
    ((= i (length position-seq)))
  (draw-rectangle* sheet
                   (elt position-seq i)
                   (elt position-seq (+ i 1))
                   (elt position-seq (+ i 2))
                   (elt position-seq (+ i 3))))
```

draw-ellipse *Function*

`draw-ellipse` *sheet center-pt radius-1-dx radius-1-dy radius-2-dx radius-2-dy* **`&key (`***filled* **`t)`** *start-angle end-angle ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

draw-ellipse* *Function*

`draw-ellipse*` *sheet center-x center-y radius-1-dx radius-1-dy radius-2-dx radius-2-dy* **`&key (`***filled* **`t)`** *start-angle end-angle ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

Summary: These functions (structured and spread arguments, respectively) draw an ellipse (when *filled* is **`t`**, the default) or an elliptical arc (when *filled* is **`nil`**) on the sheet *sheet*. The center of the ellipse is the point *center-pt*, or the position (*center-x*, *center-y*).

Two vectors, (*radius-1-dx*, *radius-1-dy*) and (*radius-2-dx*, *radius-2-dy*) specify the bounding parallelogram of the ellipse as explained in **2.5 General Geometric Objects in CLIM** All of the radii are real numbers. If the two vectors are collinear, the ellipse is not well-defined and the **`ellipse-not-well-defined`** error will be signaled. The special case of an ellipse with its major axes aligned with the coordinate axes can be obtained by setting both *radius-1-dy* and *radius-2-dx* to 0.

start-angle and *end-angle* are real numbers that specify an arc rather than a complete ellipse. Angles are measured with respect to the positive **x** axis. The elliptical arc runs positively (counter-clockwise) from *start-angle* to *end-angle*. The default for *start-angle* is 0; the default for *end-angle* is 2π.

In the case of a "filled arc" (that is, when *filled* is **t** and *start-angle* or *end-angle* are supplied and are not 0 and 2π), the figure drawn is the "pie slice" area swept out by a line from the center of the ellipse to a point on the boundary as the boundary point moves from *start-angle* to *end-angle*.

When drawing unfilled ellipses, the current line style (see **3.2 Using CLIM Drawing Options**) affects the drawing in the obvious way, except that the joint shape has no effect. Dashed elliptical arcs start dashing at *start-angle*.

draw-circle *Function*

draw-circle *sheet center-pt radius* **&key (***filled* **t)** *start-angle end-angle ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

draw-circle* *Function*

draw-circle* *sheet center-x center-y radius* **&key (***filled* **t)** *start-angle end-angle ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

Summary: These functions (structured and spread arguments, respectively) draw a circle (when *filled* is **t**, the default) or a circular arc (when *filled* is **nil**) on the sheet *sheet*. The center of the circle is *center-pt* or (*center-x, center-y*) and the radius is *radius*. These are just special cases of **draw-ellipse** and **draw-ellipse***. *filled* is as for **draw-ellipse***.

start-angle and *end-angle* allow the specification of an arc rather than a complete circle in the same manner as that of the ellipse functions.

The "filled arc" behavior is the same as that of an ellipse.

draw-text *Function*

draw-text *sheet string-or-char point* **&key** *text-style* **(***start* **0)** *end* **(***align-x* **:***left***)** **(***align-y* **:***baseline***)** *toward-point transform-glyphs ink clipping-region transformation text-style text-family text-face text-size*

draw-text* *Function*

draw-text* *sheet string-or-char x y* **&key** *text-style* **(***start* **0)** *end* **(***align-x* **:***left***)** **(***align-y* **:***baseline***)** *toward-x toward-y transform-glyphs ink clipping-region transformation text-style text-family text-face text-size*

Summary: The text specified by *string-or-char* is drawn on the sheet *sheet* starting at the position specified by the point *point*, or the position (*x*, *y*). The exact definition of "starting at" depends on *align-x* and *align-y*. *align-x* is one of **:left**, **:center**, or **:right**. *align-y* is one of **:baseline**, **:top**, **:center**, or **:bottom**. *align-x* defaults to **:left** and *align-y* defaults to **:baseline**; with these defaults, the first glyph is drawn with its left edge and its baseline at *point*.

text-style defaults to **nil**, meaning that the text will be drawn using the current text style of the sheet's medium.

start and *end* specify the start and end of the string, in the case where *string-or-char* is a string. If *start* is supplied, it must be an integer that is less than the length of the string. If *end* is supplied, it must be an integer that is less than the length of the string, but greater than or equal to *start*.

Normally, glyphs are drawn from left to right no matter what transformation is in effect. *toward-x* or *toward-y* (derived from *toward-point* in the case of **draw-text**) can be used to change the direction from one glyph to the next one. For example, if *toward-x* is less than the **x** position of *point*, then the glyphs will be drawn from right to left. If *toward-y* is greater than the **y** position of *point*, then the glyphs' baselines will be positioned one above another. More precisely, the reference point in each glyph lies on a line from *point* to *toward-point*, and the spacing of each glyph is determined by packing rectangles along that line, where each rectangle is "char-width" wide and "char-height" high.

transform-glyphs is not supported in this version of CLIM.

2.3.3 Compound Drawing Functions

CLIM also provides a few compound drawing functions. The compound drawing functions could be composed by a programmer from the basic drawing functions, but are provided by CLIM because they are commonly used.

draw-arrow *Function*

`draw-arrow` *sheet point-1 point-2* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape to-head from-head head-length head-width*

draw-arrow* *Function*

`draw-arrow*` *sheet x1 y1 x2 y2* **`&key`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape from-head to-head head-length head-width*

Summary: These functions (structured and spread arguments, respectively) draw a line segment on the sheet *sheet* from the point *point1* to *point2*, or from the position (*x1*, *y1*) to (*x2*, *y2*). If *to-head* is **`t`** (the default), then the "to" end of the line is capped by an arrowhead. If *from-head* is **`t`** (the default is **`nil`**), then the "from" end of the line is capped by an arrowhead. The arrowhead has length *head-length* (default 10) and width *head-width* (default 5).

The current line style (see **3.2 Using CLIM Drawing Options**) affects the drawing of the line portion of the arrow in the obvious way, except that the joint shape has no effect. Dashed arrows start dashing at *point1*.

draw-oval *Function*

`draw-oval` *sheet center-pt x-radius y-radius* **`&key (`***filled* **`t)`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

draw-oval* *Function*

`draw-oval*` *sheet center-x center-y x-radius y-radius* **`&key (`***filled* **`t)`** *ink clipping-region transformation line-style line-thickness line-unit line-dashes line-cap-shape*

Summary: These functions (structured and spread arguments, respectively) draw a filled or unfilled oval (that is, a "race-track" shape) on the sheet *sheet*. The oval is centered on *center-pt*, or (*center-x*, *center-y*). If *x-radius* or *y-radius* is 0, then a circle is drawn with the specified non-zero radius. Otherwise, a figure is drawn that is a rectangle with dimension *x-radius* by *y-radius*, with the two short sides replaced by a semicircular arc of the appropriate size.

2.3.4 Patterns and Stencils

Patterning creates a bounded rectangular arrangement of designs, like a checkerboard. Drawing a pattern draws a different design in each rectangular cell of the pattern. To create an infinite pattern, apply **`make-rectangular-tile`** to a pattern.

A ***stencil*** is a special kind of pattern that contains only opacities.

make-pattern *Function*

`make-pattern` *array inks*

Summary: Returns a pattern ink that has **`(array-dimension`** *array* **`0)`** cells in the vertical direction and **`(array-dimension`** *array* **`1)`** cells in the horizontal direction. *array* must be a two-dimensional array of non-negative integers less than the length of *inks*. *inks* must be a sequence of designs. The design in cell (*i*, *j*) of the resulting pattern is the *n*th element of *inks*, if *n* is the value of **`(aref`** *array* **`i j)`**. For example, *array* can be a bit-array and *inks* can be a list of two inks, the ink drawn for 0 and the one drawn for 1.

Each cell of a pattern can be regarded as a hole that allows the ink in it to show through. Each cell might have a different ink in it. The portion of the ink that shows through a hole is the portion on the part of the drawing plane where the hole is located. In other words, incorporating an ink into a pattern does not change its alignment to the drawing plane, and does not apply a coordinate transformation to the design. Drawing a pattern collects the pieces of inks that show through all the holes and draws the pieces where the holes lie on the drawing plane. The pattern is completely transparent outside the area defined by the array.

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

Tiling repeats a rectangular portion of a pattern throughout the drawing plane.

make-rectangular-tile *Function*

`make-rectangular-tile` *pattern width height*

Summary: Returns a pattern that, when used as an ink, tiles a rectangular portion of the pattern *pattern* across the entire drawing plane. The resulting pattern repeats with a period of *width* horizontally and *height* vertically. *width* and *height* must both be integers. The portion of *pattern* that appears in each tile is a rectangle whose top-left corner is at (0, 0) and whose bottom-right corner is at (*width*, *height*). The repetition of *pattern* is accomplished by applying a coordinate transformation to shift *pattern* into position for each tile, and then extracting a *width*-by-*height* portion of that pattern.

Applying a coordinate transformation to a rectangular tile does not change the portion of the argument *pattern* that appears in each tile. However, it can change the period, phase, and orientation of the repeated pattern of tiles. This is so that adjacent figures drawn using the same tile have their inks "line up".

draw-pattern* *Function*

`draw-pattern*` *sheet pattern x y* **`&key`** *clipping-region transformation*

Summary: Draws the pattern *pattern* on the sheet *sheet* at the position (*x*, *y*). *pattern* is any pattern created by **`make-pattern`**. *clipping-region* and *transformation* are as for **`with-drawing-options`** or any of the drawing functions.

Note that *transformation* only affects the position at which the pattern is drawn, not the pattern itself. If you want to affect the pattern, you should explicitly call **`transform-region`** on the pattern.

You draw a bitmap by drawing an appropriately aligned and scaled pattern constructed from the bitmap's bits. A 1 in the bitmap corresponds to **`+foreground-ink+`**. A 0 corresponds to **`+background-ink+`** if an opaque drawing operation is desired, or to **`+nowhere+`** if a transparent drawing operation is desired.

Drawing a (colored) raster image consists of drawing an appropriately aligned and scaled pattern constructed from the raster array and raster color map.

`draw-pattern*` could be implemented as follows, assuming that the functions **`pattern-width`** and **`pattern-height`** return the width and height of the pattern.

```
(defun draw-pattern* (sheet pattern x y &key clipping-region
                            transformation)
  (check-type pattern pattern)
  (let ((width (pattern-width pattern))
        (height (pattern-height pattern)))
    (if (or clipping-region transformation)
        (with-drawing-options
         (sheet
          :clipping-region clipping-region
          :transformation transformation)
         (draw-rectangle* sheet x y
                          (+ x width) (+ y height)
                          :filled t :ink pattern))
        (draw-rectangle* sheet x y (+ x width) (+ y height)
                         :filled t :ink pattern))))
```

2.3.5 Pixmaps

A ***pixmap*** can be thought of as an "off-screen window," that is, a medium that can be used for graphical output, but that is not visible on any display device. Pixmaps are provided to allow a programmer to generate a piece of output associated with some display device that can then be rapidly drawn on a real display device. For example, an electrical CAD system might generate a pixmap that corresponds to a complex, frequently-used part in a VLSI schematic, and then use **`copy-from-pixmap`** to draw the part as needed.

The exact representation of a pixmap is explicitly unspecified. There is no interaction between the pixmap operations and output recording; that is, displaying a pixmap on a medium is a pure drawing operation that affects only the display, not the output history. Some mediums may not support pixmaps; in this case, an error will be signaled.

allocate-pixmap *Generic Function*

`allocate-pixmap` *medium width height*

Summary: Allocates and returns a pixmap object that can be used on any medium that shares the same characteristics as *medium*. (What constitutes "shared characteristics" varies from host to host.) *medium* can be a sheet, a medium, or a stream.

The resulting pixmap will be *width* units wide, *height* units high, and as deep as is necessary to store the information for the medium. The exact representation of pixmaps is explicitly unspecified. The returned value is the pixmap.

deallocate-pixmap *Generic Function*

`deallocate-pixmap` *pixmap*

Summary: Deallocates the pixmap *pixmap*.

pixmap-width *Generic Function*

`pixmap-width` *pixmap*

pixmap-height *Generic Function*

`pixmap-height` *pixmap*

pixmap-depth *Generic Function*

`pixmap-depth` *pixmap*

Summary: These functions return, respectively, the programmer-specified width, height, and depth of the pixmap *pixmap*.

copy-to-pixmap *Generic Function*

`copy-to-pixmap` *medium medium-x medium-y width height* **`&optional`** *pixmap* **`(`***pixmap-x* **`0)`** **`(`***pixmap-y* **`0)`**

Summary: Copies the pixels from the medium *medium* starting at the position specified by (*medium-x*, *medium-y*) into the pixmap *pixmap* at the position specified by (*pixmap-x*, *pixmap-y*). A rectangle whose width and height is specified by *width* and *height* is copied. *medium-x* and *medium-y* are specified in user coordinates. (If *medium* is a medium or a stream, then *medium-x* and *medium-y* are transformed by the user transformation.)

If *pixmap* is not supplied, a new pixmap will be allocated. Otherwise, *pixmap* must be an object returned by **`allocate-pixmap`** that has the appropriate characteristics for *medium*.

The returned value is the pixmap.

copy-from-pixmap *Generic Function*

`copy-from-pixmap` *pixmap pixmap-x pixmap-y width height medium window-x window-y*

Summary: Copies the pixels from the pixmap *pixmap* starting at the position specified by (*pixmap-x*, *pixmap-y*) into the medium *medium* at the position (*medium-x*, *medium-y*). A rectangle whose width and height is specified by *width* and *height* is copied. *medium-x* and *medium-y* are specified in user coordinates. (If *medium* is a medium or a stream, then *medium-x* and *medium-y* are transformed by the user transformation.)

pixmap must be an object returned by **`allocate-pixmap`** that has the appropriate characteristics for *medium*.

The returned value is the pixmap. This is intended to specialize on both the *pixmap* and *medium* arguments.

copy-area *Generic Function*

`copy-area` *medium from-x from-y width height to-x to-y*

Summary: Copies the pixels from the medium *medium* starting at the position specified by (*from-x*, *from-y*) to the position (*to-x*, *to-y*) on the same medium. A rectangle whose width and height is specified by *width* and *height* is copied. *from-x*, *from-y*, *to-x*, and *to-y* are specified in user coordinates. (If *medium* is a medium or a stream, then *medium-x* and *medium-y* are transformed by the user transformation.)

with-output-to-pixmap *Macro*

`with-output-to-pixmap (`*medium-var medium* **`&key`** *width height***`) &body`** *body*

Summary: Binds *medium-var* to a "pixmap medium" (that is, a medium that does output to a pixmap with the characteristics appropriate to the medium *medium*) and then evaluates *body* in that context. All the output done to the medium designated by *medium-var* inside of *body* is drawn on the pixmap stream. The pixmap medium supports the medium output protocol, including all of the graphics functions.

width and *height* are integers that give the dimensions of the pixmap. If they are omitted, the pixmap will be large enough to contain all the output done by *body*.

medium-var must be a symbol; it is not evaluated. The returned value is a pixmap that can be drawn onto *medium* using **`copy-from-pixmap`**.

2.4 Graphics Protocols

Every medium implements methods for the various graphical drawing generic functions. Furthermore, every sheet that supports the standard output protocol implements these methods as well; often, the sheet methods will simply call the same methods on the sheet's medium.

2.4.1 Arguments

- All these generic functions take the same arguments as the non-generic spread function equivalents, except that the arguments that are keyword arguments in the non-generic functions are required arguments in the generic functions.
- The drawing-function-specific arguments are either **x** and **y** positions, or a sequence of **x** and **y** positions. Note that these positions will first be transformed by the medium's current transformation, and then transformed a second time by the medium's device transformation in order to produce the coordinates as they will actually appear on the screen.
- The ink, line style (or text style), and clipping regions arguments are optional, and default from the medium, based on **`medium-ink`**, **`medium-line-style`** (or **`medium-current-text-style`**), and **`medium-clipping-region`**, respectively.

2.4.2 General Behavior of Drawing Functions

Using **`draw-line*`** as an example, calling any of the drawing functions specified previously results in the following series of function calls on a non-output recording sheet:

- A program calls **`draw-line*`** on arguments *sheet*, *x1*, *y1*, *x2*, and *y2*, and perhaps some drawing options.
- **`draw-line*`** merges the supplied drawing options into the sheet's medium, and then calls **`medium-draw-line*`** on the sheet. (Note that a compiler macro could detect the case where there are no drawing options or constant drawing options, and do this at compile time.)
- **`medium-draw-line*`** on the sheet calls the same method—**`medium-draw-line*`**—on the medium.
- **`medium-draw-line*`** performs the necessary user transformations by applying the medium transformation to *x1*, *y1*, *x2*, and *y2*, and to the clipping region.

2.4.3 Medium-Specific Drawing Functions

All mediums and all sheets that support the standard output protocol implement methods for the following generic functions.

---

medium-draw-point* *Generic Function*

`medium-draw-point*` *medium x y*

Summary: Draws a point on the medium *medium*.

---

medium-draw-points* *Generic Function*

`medium-draw-points*` *medium coord-seq*

Summary: Draws a set of points on the medium *medium*.

---

medium-draw-line* *Generic Function*

`medium-draw-line*` *medium x1 y1 x2 y2*

Summary: Draws a line from (*x1*, *y1*) to (*x2*, *y2*) on the medium *medium*.

---

medium-draw-lines* *Generic Function*

`medium-draw-lines*` *medium coord-seq*

Summary: Draws a set of disconnected lines on the medium *medium*.

---

medium-draw-polygon* *Generic Function*

`medium-draw-polygon*` *medium coord-seq closed*

Summary: Draws a polygon or polyline on the medium *medium*.

---

medium-draw-rectangle* *Generic Function*

`medium-draw-rectangle*` *medium x1 y1 x2 y2*

Summary: Draws a rectangle whose corners are at (*x1*, *y1*) and (*x2*, *y2*) on *medium*.

---

medium-draw-ellipse* *Generic Function*

`medium-draw-ellipse*` *medium center-x center-y radius-1-dx radius-1-dy radius-2-dx radius-2-dy start-angle end-angle*

Summary: Draws a rectangle on *medium*. The center is at (*center-x*, *center-y*). The vectors (*radius-1-dx*, *radius-1-dy*) and (*radius-2-dx*, *radius-2-dy*) specify the radii. *start-angle* and *end-angle* are real numbers that specify an arc, not a complete ellipse.

medium-draw-text* *Generic Function*

medium-draw-text* *medium text x y* **(***start* **0)** *end* **(***align-x* **:***left***)** **(***align-y* **:***baseline***)** *toward-x toward-y transform-glyphs*

Summary: Draws a character or a string on the medium *medium*. The text is drawn starting at (*x*, *y*), and towards (*toward-x*, *toward-y*).

2.5 General Geometric Objects in CLIM

2.5.1 Regions in CLIM

A ***region*** is an object that denotes a set of points in the plane. Regions include their boundaries; that is, they are closed. Regions have infinite resolution.

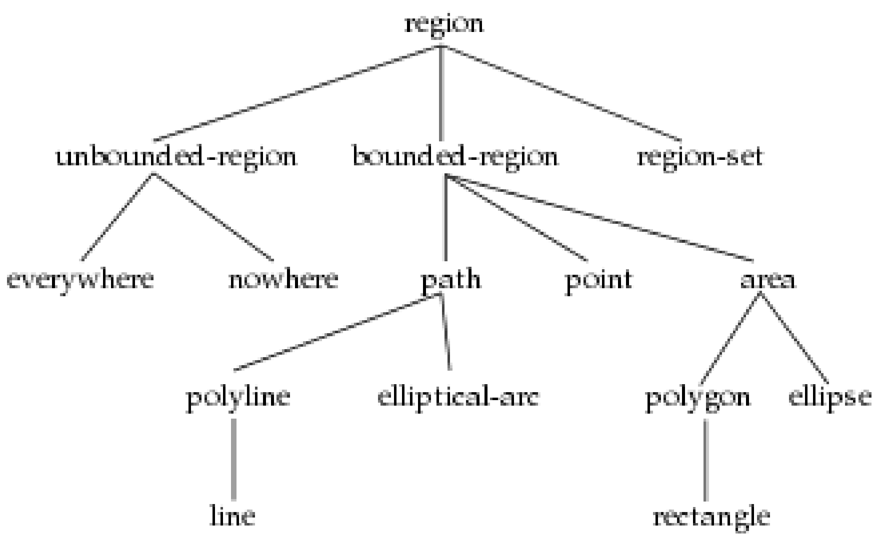
A ***bounded region*** is a region that contains at least one point for which there exists a number, *d*, called the region's diameter, such that if *p1* and *p2* are points in the region, the distance between *p1* and *p2* is always less than or equal to *d*.

An ***unbounded region*** either contains no points or contains points arbitrarily far apart. **+nowhere+** and **+everywhere+** are examples of unbounded regions.

Another way to describe a region is to say that it maps every (*x*, *y*) pair into either true or false (meaning member or not a member, respectively, of the region). Later, in Chapter 5, we will generalize a region to something called an *ink* that maps every point (*x*, *y*) into color and opacity values.

CLIM classifies the various types of regions in the following way. All regions are a subclass of **region**, and all bounded regions are also a subclass of either **point**, **path**, or **area**, as shown in **The Class Structure for All Regions**.

The Class Structure for All Regions



region *Protocol Class*

Summary: The protocol class that corresponds to a set of points. This includes both bounded and unbounded regions. This is a subclass of **ink** (see **5 Drawing in Color** for details).

If you want to create a new class that behaves like a region, it should be a subclass of **region**. Subclasses of **region** must obey the region protocol.

There is no general constructor called **make-region** because of the impossibility of a uniform way to specify the arguments to such a function.

regionp *Function*

regionp *object*

Summary: Returns **t** if *object* is a region; otherwise, it returns **nil**.

path *Protocol Class*

Summary: The protocol class **path** denotes bounded regions that have dimensionality 1 (that is, lines or curves). It is a subclass of **region** and **bounding-rectangle**. If you want to create a new class that behaves like a path, it should be a subclass of **path**. Subclasses of **path** must obey the path protocol.

Constructing a **path** object with no length (via **make-line***, for example) canonicalizes it to **+nowhere+**.

Some rendering models support the constructing of areas by filling a closed path. In this case, the path needs a direction associated with it. Since CLIM does not currently support the path-filling model, paths are directionless.

pathp *Function*

pathp *object*

Summary: Returns **t** if *object* is a path; otherwise, it returns **nil**.

Note that constructing a **path** object with no length (by calling **make-line** with two coincident points, for example) canonicalizes it to **+nowhere+**.

area *Protocol Class*

Summary: The protocol class **area** denotes bounded regions that have dimensionality 2 (that is, are flat surfaces). It is a subclass of **region** and **bounding-rectangle**. If you want to create a new class that behaves like an area, it should be a subclass of **area**. Subclasses of **area** must obey the area protocol.

Note that constructing an **area** object with no area (by calling **make-rectangle** with two coincident points, for example) canonicalizes it to **+nowhere+**.

areap *Function*

areap *object*

Summary: Returns **t** if *object* is an area; otherwise, it returns **nil**.

coordinate *Type*

Summary: The type that represents a coordinate. All of the specific region classes and subclasses of **bounding-rectangle** will use this type to store their coordinates. However, the constructor functions for the region classes and for bounding rectangles accept numbers of any type and coerce them to **coordinate**.

The following two constants represent the regions that correspond, respectively, to all of the points on the drawing plane and to none of the points on the drawing plane.

+everywhere+ *Constant*

Summary: The region that includes all the points on the infinite drawing plane.

+nowhere+ *Constant*

Summary: The empty region (the opposite of **`+everywhere+`**).

2.5.1.1 Region Predicates in CLIM

The following generic functions comprise the region predicate protocol. All classes that are subclasses of **`region`** must either inherit or implement methods for these generic functions.

The methods for **`region-equal`**, **`region-contains-region-p`**, and **`region-intersects-region-p`** will typically specialize both the *region1* and *region2* arguments.

region-equal *Generic Function*

`region-equal` *region1 region2*

Summary: Returns **`t`** if the two regions *region1* and *region2* contain exactly the same set of points; otherwise, it returns **`nil`**.

region-contains-region-p *Generic Function*

`region-contains-region-p` *region1 region2*

Summary: Returns **`t`** if all points in the region *region2* are members of the region *region1*; otherwise, it returns **`nil`**.

region-contains-position-p *Generic Function*

`region-contains-position-p` *region x y*

Summary: Returns **`t`** if the point at (*x*, *y*) is contained in the region *region*; otherwise, it returns **`nil`**. Since regions in CLIM are closed, this must return **`t`** if the point at (*x*, *y*) is on the region's boundary.

`region-contains-position-p` is a special case of **`region-contains-region-p`** in which the region is the point (*x*, *y*).

region-intersects-region-p *Generic Function*

`region-intersects-region-p` *region1 region2*

Summary: Returns **`nil`** if **`region-intersection`** of the two regions *region1* and *region2* would be **`+nowhere+`**; otherwise, it returns **`t`**.

2.5.1.2 Composition of CLIM Regions

Region composition in CLIM is the process in which two regions are combined in some way (such as union or intersection) to produce a third region.

Since all regions in CLIM are closed, region composition is not always equivalent to simple set operations. Instead, composition attempts to return an object that has the same dimensionality as one of its arguments. If this is not possible, then the result is defined to be an empty region, which is canonicalized to **`+nowhere+`**. (The exact details of this are specified with each function.)

Sometimes composition of regions can produce a result that is not a simple contiguous region. For example, **`region-union`** of two rectangular regions might not be rectangular. In order to support cases like this, CLIM has the concept of a ***region set***, an object that represents one or more region objects related by some region operation, usually a union.

region-set *Protocol Class*

Summary: The protocol class that represents a region set; a subclass of **`region`** and **`bounding-rectangle`**.

Members of this class are immutable.

region-set-p *Function*

`region-set-p` *object*

Summary: Returns **`t`** if *object* is a region set; otherwise, it returns **`nil`**.

standard-rectangle-set *Class*

Summary: This instantiable subclass of **`region-set`** and **`bounding-rectangle`** represents the union of several axis-aligned rectangles.

standard-region-union

standard-region-intersection

standard-region-difference *Classes*

Summary: These three instantiable classes respectively implement the union, intersection, and differences of regions.

Region sets that are composed entirely of axis-aligned rectangles must be canonicalized into either a single rectangle or a union of rectangles. Furthermore, the rectangles in the union must not overlap each other.

The following generic functions comprise the region composition protocol. All classes that are subclasses of **`region`** must implement methods for these generic functions.

The methods for **`region-union`**, **`region-intersection`**, and **`region-difference`** will typically specialize both the *region1* and *region2* arguments.

region-set-regions *Generic Function*

`region-set-regions` *region* **`&key`** *normalize*

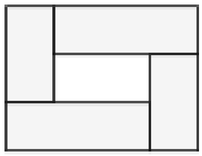
Summary: Returns a sequence of the regions in the region set *region*. *region* can be either a region set or a "simple" region, in which case the result is simply a sequence of one element: *region*.

Note: This function returns objects that reveal CLIM's internal state; do not modify these objects.

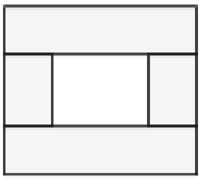
For the case of region sets that are unions of axis-aligned rectangles, the rectangles returned by **`region-set-regions`** are guaranteed not to overlap.

If *normalize* is supplied, it must be either **`:x-banding`** or **`:y-banding`**. If it is **`:x-banding`** and all the regions in *region* are axis-aligned rectangles, the result is normalized by merging adjacent rectangles with banding done in the **`x`** direction. If it is **`:y-banding`** and all the regions in *region* are rectangles, the result is normalized with banding done in the **`y`** direction. Normalizing a region set that is not composed entirely of axis-aligned rectangles using x- or y-banding causes CLIM to signal the **`region-set-not-rectangular`** error.

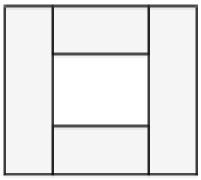
Normalization of Rectangular Region Sets



A Region Consisting of Four Rectangles



After Normalizing with X-Banding



After Normalizing with Y-Banding

map-over-region-set-regions *Generic Function*

`map-over-region-set-regions` *function region* **`&key`** *normalize*

Summary: Calls *function* on each region in the region set *region*. This is often more efficient than calling **`region-set-regions`**. *function* is a function of one argument, a region; it has dynamic extent. *region* can be either a region set or a "simple" region, in which case *function* is called once on *region* itself. *normalize* is as for **`region-set-regions`**.

region-union *Generic Function*

`region-union` *region1 region2*

Summary: Returns a region that contains all points that are in either of the regions *region1* or *region2* (possibly with some points removed in order to satisfy the dimensionality rule). The result of **`region-union`** always has dimensionality that is the maximum dimensionality of *region1* and *region2*. For example, the union of a path and an area produces an area; the union of two paths is a path.

`region-union` will return either a simple region or a member of the class **`standard-region-union`**.

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

region-intersection *Generic Function*

`region-intersection` *region1 region2*

Summary: Returns a region that contains all points that are in both of the regions *region1* and *region2* (possibly with some points removed in order to satisfy the dimensionality rule). The result of **`region-intersection`** has dimensionality that is the minimum dimensionality of *region1* and *region2*, or is **`+nowhere+`**. For example, the intersection of two areas is either another area or **`+nowhere+`**; the intersection of two paths is either another path or **`+nowhere+`**; the intersection of a path and an area produces the path clipped to stay inside of the area.

`region-intersection` will return either a simple region or a member of the class **`standard-region-intersection`**.

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

region-difference

Generic Function

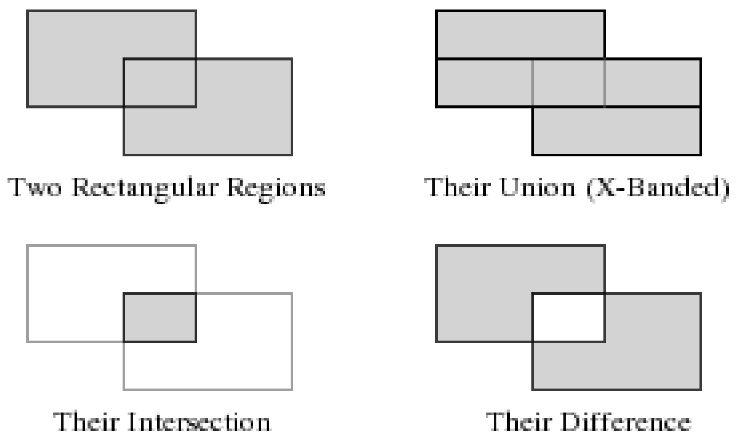
region-difference *region1 region2*

Summary: Returns a region that contains all points in the region *region1* that are not in the region *region2* (possibly plus additional boundary points to make the result closed). The result of **region-difference** has the same dimensionality as *region1*, or is **+nowhere+**. For example, the difference of an area and a path produces the same area; the difference of a path and an area produces the path clipped to stay outside of the area.

region-difference will return either a simple region, a region set, or a member of the class **standard-region-difference**.

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

Examples of Region Union, Intersection, and Difference



2.5.2 CLIM Point Objects

A ***point*** is a mathematical point in the drawing plane that is identified by its coordinates, a pair of real numbers. Points have neither area nor length. Note that a point is not the same thing as a pixel; CLIM's model of the drawing plane has continuous coordinates.

You can create point objects and use them as arguments to the drawing functions. Alternatively, you can use the ***spread*** versions of the drawing functions, that is, the drawing functions with stars appended to their names. For example, instead of **draw-point**, use **draw-point***, which takes two arguments specifying a point by its coordinates. (Note that, for performance reasons, we generally recommend the use of the spread versions.)

The operations for creating and dealing with points are:

point

Protocol Class

Summary: The protocol class that corresponds to a mathematical point. This is a subclass of **region** and **bounding-rectangle**. If you want to create a new class that behaves like a point, it should be a subclass of **point**. Subclasses of **point** obey the point protocol.

pointp

Function

pointp *object*

Summary: Returns **t** if *object* is a point; otherwise, it returns **nil**.

standard-point *Class*

Summary: An instantiable class that implements a point. This is a subclass of **`point`**. This is the class that **`make-point`** instantiates. Members of this class are immutable.

make-point *Function*

`make-point` *x y*

Summary: Returns an object of class **`standard-point`** whose coordinates are *x* and *y*. *x* and *y* must be real numbers.

The following generic functions comprise the point Application Programmer Interface. Only **`point-position`** is in the point protocol; that is, all classes that are subclasses of **`point`** must implement methods for **`point-position`**, but need not implement methods for **`point-x`** and **`point-y`**.

point-position *Generic Function*

`point-position` *point*

Summary: Returns both the *x* and *y* coordinates of the point *point* as two values.

point-x *Generic Function*

`point-x` *point*

point-y *Generic Function*

`point-y` *point*

Summary: Returns the *x* or *y* coordinate of the point *point*, respectively. CLIM will supply default methods for **`point-x`** and **`point-y`** on the protocol class **`point`** that are implemented by calling **`point-position`**.

2.5.3 Polygons and Polylines in CLIM

A ***polyline*** is a path that consists of one or more line segments joined consecutively at their end-points. A ***line*** is a polyline that has only one segment.

Polylines that have the end-point of their last line segment coincident with the start-point of their first line segment are called ***closed***; this use of the term "closed" should not be confused with closed sets of points.

A ***polygon*** is an area bounded by a closed polyline.

If the boundary of a polygon intersects itself, the odd-even winding-rule defines the polygon: a point is inside the polygon if a ray from the point to infinity crosses the boundary an odd number of times.

Polylines and polygons are closed under affine transformations.

The classes that correspond to polylines and polygons are:

polyline *Protocol Class*

Summary: The protocol class that corresponds to a polyline. It is a subclass of **`path`**. If you want to create a new class that behaves like a polyline, it should be a subclass of **`polyline`**. Subclasses of **`polyline`** must obey the polyline protocol.

polylinep *Function*

`polylinep` *object*

Summary: Returns **t** if *object* is a polyline; otherwise, it returns **nil**.

polygon *Class*

Summary: The protocol class (a subclass of **area**) that corresponds to a mathematical polygon. If you want to create a new class that behaves like a polygon, it should be a subclass of **polygon**. Subclasses of **polygon** must obey the polygon protocol.

polygonp *Function*

polygonp *object*

Summary: Returns **t** if *object* is a polygon; otherwise, it returns **nil**.

standard-polyline *Class*

Summary: A class that implements a polyline. This is a subclass of **polyline**. This is the class that **make-polyline** and **make-polyline*** instantiate. Members of this class are immutable.

standard-polygon *Class*

Summary: A class that implements a polygon. This is a subclass of **polygon**. This is the class that **make-polygon** and **make-polygon*** instantiate. Members of this class are immutable.

2.5.3.1 Constructors for CLIM Polygons and Polylines

The following functions can be used to create polylines and polygons:

make-polyline *Function*

make-polyline *point-seq* **&key** *closed*

make-polyline* *Function*

make-polyline* *coord-seq* **&key** *closed*

Summary: Returns an object of class **standard-polyline** consisting of the segments connecting each of the points in *point-seq* (or the points represented by the coordinate pairs in *coord-seq*).

If *closed* is **t**, then the segment connecting the first point and the last point is included in the polyline. The default for *closed* is **nil**.

These functions capture their mutable inputs; the consequences of modifying those objects are unspecified.

make-polygon *Function*

make-polygon *point-seq*

make-polygon* *Function*

make-polygon* *coord-seq*

Summary: Returns an object of class **standard-polygon** consisting of the area contained in the boundary that is specified by the segments connecting each of the points in *point-seq* (or the points represented by the coordinate pairs in *coord-seq*).

These functions capture their mutable inputs; the consequences of modifying those objects are unspecified.

2.5.3.2 Accessors for CLIM Polygons and Polylines

The following generic functions comprise the polygon and polyline protocol. All classes that are subclasses of **polygon** or **polyline** must implement methods for them. Some of the functions take an argument *polygon-or-polyline*, which may be a polygon or a polyline.

polygon-points *Generic Function*

polygon-points *polygon-or-polyline*

> *Summary:* Returns a sequence of points that specify the segments in *polygon-or-polyline*. This function returns objects that reveal CLIM's internal state; do not modify those objects.

map-over-polygon-coordinates *Generic Function*

map-over-polygon-coordinates *function polygon-or-polyline*

> *Summary:* Applies *function* to all of the coordinates of the vertices of *polygon-or-polyline*. *function* is a function of two arguments, the *x* and *y* coordinates of the vertex; it has dynamic extent.

map-over-polygon-segments *Generic Function*

map-over-polygon-segments *function polygon-or-polyline*

> *Summary:* Applies *function* to the segments that compose *polygon-or-polyline*. *function* is a function of four arguments, the *x* and *y* coordinates of the start of the segment, and the *x* and *y* coordinates of the end of the segment; it has dynamic extent. When **map-over-polygon-segments** is called on a closed polyline, it will call *function* on the segment that connects the last point back to the first point.

polyline-closed *Generic Function*

polyline-closed *polyline*

> *Summary:* Returns **t** if the polyline *polyline* is closed; otherwise, it returns **nil**.

2.5.4 Lines in CLIM

A line is a special case of a polyline having only one segment. The functions for making and dealing with lines are the following:

line *Protocol Class*

> *Summary:* The protocol class that corresponds to a mathematical line segment, that is, a polyline with only a single segment. This is a subclass of **polyline**. If you want to create a new class that behaves like a line, it should be a subclass of **line**. Subclasses of **line** must obey the line protocol.

linep *Function*

linep *object*

> *Summary:* Returns **t** if *object* is a line; otherwise, it returns **nil**.

standard-line *Class*

> *Summary:* An instantiable class that implements a line segment. This is a subclass of **line**. This is the class that **make-line** and **make-line*** instantiate. Members of this class are immutable.

make-line *Function*

`make-line` *start-point end-point*

make-line* *Function*

`make-line*` *start-x start-y end-x end-y*

Summary: Returns an object of class **`standard-line`** that connects the two points *start-point* and *end-point*, or the positions (*start-x*, *start-y*) and (*end-x*, *end-y*).

These functions capture their mutable inputs; the consequences of modifying those objects are unspecified.

The following generic functions comprise the line Application Programmer Interface. Only **`line-start-point*`** and **`line-end-point*`** are in the line protocol; that is, all classes that are subclasses of **`line`** must implement methods for **`line-start-point*`** and **`line-end-point*`**, but need not implement methods for **`line-start-point`** and **`line-end-point`**.

line-start-point* *Generic Function*

`line-start-point*` *line*

line-end-point* *Generic Function*

`line-end-point*` *line*

Summary: Returns the starting or ending point, respectively, of the line *line* as two real numbers representing the coordinates of the point.

line-start-point *Generic Function*

`line-start-point` *line*

line-end-point *Generic Function*

`line-end-point` *line*

Summary: Returns the starting or ending point of the line *line*, respectively.

CLIM will supply default methods for **`line-start-point`** and **`line-end-point`** on the protocol class **`line`** that are implemented by calling **`line-start-point*`** and **`line-end-point*`**.

2.5.5 Rectangles in CLIM

A ***rectangle*** is a special case of a four-sided polygon whose edges are parallel to the coordinate axes. A rectangle can be specified completely by four real numbers (**min-x**, **min-y, max-x, max-y**). They are not closed under affine transformations, although they are closed under rectilinear transformations. CLIM uses rectangles extensively for various purposes, particularly in optimizations.

The functions for creating and dealing with rectangles are the following:

rectangle *Protocol Class*

Summary: The protocol class that corresponds to a mathematical rectangle, that is, a rectangular polygons whose sides are parallel to the coordinate axes. This is a subclass of **`polygon`**. If you want to create a new class that behaves like a rectangle, it should be a subclass of **`rectangle`**. Subclasses of **`rectangle`** must obey the rectangle protocol.

rectanglep *Function*

rectanglep *object*

Summary: Returns **t** if *object* is a rectangle; otherwise, it returns **nil**.

standard-rectangle *Class*

Summary: An instantiable class that implements an axis-aligned rectangle. This is a subclass of **rectangle**. This is the class that **make-rectangle** and **make-rectangle*** instantiate. Members of this class are immutable.

make-rectangle *Function*

make-rectangle *point1 point2*

make-rectangle* *Function*

make-rectangle* *x1 y1 x2 y2*

Summary: Returns an object of class **standard-rectangle** whose edges are parallel to the coordinate axes. One corner is at the point *point1*, or the position (*x1*, *y1*), and the opposite corner is at the point *point2*, or the position (*x2*, *y2*). There are no ordering constraints among *point1* and *point2* (or *x1* and *x2*, and *y1* and *y2*).

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

The following generic functions comprise the rectangle Application Programmer Interface. Only **rectangle-edges*** is in the rectangle protocol; that is, all classes that are subclasses of **rectangle** must implement methods for **rectangle-edges***, but need not implement methods for the remaining functions.

rectangle-edges* *Generic Function*

rectangle-edges* *rectangle*

Summary: Returns the coordinates of the minimum *x* and *y* and maximum *x* and *y* of the rectangle *rectangle* as four values, *min-x*, *min-y*, *max-x*, and *max-y*.

rectangle-min-point *Generic Function*

rectangle-min-point *rectangle*

rectangle-max-point *Generic Function*

rectangle-max-point *rectangle*

Summary: Returns the min point and max point of the rectangle *rectangle*, respectively. The position of a rectangle is specified by its min point.

CLIM supplies default methods for **rectangle-min-point** and **rectangle-max-point** on the protocol class **rectangle** that are implemented by calling **rectangle-edges***.

rectangle-min-x *Generic Function*

rectangle-min-x *rectangle*

rectangle-min-y *Generic Function*

rectangle-min-y *rectangle*

rectangle-max-x *Generic Function*

`rectangle-max-x` *rectangle*

rectangle-max-y *Generic Function*

`rectangle-max-y` *rectangle*

> *Summary:* Returns (respectively) the minimum *x* and *y* coordinate and maximum *x* and *y* coordinate of the rectangle *rectangle*.

CLIM supplies default methods for these four generic functions on the protocol class **`rectangle`** that are implemented by calling **`rectangle-edges*`**.

rectangle-width *Generic Function*

`rectangle-width` *rectangle*

rectangle-height *Generic Function*

`rectangle-height` *rectangle*

rectangle-size *Generic Function*

`rectangle-size` *rectangle*

> *Summary:* **`rectangle-width`** returns the width of the rectangle *rectangle*, which is the difference between its maximum and minimum *x* values. **`rectangle-height`** returns the height, which is the difference between its maximum and minimum *y* values. **`rectangle-size`** returns two values, the width and the height.

CLIM supplies default methods for these four generic functions on the protocol class **`rectangle`** that are implemented by calling **`rectangle-edges*`**.

2.5.6 Ellipses and Elliptical Arcs in CLIM

An ***ellipse*** is an area that is the outline and interior of an ellipse. Circles are special cases of ellipses.

An ***elliptical arc*** is a path consisting of all or a portion of the outline of an ellipse. ***Circular arcs*** are special cases of elliptical arcs.

An ellipse is specified in a manner that is easy to transform, and treats all ellipses on an equal basis. An ellipse is specified by its center point and two vectors that describe a bounding parallelogram of the ellipse. The bounding parallelogram is made by adding and subtracting the vectors from the center point in the following manner:

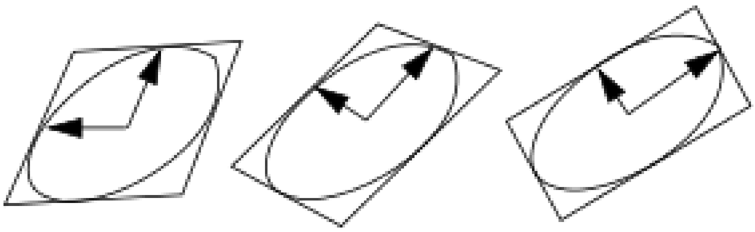
Bounding Parallelogram of an Ellipse

	x coordinate	**y** coordinate
Center of Ellipse	$\mathbf{x}_c$	$\mathbf{y}_c$
Vectors	$\mathbf{dx}_1$ $\mathbf{dx}_2$	$\mathbf{dy}_1$ $\mathbf{dy}_2$
Corners of Parallelogram	$\mathbf{x}_c + \mathbf{dx}_1 + \mathbf{dx}_2$ $\mathbf{x}_c + \mathbf{dx}_1 - \mathbf{dx}_2$ $\mathbf{x}_c - \mathbf{dx}_1 - \mathbf{dx}_2$ $\mathbf{x}_c - \mathbf{dx}_1 + \mathbf{dx}_2$	$\mathbf{y}_c + \mathbf{dy}_1 + \mathbf{dy}_2$ $\mathbf{y}_c + \mathbf{dy}_1 - \mathbf{dy}_2$ $\mathbf{y}_c - \mathbf{dy}_1 - \mathbf{dy}_2$ $\mathbf{y}_c - \mathbf{dy}_1 + \mathbf{dy}_2$

The special case of an ellipse with its axes aligned with the coordinate axes can be obtained by setting $\mathbf{dx}_2$ and $\mathbf{dy}_1$ to 0, or setting $\mathbf{dx}_1$ and $\mathbf{dy}_2$ to 0.

Note that several different parallelograms specify the same ellipse, as shown here:

Ellipses Specified by Parallelograms



One parallelogram is bound to be a rectangle—the vectors will be perpendicular and correspond to the semi-axes of the ellipse.

The following classes and functions are used to represent and operate on ellipses and elliptical arcs.

ellipse *Protocol Class*

Summary: The protocol class that corresponds to a mathematical ellipse. This is a subclass of **`area`**. If you want to create a new class that behaves like an ellipse, it should be a subclass of **`ellipse`**. Subclasses of **`ellipse`** must obey the ellipse protocol.

ellipsep *Function*

`ellipsep` *object*

Summary: Returns **`t`** if *object* is an ellipse; otherwise, it returns **`nil`**.

standard-ellipse *Class*

Summary: An instantiable class that implements an ellipse. This is a subclass of **`ellipse`**. This is the class that **`make-ellipse`** and **`make-ellipse*`** instantiate. Members of this class are immutable.

elliptical-arc *Protocol Class*

Summary: The protocol class that corresponds to a mathematical elliptical arc. This is a subclass of **`path`**. If you want to create a new class that behaves like an elliptical arc, it should be a subclass of **`elliptical-arc`**. Subclasses of **`elliptical-arc`** must obey the elliptical arc protocol.

elliptical-arc-p *Function*

`elliptical-arc-p` *object*

Summary: Returns **`t`** if *object* is an elliptical arc; otherwise, it returns **`nil`**.

standard-elliptical-arc *Class*

Summary: An instantiable class that implements an elliptical arc. This is a subclass of **`elliptical-arc`**. This is the class that **`make-elliptical-arc`** and **`make-elliptical-arc*`** instantiate. Members of this class are immutable.

2.5.6.1 Constructor Functions for Ellipses and Elliptical Arcs in CLIM

make-ellipse *Function*

`make-ellipse` *center-point radius-1-dx radius-1-dy radius-2-dx radius-2-dy* **`&key`** *start-angle end-angle*

make-ellipse* *Function*

`make-ellipse*` *center-x center-y radius-1-dx radius-1-dy radius-2-dx radius-2-dy* **`&key`** *start-angle end-angle*

Summary: Returns an object of class **`standard-ellipse`**. The center of the ellipse is at the point *center-point*, or the position (*center-x*, *center-y*).

Two vectors, (*radius-1-dx*, *radius-1-dy*) and (*radius-2-dx*, *radius-2-dy*) specify the bounding parallelogram of the ellipse as explained previously. All of the radii are real numbers. If the two vectors are collinear, the ellipse is not well-defined and the **`ellipse-not-well-defined`** error will be signaled. The special case of an ellipse with its axes aligned with the coordinate axes can be obtained by setting both *radius-1-dy* and *radius-2-dx* to 0.

If *start-angle* or *end-angle* are supplied, the ellipse is the "pie slice" area swept out by a line from the center of the ellipse to a point on the boundary as the boundary point moves from the angle *start-angle* to *end-angle*. Angles are measured counter-clockwise with respect to the positive **x** axis. If *end-angle* is supplied, the default for *start-angle* is 0; if *start-angle* is supplied, the default for *end-angle* is 2π; if neither is supplied, then the region is a full ellipse and the angles are meaningless.

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

make-elliptical-arc *Function*

`make-elliptical-arc` *center-point radius-1-dx radius-1-dy radius-2-dx radius-2-dy* **`&key`** *start-angle end-angle*

make-elliptical-arc* *Function*

`make-elliptical-arc*` *center-x center-y radius-1-dx radius-1-dy radius-2-dx radius-2-dy* **`&key`** *start-angle end-angle*

Summary: Returns an object of class **`standard-elliptical-arc`**. The center of the ellipse is at the point *center-point*, or the position (*center-x*, *center-y*).

Two vectors, (*radius-1-dx*, *radius-1-dy*) and (*radius-2-dx*, *radius-2-dy*), specify the bounding parallelogram of the ellipse as explained previously. All of the radii are real numbers. If the two vectors are collinear, the ellipse is not well-defined and the **`ellipse-not-well-defined`** error will be signaled. The special case of an elliptical arc with its axes aligned with the coordinate axes can be obtained by setting both *radius-1-dy* and *radius-2-dx* to 0.

If *start-angle* and *start-angle* are supplied, the arc is swept from *start-angle* to *end-angle*. Angles are measured counter-clockwise with respect to the positive **x** axis. If *end-angle* is supplied, the default for *start-angle* is 0; if *start-angle* is supplied, the default for *end-angle* is 2π; if neither is supplied, then the region is a closed elliptical path and the angles are meaningless.

This function captures its mutable inputs; the consequences of modifying those objects are unspecified.

2.5.6.2 Accessors for CLIM Elliptical Objects

The following functions apply to both ellipses and elliptical arcs. In all cases, the name *elliptical-object* means that the argument may be an ellipse or an elliptical arc. These generic functions comprise the ellipse protocol. All classes that are subclasses of either **`ellipse`** or **`elliptical-arc`** must implement methods for these functions.

ellipse-center-point* *Generic Function*

`ellipse-center-point*` *elliptical-object*

Summary: Returns the center point of *elliptical-object* as two values representing the coordinate pair.

ellipse-center-point *Generic Function*

`ellipse-center-point` *elliptical-object*

Summary: Returns the center point of *elliptical-object*.

`ellipse-center-point` is part of the ellipse Application Programmer Interface, but not part of the ellipse protocol. CLIM will supply default methods for **`ellipse-center-point`** on the protocol classes **`ellipse`** and **`elliptical-arc`** that are implemented by calling **`ellipse-center-point*`**.

ellipse-radii *Generic Function*

`ellipse-radii` *elliptical-object*

Summary: Returns four values corresponding to the two radius vectors of *elliptical-arc*. These values may be canonicalized in some way, and so may not be the same as the values passed to the constructor function.

ellipse-start-angle *Generic Function*

`ellipse-start-angle` *elliptical-object*

Summary: Returns the start angle of *elliptical-object*. If *elliptical-object* is a full ellipse or closed path, then **`ellipse-start-angle`** will return **`nil`**; otherwise the value will be a number greater than or equal to zero, and less than 2π.

ellipse-end-angle *Generic Function*

`ellipse-end-angle` *elliptical-object*

Summary: Returns the end angle of *elliptical-object*. If *elliptical-object* is a full ellipse or closed path, then **`ellipse-end-angle`** will return **`nil`**; otherwise the value will be a number greater than zero, and less than or equal to 2π.

2.5.7 Bounding Rectangles

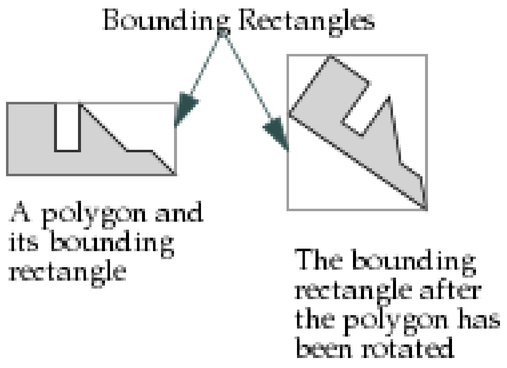
Every bounded region in CLIM has a ***derived bounding rectangle***, which is the smallest rectangle that contains every point in the region and which may contain additional points as well. Unbounded regions do not have any bounding rectangle. For example, all windows and output records have bounding rectangles whose coordinates are relative to the bounding rectangle of the parent of the window or output record.

The coordinate system in which the bounding rectangle is maintained depends on the context. For example, the coordinates of the bounding rectangle of a sheet are expressed in the sheet's parent's coordinate system. For output records, the coordinates of the bounding rectangle are maintained in the coordinate system of the stream with which the output record is associated.

Note that the bounding rectangle of a transformed region is not in general the same as the result of transforming the bounding rectangle of a region, as shown in **The Bounding Rectangle of an Output Record**. For transformations that satisfy **`rectilinear-transformation-p`**, the following equality holds. For all other transformations, it does not hold.

```
(region-equal
 (transform-region transformation
                   (bounding-rectangle region))
 (bounding-rectangle (transform-region
                      transformation region)))
```

The Bounding Rectangle of an Output Record



CLIM uses bounding rectangles for a variety of purposes. For example, repainting of windows is driven from the bounding rectangle of the window's viewport, intersected with a "damage" region. The formatting engines used by **`formatting-table`** and **`formatting-graph`** operate on the bounding rectangles of the output records in the output. Bounding rectangles are also used internally by CLIM to achieve greater efficiency. For instance, when performing hit detection to see if the pointer is within the region of an output record, CLIM first checks to see if the pointer is within the bounding rectangle of the output record.

Note that the bounding rectangle for an output record may have a different size depending on the medium on which the output record is rendered. Consider the case of rendering text on different output devices; the font chosen for a particular text style may vary considerably in size from one device to another.

bounding-rectangle *Protocol Class*

Summary: The protocol class that represents a bounding rectangle. If you want to create a new class that behaves like a bounding rectangle, it should be a subclass of **`bounding-rectangle`**. Subclasses of **`bounding-rectangle`** must obey the bounding rectangle protocol.

Note that bounding rectangles are not a subclass of **`rectangle`**, nor even a subclass of **`region`**. This is because, in general, bounding rectangles do not obey the region protocols. However, all bounded regions and sheets that obey the bounding rectangle protocol are subclasses of **`bounding-rectangle`**.

Bounding rectangles are immutable, but since they reflect the live state of such mutable objects as sheets and output records, bounding rectangles are volatile. Therefore, programmers must not depend on the bounding rectangle associated with a mutable object remaining constant.

bounding-rectangle-p *Function*

`bounding-rectangle-p` *object*

Summary: Returns **`t`** if *object* is a bounding rectangle (that is, supports the bounding rectangle protocol); otherwise, it returns **`nil`**.

standard-bounding-rectangle *Class*

Summary: An instantiable class that implements a bounding rectangle. This is a subclass of both **`bounding-rectangle`** and **`rectangle`**; that is, standard bounding rectangles obey the rectangle protocol.

`make-bounding-rectangle` returns an object of this class.

The representation of bounding rectangles in CLIM is chosen to be efficient. CLIM represents such rectangles by storing the coordinates of two opposing corners of the rectangle, namely, the "min point" and the "max point." Because this representation is not sufficient to represent the result of arbitrary transformations of arbitrary rectangles, CLIM returns a polygon as the result of such a transformation. (The most general class of transformations that is guaranteed to always turn a rectangle into another rectangle is the class of transformations that satisfy **`rectilinear-transformation-p`**.)

make-bounding-rectangle *Function*

`make-bounding-rectangle` *x1 y1 x2 y2*

Summary: Returns an object of the class **`standard-bounding-rectangle`** with the edges specified by *x1*, *y1*, *x2*, and *y2*, which must be real numbers.

x1, *y1*, *x2*, and *y2* are "canonicalized" in the following way. The min point of the rectangle has an **x** coordinate that is the smaller of *x1* and *x2* and a **y** coordinate that is the smaller of *y1* and *y2*. The max point of the rectangle has an **x** coordinate that is the larger of *x1* and *x2* and a **y** coordinate that is the larger of *y1* and *y2*. (Therefore, in a right-handed coordinate system the canonicalized values of *x1*, *y1*, *x2*, and *y2* correspond to the left, top, right, and bottom edges of the rectangle, respectively.)

This function returns fresh objects that may be modified.

2.5.7.1 The Bounding Rectangle Protocol

The following generic functions comprise the bounding rectangle protocol. All classes that participate in this protocol (including all subclasses of **`region`** that are bounded regions) implement a method for **`bounding-rectangle*`**.

These functions take the argument *region*, which must be either a bounded region (such as a line or an ellipse) or some other object that obeys the bounding rectangle protocol, such as a sheet or an output record.

bounding-rectangle* *Generic Function*

`bounding-rectangle*` *region*

Summary: Returns the bounding rectangle of *region* as four real numbers specifying the **x** and **y** coordinates of the min point and the **x** and **y** coordinates of the max point of the rectangle.

The four returned values *min-x*, *min-y*, *max-x*, and *max-y* satisfy the inequalities:

min-x ≤ *max-x*
min-y ≤ *max-y*

bounding-rectangle *Generic Function*

`bounding-rectangle` *region*

Summary: Returns the bounding rectangle of *region* as an object that is a subclass of **`rectangle`** (described in **2.5.5 Rectangles in CLIM**). Since bounding rectangles are volatile, programmers should not depend on the object returned by **`bounding-rectangle`** remaining constant.

`bounding-rectangle` is part of the bounding rectangle Application Programmer Interface, but is not part of the bounding rectangle protocol. CLIM supplies a default method for **`bounding-rectangle`** on the protocol class **`bounding-rectangle`** that calls **`bounding-rectangle*`**.

2.5.7.2 Bounding Rectangle Convenience Functions

The following functions are part of the bounding rectangle Application Programmer Interface, but are not part of the bounding rectangle protocol. They are provided as a convenience to programmers who wish to specialize classes that participate in the bounding rectangle protocol, but they will not complicate the task of those programmers who define their own types (such as sheet classes) that participate in this protocol.

CLIM supplies default methods for all of these generic functions on the protocol class **`bounding-rectangle`** that are implemented by calling **`bounding-rectangle*`**.

with-bounding-rectangle* *Macro*

`with-bounding-rectangle* (`*min-x min-y max-x max-y***`)`** *region* **`&body`** *body*

Summary: Binds *min-x*, *min-y*, *max-x*, and *max-y* to the edges of the bounding rectangle of *region*, and then executes *body* in that context. The argument *region* must be either a bounded region (such as a line or an ellipse) or some other object that obeys the bounding rectangle protocol, such as a sheet or an output record.

The arguments *min-x*, *min-y*, *max-x*, and *max-y* are not evaluated. *body* may have zero or more declarations as its first forms.

`with-bounding-rectangle*` calls **`bounding-rectangle*`**.

bounding-rectangle-position *Generic Function*

`bounding-rectangle-position` *region*

Summary: Returns the position of the bounding rectangle of *region*. The position of a bounding rectangle is specified by its min point.

bounding-rectangle-min-x *Generic Function*

`bounding-rectangle-min-x` *region*

bounding-rectangle-min-y *Generic Function*

`bounding-rectangle-min-y` *region*

bounding-rectangle-max-x *Generic Function*

`bounding-rectangle-max-x` *region*

bounding-rectangle-max-y *Generic Function*

`bounding-rectangle-max-y` *region*

Summary: Returns (respectively) the **x** and **y** coordinates of the min point and the **x** and **y** coordinates of the max point of the bounding rectangle of *region*. The argument *region* must be either a bounded region or some other object that obeys the bounding rectangle protocol.

bounding-rectangle-width *Generic Function*

`bounding-rectangle-width` *region*

bounding-rectangle-height *Generic Function*

`bounding-rectangle-height` *region*

bounding-rectangle-size *Generic Function*

`bounding-rectangle-size` *region*

Summary: Returns the width, height, or size (as two values, the width and height) of the bounding rectangle of *region*, respectively. *region* must be either a bounded region or some other object that obeys the bounding rectangle protocol.

The width of a bounding rectangle is the difference between its maximum **x** coordinate and its minimum **x** coordinate. The height is the difference between the maximum **y** coordinate and its minimum **y** coordinate.

2.6 Drawing with LispWorks Graphics Ports

You can use Graphics Ports drawing in your CLIM application with the functions and macros described in this section. For more information about LispWorks Graphics Ports, see the *CAPI User Guide and Reference Manual*.

2.6.1 Arguments

- *gp-port* is a symbol (not evaluated).
- *sheet* is a CLIM sheet.
- *x*, *y*, *width*, *height* are each integers or **`nil`**.
- *to-x*, *to-y*, *to-width*, *to-height*, *from-x*, *from-y*, *from-width*, *from-height* are each integers or **`nil`**.
- *background* is a graphics ports color specifier.
- *body* is an implicit progn.
- *gp-drawing-func* is a function that takes one argument, a *gp-port*.
- *pixmap* is a graphics port pixmap.
- *image* is a graphics ports BMP image.

2.6.2 API for Drawing with Graphics Ports (deprecated)

with-gp-drawing-to-sheet *Macro*

`with-gp-drawing-to-sheet (`*gp-port sheet* **`&key`** *x y width height background***`) &body`** *body*

perform-gp-drawing *Function*

`perform-gp-drawing` *sheet gp-drawing-func* **`&key`** *x y width height background*

Summary: Binds *gp-port* to a graphics port, executes the *body*, and then copies the drawing on the port to the screen. *x* and *y* specify the position in the *sheet* to which the contents of the port are copied. They both default to 0. *width* and *height* specify the dimensions of the port. *width* defaults to the width of the *sheet* minus *x*, and *height* defaults to the height of the *sheet* minus *y*. *background* specifies the background of the port. It is a graphics port color specification, rather than a CLIM ink. See "The Color System" chapter in the *CAPI User Guide and Reference Manual* for details. Note that named colors can be specified by keywords like **`:red`**, **`:green`** and so on. *background* defaults to **`:white`**.
`with-gp-drawing-to-sheet` creates the port using *width* and *height* and *background*, binds *gp-port* to it and evaluates the *body*. When the *body* finishes, it copies the contents to the *sheet* at the position specified by *x* and *y*.
`perform-gp-drawing` is equivalent to:

```
(with-gp-drawing-to-sheet
 (gp-port sheet :x x :y y
          :width width :height height
          :background background)
 (funcall gp-drawing-func gp-port))
```

Note: In general, *body* should contain calls to graphics ports drawing functions like **`gp:draw-string`**, with the *port* argument *gp-port*.

Note: Drawings into the *port* can exceed the dimensions. Any drawing beyond *width* and *height* is ignored.

Note: The coping completely overwrites the contents of the *sheet* in the rectangle specified by *x*, *y*, *width* and *height*.

Note: **`perform-gp-drawing`** is especially convenient when drawing something that also needs to be printed, because *gp-drawing-func* can also be used to do the drawing to a **`capi:printer-port`**.

In this example **`draw-some-strings`** draws a string with fonts in different sizes using **`gp:draw-string`**. This is purely a graphics ports function, without any relation to CLIM, and can be used to draw into a **`capi:output-pane`**, or to a **`capi:printer-port`**:

```
(defun draw-some-strings(port)
  (dotimes (x 10)
    (let ((font
           (gp:find-best-font
            port
            (gp:make-font-description :size (+ 6 (* x 3))))))
      (gp:draw-string port "A string " 30 (+ 40 (* x 30))
                      :font font))))
```

In this example we use **`draw-some-strings`** to draw into a CLIM stream (using **`*standard-output*`** here). Note that only the first few strings are visible, because we restrict the drawing to 100x100. The background is yellow and we also draw a pink circle under the strings:

```
(clim:with-gp-drawing-to-sheet (port *standard-output*
                                     :x 0 :y 100
                                     :width 100 :height 100
                                     :background :yellow)
  (gp:draw-circle port 50 50  50 :foreground :pink :filled t)
  (draw-some-strings port))
```

In this example **`perform-gp-drawing`** draws into a CLIM stream (again using **`*standard-output*`**). The drawing is offset by 100 in the x direction, but fills the full height:

```
(clim:perform-gp-drawing *standard-output*
                         'draw-some-strings
                         :x 100)
```

This form sends the same drawing to a printer specified by *my-printer*:

```
(capi:with-print-job (printer-port :printer my-printer)
  (draw-some-strings printer-port))
```

See also **`perform-gp-drawing`**.

3 The CLIM Drawing Environment

3.1 CLIM Mediums

Drawing in CLIM is done through a medium. A ***medium*** can be thought of as an object that knows how to draw on a specific device. For example, a medium translates a CLIM **`draw-rectangle`** call into the appropriate draw-rectangle call to the underlying graphics host. Mediums also keep track of default drawing options, such as a drawing plane, foreground and background inks, a transformation, a clipping region, a line style, and a text style. These default values are used when these function-call parameters are left otherwise unspecified. For related information, refer to **2.1.4 Mediums, Sheets, and Streams**.

The drawing environment is dynamic. The CLIM facilities for affecting the drawing environment do so within their dynamic extent. For example, any drawing done by the user function **`draw-stuff`** (as well as any drawing performed by its callees) will be affected by the scaling transformation:

```
(clim:with-scaling (medium 2 1) (draw-stuff medium))
```

The medium has components that are used to keep track of the drawing environment. The drawing environment is controlled through the use of drawing options that can be provided as keyword arguments to all of the drawing functions.

Each CLIM medium contains components that correspond to the drawing options. These components provide the default values for the drawing options. When drawing functions are called and some options are unspecified, the options default to the values maintained by the medium.

CLIM provides accessors that enable you to read and write the values of these components. Also, these components are temporarily bound within a dynamic context by using **`with-drawing-options`**, **`with-text-style`**, and related forms. Using **`setf`** on a component while it is temporarily bound takes effect immediately but is undone when the dynamic context is exited.

The following functions read and write components of a medium related to drawing options. While these functions are defined for mediums, they can also be called on sheets that support the sheet output protocol and on streams that output to such sheets. All classes that support the medium protocol implement methods for these generic functions. Often, a sheet class that supports the output protocol will implement a "trampoline" method that passes the operation directly on to **`sheet-medium`** of the sheet.

medium-foreground *Generic Function*

`medium-foreground` *medium*

medium-background *Generic Function*

`medium-background` *medium*

Summary: Returns the foreground and background inks (which are designs) for the medium *medium*, respectively. The foreground ink is the default ink used when drawing. The background ink is the ink used when erasing. See **5 Drawing in Color** for a more complete description of designs.

Any indirect inks are resolved against the foreground and background at the time a design is rendered.

(setf medium-foreground) *Generic Function*

`(setf medium-foreground)` *ink medium*

(setf medium-background) *Generic Function*

`(setf medium-background)` *ink medium*

Summary: Sets the foreground and background ink, respectively, for the medium *medium* to *ink*. You may not set **`medium-foreground`** or **`medium-background`** to an indirect ink.

Changing the foreground or background of a sheet that supports output recording causes the contents of the stream's viewport to be erased and redrawn using the new foreground and background.

medium-ink *Generic Function*

`medium-ink` *medium*

Summary: The current drawing ink for the medium *medium*, which can be any design. The drawing functions draw with the color and pattern that this specifies. See **5 Drawing in Color** for a more complete description of inks. The **`:ink`** drawing option temporarily changes the value of **`medium-ink`**.

(setf medium-ink) *Generic Function*

`(setf medium-ink)` *ink medium*

Summary: Sets the current drawing ink for the medium *medium* to *ink*. *ink* is as for **`medium-foreground`**, and may be an indirect ink as well.

medium-transformation *Generic Function*

`medium-transformation` *medium*

Summary: The current user transformation for the medium *medium*. This is used to transform the coordinates supplied as arguments to drawing functions to the coordinate system of the drawing plane. See **3.5 The Transformations Used by CLIM** for a complete description of transformations. The **`:transformation`** drawing option temporarily changes the value of **`medium-transformation`**.

(setf medium-transformation) *Generic Function*

`(setf medium-transformation)` *transformation medium*

Summary: Sets the current user transformation for the medium *medium* to the transformation *transformation*.

medium-clipping-region *Generic Function*

`medium-clipping-region` *medium*

Summary: The current clipping region for the medium *medium*. The drawing functions do not affect the drawing plane outside this region. The **`:clipping-region`** drawing option temporarily changes the value of **`medium-clipping-region`**.

The clipping region is expressed in user coordinates.

(setf medium-clipping-region) *Generic Function*

`(setf medium-clipping-region)` *region medium*

Summary: Sets the current clipping region for the medium *medium* to *region*. *region* must be a subclass of **`area`**.

medium-line-style

Generic Function

`medium-line-style` *medium*

Summary: The current line style for the medium *medium*. The line and arc drawing functions render according to this line style. See **3.3 CLIM Line Styles** for a complete description of line styles. The **`:line-style`** drawing option temporarily changes the value of **`medium-line-style`**.

(setf medium-line-style)

Generic Function

`(setf medium-line-style)` *line-style medium*

Summary: Sets the current line style for the medium *medium* to the line style *line-style*.

medium-default-text-style

Generic Function

`medium-default-text-style` *medium*

Summary: The default text style for the medium *medium*. **`medium-default-text-style`** will return a fully specified text style, unlike **`medium-text-style`**, which may return a text style with null components. Any text styles that are not fully specified by the time they are used for rendering are merged against **`medium-default-text-style`** using **`merge-text-styles`**.

The default value for **`medium-default-text-style`** for any medium is **`*default- text-style*`**.

4 Text Styles for a complete description of text styles.

(setf medium-default-text-style)

Generic Function

`(setf medium-default-text-style)` *text-style medium*

Summary: Sets the default text style for the medium *medium* to the text style *text-style*. *text-style* must be a fully specified text style.

medium-text-style

Generic Function

`medium-text-style` *medium*

Summary: The current text style for the medium *medium*. The text drawing functions, including ordinary stream output, render text as directed by this text style merged against the default text style. This controls both graphical text (such as that drawn by **`draw-text*`**) and stream text (such as that written by **`write-string`**). **4 Text Styles** for a complete description of text styles. The **`:text-style`** drawing option temporarily changes the value of **`medium-text-style`**.

(setf medium-text-style)

Generic Function

`(setf medium-text-style)` *text-style medium*

Summary: Sets the current text style for the medium *medium* to the text style *text-style*. *text-style* need not be a fully merged text style.

medium-current-text-style

Generic Function

`medium-current-text-style` *medium*

Summary: The current, fully merged text style for the medium *medium*. This is the text style that will be used when drawing text output, and is the result of merging **`medium-text-style`** against **`medium-default-text-style`**.

3.2 Using CLIM Drawing Options

Drawing options control various aspects of the drawing process. You can supply drawing options in a number of ways:

- The medium (the destination for graphic output) itself has default drawing options. If a drawing option is not supplied elsewhere, the medium supplies the value. See the preceding section, **3.1 CLIM Mediums**.
- You can use **`with-drawing-options`** to bind the drawing options of the medium temporarily. In many cases, it is convenient to use **`with-drawing-options`** to surround several calls to drawing functions, each using the same options.
- You can supply the drawing options as keyword arguments to the drawing functions. These override the drawing options specified by **`with-drawing-options`**.

In some cases, it is important to distinguish between drawing options and suboptions. Both text and lines have an option that controls the complete specification of the text and line style, and there are suboptions that can affect one aspect of the text or line style. For example, the value of the **`:text-style`** option is a text style object, which describes a complete text style consisting of family, face, and size. There are also suboptions called **`:text-family`**, **`:text-face`**, and **`:text-size`**. Each suboption specifies a single aspect of the text style, while the option specifies the entire text style. Line styles are analogous to text styles; there is a **`:line-style`** option and some suboptions.

In a given call to **`with-drawing-options`** or a drawing function, you would normally supply either the **`:text-style`** option or a text style suboption (or more than one suboption), but not both. If you do supply both, then the text style comes from the result of merging the suboptions with the **`:text-style`** option, and then merging that with the prevailing text style.

with-drawing-options *Macro*

`with-drawing-options (`*medium* **`&rest`** *drawing-options***`) &body`** *body*

Summary: Binds the state of the medium designated by *medium* to correspond to the supplied drawing options, and executes the body with the new drawing options specified by *drawing-options* in effect. Each option causes binding of the corresponding component of the medium for the dynamic extent of the body. The drawing functions effectively do a **`with-drawing-options`** when drawing option arguments are supplied to them.

medium can be a medium, a sheet that supports the sheet output protocol, or a stream that outputs to such a sheet. The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard- output*`** is used. *body* may have zero or more declarations as its first forms.

`with-drawing-options` expands into a call to **`invoke-with-drawing-options`**, supplying a function that executes *body* as the *continuation* argument to **`invoke-with-drawing-options`**.

invoke-with-drawing-options *Generic Function*

`invoke-with-drawing-options` *medium continuation* **`&rest`** *drawing-options*

Summary: Binds the state of the medium *medium* to correspond to the supplied drawing options, and then calls the function *continuation* with the new drawing options in effect. *continuation* is a function of one argument, the medium; it has dynamic extent. *drawing-options* is a list of alternating keyword-value pairs, and must have even length. Each option in *drawing-options* causes binding of the corresponding component of the medium for the dynamic extent of the body.

medium can be a medium, a sheet that supports the sheet output protocol, or a stream that outputs to such a sheet. All classes that obey the medium protocol implement a method for **`invoke-with-drawing-options`**.

drawing-options can be any of the following, plus any of the suboptions for line and text styles. The default value specified for a drawing option is the value to which the corresponding component of a medium is normally initialized.

3.2.1 Set of CLIM Drawing Options

Drawing options can be any of the following, plus any of the line-style or text-style suboptions.

:ink *Option*

Summary: The drawing functions draw with the color and pattern that this ink specifies. The default value is **`+foreground-ink+`**. **5 Drawing in Color** for a complete description of inks.

The **`:ink`** drawing option temporarily changes the value of **`(medium-ink`** *medium***`)`** to *ink*, replacing (not combining) the previous ink.

:transformation *Option*

Summary: This transforms the coordinates used as arguments to drawing functions to the coordinate system of the drawing plane. The default value is **`+identity-transformation+`**. See **3.5 The Transformations Used by CLIM** for a complete description of transformations.

The **`:transformation`** *xform* drawing option temporarily changes the value of **`(medium-transformation`** *medium***`)`** to:

```
(compose-transformations (medium-transformation medium) xform)
```

:clipping-region *Option*

Summary: The drawing functions do not affect the drawing plane outside this region, which must be an **`area`**. Rendering is clipped both by this clipping region and by other clipping regions associated with the mapping from the target drawing plane to the viewport that displays a portion of the drawing plane. The default is **`+everywhere+`**, or in other words, no clipping occurs in the drawing plane, only in the viewport.

The **`:clipping-region`** *region* drawing option temporarily changes the value of **`(medium-clipping-region`** *medium***`)`** to:

```
(region-intersection
 (transform-region
  (medium-transformation medium) region)
 (medium-clipping-region medium))
```

If both a clipping region and a transformation are supplied in the same set of drawing options, the clipping region argument is transformed by the newly composed transformation before calling **`region-intersection`**.

:line-style *Option*

Summary: The line- and arc-drawing functions render according to this line style. The line style suboptions and default are defined in **3.3 CLIM Line Styles**.

The **`:line-style`** *ls* drawing option temporarily changes the value of **`(medium-line-style`** *medium***`)`** to *ls*, replacing the previous line style; the new and old line styles are not combined in any way.

If line-style suboptions are supplied, they temporarily change the value of **`(medium-line-style`** *medium***`)`** to a line style constructed from the specified suboptions. Components not specified by suboptions default from the **`:line-style`** drawing option, if it is supplied, or else from the previous value of **`(medium-line-style`** *medium***`)`**. That is, if both the **`:line-style`** option and line-style suboptions are supplied, the suboptions take precedence over the components of the **`:line-style`** option.

:text-style *Option*

Summary: The text drawing functions, including ordinary stream output, render text as directed by this text style merged against the default text style. The default value has all null components. See **4 Text Styles** for a complete description of text styles, including the text style suboptions.

The **:text-style** *ts* drawing option temporarily changes the value of **(medium-text-style** *medium***)** to:

```
(merge-text-styles ts (medium-text-style medium))
```

If text-style suboptions are supplied, they temporarily change the value of **(medium-text-style** *medium***)** to a text style constructed from the specified suboptions, merged with the **:text-style** drawing option if it is specified, and then merged with the previous value of **(medium-text-style** *medium***)**. That is, if both the **:text-style** option and text-style suboptions are supplied, the suboptions take precedence over the components of the **:text-style** option.

3.2.2 Using the :filled Option

Certain drawing functions can draw either an area or the outline of that area. This is controlled by the **:filled** keyword argument to these functions. If the value is **t** (the default), then the function paints the entire area. If the value is **nil**, then the function outlines the area under the control of the line-style drawing option.

The **:filled** keyword argument is not a drawing option and cannot be specified to **with-drawing-options**.

The following functions have a **:filled** keyword argument:

- **draw-circle**
- **draw-circle***
- **draw-ellipse**
- **draw-ellipse***
- **draw-polygon**
- **draw-polygon***
- **draw-rectangle***

3.3 CLIM Line Styles

A line is a one-dimensional object. In order to be visible, however, the rendering of a line must occupy some non-zero area on the display hardware. CLIM uses a line style object to represent the advice supplied to the rendering substrate on how to perform the rendering.

It is often useful to create a line style object that represents a style you wish to use frequently, rather than continually specifying the corresponding line style suboptions.

---

line-style *Protocol Class*

Summary: The protocol class for line styles. If you want to create a new class that behaves like a line style, it should be a subclass of **line-style**. Subclasses of **line-style** must obey the line style protocol.

---

line-style-p *Function*

line-style-p *object*

Summary: Returns **t** if *object* is a line style; otherwise, it returns **nil**.

standard-line-style *Class*

Summary: An instantiable class that implements line styles. A subclass of **`line-style`**, this is the class that **`make-line-style`** instantiates. Members of this class are immutable.

make-line-style *Function*

`make-line-style &key` *unit thickness joint-shape cap-shape dashes*

Summary: Returns an object of class **`standard-line-style`** with the supplied characteristics. The arguments and their default values are described in **3.3 CLIM Line Styles**.

Each of the following suboptions has a corresponding reader that can be used to extract a particular component from a line style. The following generic functions comprise the line style protocol; all subclasses of **`line-style`** implement methods for these generic functions.

:line-unit *Option*

line-style-unit *Generic Function*

`line-style-unit` *line-style*

Summary: Gives the unit used for measuring line thickness and dash pattern length for the line style. Possible values are as follows:

- **`:normal`**—thicknesses and lengths are given in a relative measure in terms of the usual or "normal" line thickness, which is the thickness of the "comfortably visible thin line," a property of the underlying rendering substrate. (This is the default value.)
- **`:point`**—thicknesses and lengths are given in an absolute measure in terms of printer's points (approximately 1/72 of an inch). This measure was chosen so that CLIM implementors who interface CLIM to an underlying rendering engine (the window system) may legitimately choose to make it render as 1 pixel on current (1992) display devices.
- **`:coordinate`**—the same units should be used for line thickness as are used for coordinates. In this case, the line thickness is scaled by the medium's current transformation, whereas **`:normal`** and **`:point`** do not scale the line thickness.

:line-thickness *Option*

line-style-thickness *Generic Function*

`line-style-thickness` *line-style*

Summary: The thickness, in the units indicated by **`line-style-unit`**, of the lines or arcs drawn by a drawing function. The thickness must be a real number. The default is 1, which, when combined with the default unit of **`:normal`**, means that the default line drawn is the "comfortably visible thin line".

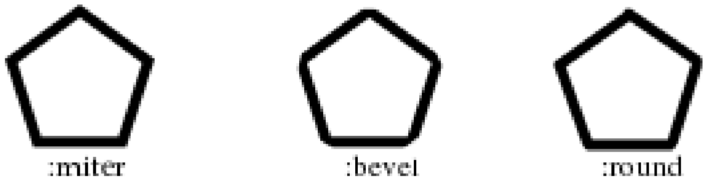
:line-joint-shape *Option*

line-style-joint-shape *Generic Function*

`line-style-joint-shape` *line-style*

Summary: Specifies the shape of joints between segments of unfilled figures. The possible shapes are **`:miter`**, **`:bevel`**, **`:round`**, and **`:none`**; the default is **`:miter`**. Note that the joint shape is implemented by the host window system, so not all platforms will necessarily fully support it.

Line Joint Shapes



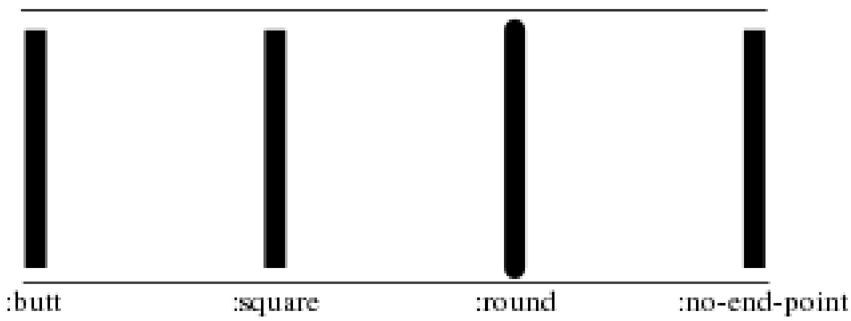
:line-cap-shape *Option*

line-style-cap-shape *Generic Function*

`line-style-cap-shape` *line-style*

Summary: Specifies the shape for the ends of lines and arcs drawn by a drawing function, one of **`:butt`**, :**`square`**, **`:round`**, or **`:no-end-point`**; the default is **`:butt`**. Note that the cap shape is implemented by the host window system, so not all platforms will necessarily fully support it.

Line Cap Shapes



:line-dashes *Option*

line-style-dashes *Generic Function*

`line-style-dashes` *line-style*

Summary: Controls whether lines or arcs are drawn as dashed figures, and if so, what the dashing pattern is. Possible values are:

- **`nil`**—lines are drawn solid, with no dashing. This is the default.
- **`t`**—lines are drawn dashed, with a dash pattern that is unspecified and may vary with the rendering engine. This allows the underlying display substrate to provide a default dashed line for the programmer whose only requirement is to draw a line that is visually distinguishable from the default solid line.
- A sequence—specifies a sequence, usually a vector, controlling the dash pattern of a drawing function. It is an error if the sequence does not contain an even number of elements. The elements of the sequence are lengths (as real numbers) of individual components of the dashed line or arc. The odd elements specify the length of inked components; the even elements specify the gaps. All lengths are expressed in the units described by **`line-style-unit`**.

make-contrasting-dash-patterns *Function*

`make-contrasting-dash-patterns` *n* **`&optional`** *k*

Summary: If *k* is not supplied, this returns a vector of *n* dash patterns with recognizably different appearance. Elements of the vector are guaranteed to be acceptable values for **`:dashes`**, and do not include **`nil`**, but their class is not otherwise specified. The vector is a fresh object that may be modified.

If *k* is supplied, it must be an integer between 0 and **n**–1 (inclusive), in which case **`make-contrasting-dash-patterns`** returns the k^{th} dash-pattern rather than returning a vector of dash-patterns.

CLIM has at least 8 different contrasting dash patterns. If *n* is greater than 8, **`make-contrasting-dash-patterns`** signals an error.

---

contrasting-dash-pattern-limit *Generic Function*

`contrasting-dash-pattern-limit` *port*

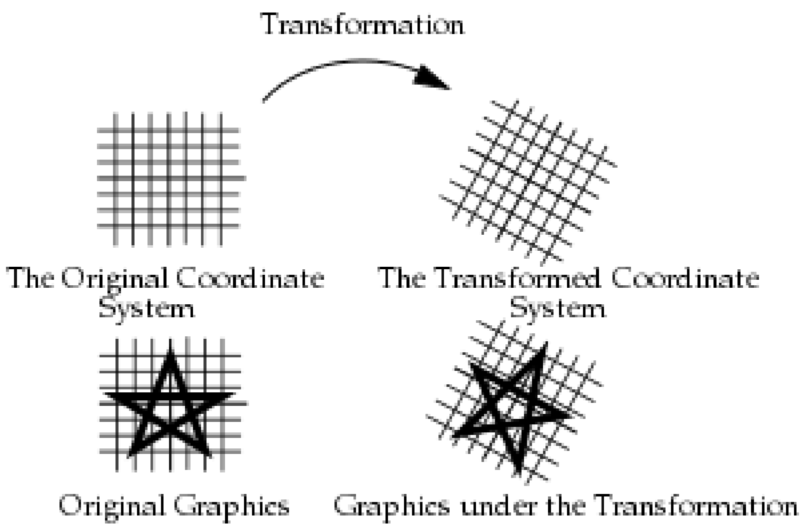
Summary: Returns the number of contrasting dash patterns that can be rendered on any medium on the port *port*. It is at least 8. All classes that obey the port protocol implement a method for this generic function.

3.4 Transformations in CLIM

One of the features of CLIM's graphical capabilities is the use of coordinate system transformations. By using transformations, you can often write simpler graphics code because you can choose a coordinate system in which to express the graphics that simplifies the description of the drawing.

A ***transformation*** is an object that describes how one coordinate system is related to another. A graphic function performs its drawing in the current coordinate system of the stream. A new coordinate system is defined by describing its relationship to the old one (the transformation). The drawing can now take place in the new coordinate system. The basic concept of graphic transformations is illustrated in **Graphic Transformation**.

Graphic Transformation



For example, you might define the coordinates of a five-pointed star and a function to draw it.

```
(defvar *star* '(0 3 2 -3 -3 1/2 3 1/2 -2 -3))

(defun draw-star (stream)
  (clim:draw-polygon* stream *star* :closed t :filled nil))
```

Without any transformation, the function draws a small star centered around the origin. By applying a transformation, the same function can be used to draw a star of any size, anywhere. For example:

```
(clim:with-room-for-graphics (stream)
```

```
(clim:with-translation (stream 100 100)
                       (clim:with-scaling (stream 10)
                        (draw-star stream)))
(clim:with-translation (stream 240 110)
                       (clim:with-rotation (stream -0.5)
                        (clim:with-scaling (stream 12 8)
                         (draw-star stream))))
```

will draw a picture somewhat like **Graphic Transformation** on **`stream`**.

3.5 The Transformations Used by CLIM

The type of transformations that CLIM uses are called affine transformations. An ***affine transformation*** is a transformation that preserves straight lines. In other words, if you take a number of points that fall on a straight line and apply an affine transformation to their coordinates, the transformed coordinates will fall on a straight line in the new coordinate system. Affine transformations include translations, scalings, rotations, and reflections.

A ***translation*** is a transformation that preserves the length, angle, and orientation of all geometric entities.

A ***rotation*** is a transformation that preserves the length and angles of all geometric entities. Rotations also preserve one point and the distance of all entities from that point. You can think of that point as the "center of rotation"; it is the point around which everything rotates.

There is no single definition of a ***scaling transformation.*** Transformations that preserve all angles and multiply all lengths by the same factor (preserving the "shape" of all entities) are certainly scaling transformations. However, scaling is also used to refer to transformations that scale distances in the **x** direction by one amount and distances in the **y** direction by another amount.

A ***reflection*** is a transformation that preserves lengths and magnitudes of angles but changes the sign (or "handedness") of angles. If you think of the drawing plane on a transparent sheet of paper, a reflection is a transformation that "turns the paper over".

If we transform from one coordinate system to another, then from the second to a third coordinate system, we can regard the resulting transformation as a single transformation resulting from ***composing*** the two component transformations. It is an important and useful property of affine transformations that they are closed under composition.

Note that composition is not commutative; in general, the result of applying transformation A and then applying transformation B is not the same as applying B first, then A.

Any arbitrary transformation can be built up by composing a number of simpler transformations, but that same transformation can often be constructed by a different composition of different transformations.

Transforming a region applies a coordinate transformation to that region, thus moving its position on the drawing plane, rotating it, or scaling it. Note that this creates a new region, but it does not affect the *region* argument.

The user interface to transformations is the **`:transformation`** option to the drawing functions. Users can create transformations with constructors. See **3.5.1 CLIM Transformation Constructors**. The other operators documented in this section are used by CLIM itself, and are not often needed by users.

3.5.1 CLIM Transformation Constructors

The following functions create transformation objects that can be used, for instance, in a call to **`compose-transformations`**. The transformation constructors do not capture any of their inputs. The constructors all create objects that are subclasses of **`transformation`**.

make-translation-transformation *Function*

`make-translation-transformation` *translation-x translation-y*

Summary: A translation is a transformation that preserves the length, angle, and orientation of all geometric entities.

`make-translation-transformation` returns a transformation that translates all points by *translation-x* in the **x** direction and *translation-y* in the **y** direction. *translation-x* and *translation-y* must be real numbers.

make-rotation-transformation *Function*

`make-rotation-transformation` *angle* **`&optional`** *origin*

make-rotation-transformation* *Function*

`make-rotation-transformation*` *angle* **`&optional`** *origin-x origin-y*

Summary: A rotation is a transformation that preserves the length and angles of all geometric entities. Rotations also preserve one point (the origin) and the distance of all entities from that point.

`make-rotation-transformation` returns a transformation that rotates all points by *angle* (which is a real number indicating an angle in radians) around the point *origin*. If *origin* is supplied it must be a point; if not supplied, it defaults to (0, 0). *origin-x* and *origin-y* must be real numbers.

make-scaling-transformation *Function*

`make-scaling-transformation` *scale-x scale-y* **`&optional`** *origin*

make-scaling-transformation* *Function*

`make-scaling-transformation*` *scale-x scale-y* **`&optional`** *origin-x origin-y*

Summary: As discussed previously, there is no single definition of a scaling transformation.
`make-scaling-transformation` returns a transformation that multiplies the **x**-coordinate distance of every point from *origin* by *scale-x* and the **y**-coordinate distance of every point from *origin* by *scale-y*. *scale-x* and *scale-y* must be real numbers. If *origin* is supplied it must be a point; if not supplied, it defaults to (0, 0). *origin-x* and *origin-y* must be real numbers.

make-reflection-transformation *Function*

`make-reflection-transformation` *point1 point2*

make-reflection-transformation* *Function*

`make-reflection-transformation*` *x1 y1 x2 y2*

Summary: A reflection is a transformation that preserves lengths and magnitudes of angles, but changes the sign (or "handedness") of angles. If you think of the drawing plane on a transparent sheet of paper, a reflection is a transformation that "turns the paper over".

`make-reflection-transformation` returns a transformation that reflects every point through the line passing through the points *point1* and *point2* (or through the positions **(x1, y1)** and **(x2, y2)** in the case of the spread version).

make-transformation *Function*

`make-transformation` *a b c d u v*

Summary: Returns a general transformation whose effect is:

$x' = ax+by+u$

y' = cx+dy+v

where *x* and *y* are the coordinates of a point before the transformation and *x'* and *y'* are the coordinates of the corresponding point after.

All of the arguments to **`make-transformation`** must be real numbers.

make-3-point-transformation *Function*

`make-3-point-transformation` *point-1 point-2 point-3 point-1-image point-2-image point-3-image*

Summary: Returns a transformation that takes points *point-1* into *point-1-image*, *point-2* into *point-2-image*, and *point-3* into *point-3-image*. Three non-collinear points and their images under the transformation are enough to specify any affine transformation.

If *point-1*, *point-2*, and *point-3* are collinear, the **`transformation-underspecified`** error will be signaled. If *point-1-image*, *point-2-image*, and *point-3-image* are collinear, the resulting transformation will be singular (that is, will have no inverse), but this is not an error.

make-3-point-transformation* *Function*

`make-3-point-transformation*` *x1 y1 x2 y2 x3 y3 x1-image y1-image x2-image y2-image x3-image y3-image*

Summary: Returns a transformation that takes the points at the positions (*x1*, *y1*) into (*x1-image*, *y1-image*), (*x2*, *y2*) into (*x2-image*, *y2-image*) and (*x3*, *y3*) into (*x3-image*, *y3-image*). Three non-collinear points and their images under the transformation are enough to specify any affine transformation.

If the positions **(x1, y1)**, **(x2, y2)**, and **(x3, y3)** are collinear, the **`transformation-underspecified`** error will be signaled. If (*x1-image*, *y1-image*), (*x2-image*, *y2-image*), and (*x3-image*, *y3-image*) are collinear, the resulting transformation will be singular, but this is not an error.

This is the spread version of **`make-3-point-transformation`**.

3.5.2 CLIM Transformation Protocol

transformation *Protocol Class*

Summary: The protocol class of all transformations. There are one or more subclasses of **`transformation`** that implement transformations, the exact names of which are explicitly unspecified. If you want to create a new class that behaves like a transformation, it should be a subclass of **`transformation`**. Subclasses of **`transformation`** obey the transformation protocol.

All of the instantiable transformation classes provided by CLIM are immutable.

transformationp *Function*

`transformationp` *object*

Summary: Returns **`t`** if *object* is a transformation; otherwise, it returns **`nil`**.

+identity-transformation+ *Constant*

Summary: An instance of a transformation that is guaranteed to be an identity transformation, that is, the transformation that "does nothing".

transformation-error *Condition Class*

Summary: The class that is the superclass of the following three conditions. This class is a subclass of **`error`**.

transformation-underspecified *Condition Class*

Summary: The error that is signaled when **make-3-point-transformation** is given three collinear image points.

reflection-underspecified *Condition Class*

Summary: The error that is signaled when **make-reflection-transformation** is given two coincident points.

singular-transformation *Condition Class*

Summary: The error that is signaled when **invert-transformation** is called on a singular transformation, that is, a transformation that has no inverse.

3.5.3 CLIM Transformation Predicates

The following predicates are provided in order to be able to determine whether or not a transformation has a particular characteristic.

transformation-equal *Generic Function*

transformation-equal *transformation1 transformation2*

Summary: Returns **t** if the two transformations have equivalent effects (that is, are mathematically equal); otherwise, it returns **nil**.

identity-transformation-p *Generic Function*

identity-transformation-p *transformation*

Summary: Returns **t** if *transformation* is equal (in the sense of **transformation-equal**) to the identity transformation; otherwise, it returns **nil**.

translation-transformation-p *Generic Function*

translation-transformation-p *transformation*

Summary: Returns **t** if *transformation* is a pure translation, that is, a transformation that moves every point by the same distance in **x** and the same distance in **y**. Otherwise, it returns **nil**.

invertible-transformation-p *Generic Function*

invertible-transformation-p *transformation*

Summary: Returns **t** if *transformation* has an inverse; otherwise, it returns **nil**.

reflection-transformation-p *Generic Function*

reflection-transformation-p *transformation*

Summary: Returns **t** if *transformation* inverts the "handedness" of the coordinate system; otherwise, it returns **nil**. Note that this is a very inclusive category—transformations are considered reflections even if they distort, scale, or skew the coordinate system, as long as they invert the handedness.

rigid-transformation-p *Generic Function*

rigid-transformation-p *transformation*

Summary: Returns **t** if *transformation* transforms the coordinate system as a rigid object, that is, as a combination of translations, rotations, and pure reflections. Otherwise, it returns **nil**.

Rigid transformations are the most general category of transformations that preserve magnitudes of all lengths and angles.

even-scaling-transformation-p *Generic Function*

even-scaling-transformation-p *transformation*

Summary: Returns **t** if *transformation* multiplies all **x**-lengths and **y**-lengths by the same magnitude; otherwise, it returns **nil**. This includes pure reflections through vertical and horizontal lines.

scaling-transformation-p *Generic Function*

scaling-transformation-p *transformation*

Summary: Returns **t** if *transformation* multiplies all **x**-lengths by one magnitude and all **y**-lengths by another magnitude; otherwise, it returns **nil**. This category includes even scalings as a subset.

rectilinear-transformation-p *Generic Function*

rectilinear-transformation-p *transformation*

Summary: Returns **t** if *transformation* will always transform any axis-aligned rectangle into another axis-aligned rectangle; otherwise, it returns **nil**. This category includes scalings as a subset, and also includes 90 degree rotations.

Rectilinear transformations are the most general category of transformations for which the bounding rectangle of a transformed object can be found by transforming the bounding rectangle of the original object.

3.5.4 CLIM Transformation Functions

compose-transformations *Generic Function*

compose-transformations *transformation1 transformation2*

Summary: Returns a transformation that is the mathematical composition of its arguments. Composition is in right-to-left order; that is, the resulting transformation represents the effects of applying the transformation *transformation2* followed by the transformation *transformation1*.

invert-transformation *Generic Function*

invert-transformation *transformation*

Summary: Returns a transformation that is the inverse of the transformation *transformation*. The result of composing a transformation with its inverse is equal to the identity transformation.

If *transformation* is singular, **invert-transformation** will signal the **singular-transformation** error, with a named restart that is invoked with a transformation and makes **invert-transformation** return that transformation. This is to allow a drawing application, for example, to use a generalized inverse to transform a region through a singular transformation.

Note that with finite-precision arithmetic there are several low-level conditions that might occur during the attempt to invert a singular or "almost singular" transformation. (These include computation of a zero determinant, floating-point underflow during computation of the determinant, or floating-point overflow during subsequent multiplication.) **invert-transformation** signals the **singular-transformation** error for all of these cases.

compose-translation-with-transformation *Function*

compose-translation-with-transformation *transformation dx dy*

compose-scaling-with-transformation *Function*

compose-scaling-with-transformation *transformation sx sy* **&optional** *origin*

compose-rotation-with-transformation *Function*

compose-rotation-with-transformation *transformation angle* **&optional** *origin*

Summary: These functions create a new transformation by composing the transformation *transformation* with a given translation, scaling, or rotation, respectively. The order of composition is that the translation, scaling, or rotation "transformation" is first, followed by *transformation*.

dx and *dy* are as for **make-translation-transformation**. *sx* and *sy* are as for **make-scaling-transformation**. *angle* and *origin* are as for **make-rotation-transformation**.

Note that these functions could be implemented by using the various constructors. They are provided because it is common to build up a transformation as a series of simple transformations.

compose-transformation-with-translation *Function*

compose-transformation-with-translation *transformation dx dy*

compose-transformation-with-scaling *Function*

compose-transformation-with-scaling *transformation sx sy* **&optional** *origin*

compose-transformation-with-rotation *Function*

compose-transformation-with-rotation *transformation angle* **&optional** *origin*

Summary: These functions create a new transformation by composing a given translation, scaling, or rotation, respectively, with the transformation *transformation*. The order of composition is *transformation* first, followed by the translation, scaling, or rotation "transformation".

dx and *dy* are as for **make-translation-transformation**. *sx* and *sy* are as for **make-scaling-transformation**. *angle* and *origin* are as for **make-rotation-transformation**.

Note that these functions could be implemented by using the various constructors and **compose-transformations**. They are provided because it is common to build up a transformation as a series of simple transformations.

The following three functions are no different than using **with-drawing-options** with the **:transformation** keyword argument supplied. However, they are sufficiently useful that they are provided as a convenience to programmers.

In order to preserve referential transparency, these three forms apply the translation, rotation, or scaling transformation first, then the rest of the transformation from **(medium-transformation** *medium***)**. That is, the following two forms would return the same transformation (assuming that the medium's transformation in the second example is the identity transformation):

```
(compose-transformations
 (make-translation-transformation dx dy)
 (make-rotation-transformation angle))

(with-translation (medium dx dy)
  (with-rotation (medium angle)
    (medium-transformation medium)))
```

with-translation *Macro*

with-translation (*medium dx dy***) &body** *body*

Summary: Establishes a translation on the medium *medium* that translates by *dx* in the **x** direction and *dy* in the **y** direction, and then executes *body* with that transformation in effect.

dx and *dy* are as for **`make-translation-transformation`**.

The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

with-scaling *Macro*

`with-scaling (`*medium sx* **`&optional`** *sy origin***`) &body`** *body*

Summary: Establishes a scaling transformation on the medium *medium* that scales by *sx* in the **x** direction and *sy* in the **y** direction, and then executes *body* with that transformation in effect. If *sy* is not supplied, it defaults to *sx*. If *origin* is supplied, the scaling is about that point; if it is not supplied, it defaults to (0, 0).

sx and *sy* are as for **`make-scaling-transformation`**.

The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

with-rotation *Macro*

`with-rotation (`*medium angle* **`&optional`** *origin***`) &body`** *body*

Summary: Establishes a rotation on the medium *medium* that rotates by *angle*, and then executes *body* with that transformation in effect. If *origin* is supplied, the rotation is about that point; if it is not supplied, it defaults to (0, 0).

angle and *origin* are as for **`make-rotation-transformation`**.

The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

These two functions also compose a transformation into the current transformation of a stream, but have more complex behavior.

with-local-coordinates *Macro*

`with-local-coordinates (`*medium* **`&optional`** *x y***`) &body`** *body*

Summary: Binds the dynamic environment to establish a local coordinate system on the medium *medium* with the origin of the new coordinate system at the position **(x, y)**. The "directionality" of the coordinate system is otherwise unchanged. *x* and *y* are real numbers, and both default to 0.

The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

with-first-quadrant-coordinates *Macro*

`with-first-quadrant-coordinates (`*medium* **`&optional`** *x y***`) &body`** *body*

Summary: Binds the dynamic environment to establish a local coordinate system on the medium *medium* with the positive **x** axis extending to the right and the positive **y** axis extending upward, with the origin of the new coordinate system at the position **(x, y)**. *x* and *y* are real numbers, and both default to 0.

The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

3.5.5 Applying CLIM Transformations

Transforming a region applies a coordinate transformation to that region, thus moving its position on the drawing plane, rotating it, or scaling it. Note that transforming a region does not affect the *region* argument; it is free to either create a new region or return an existing (cached) region.

These generic functions are implemented for all classes of transformations. Furthermore, all subclasses of **`region`** and **`ink`** implement methods for **`transform-region`** and **`untransform-region`**. That is, methods for the following generic functions will typically specialize both the *transformation* and *region* arguments.

transform-region *Generic Function*

`transform-region` *transformation region*

Summary: Applies *transformation* to the region *region*, and returns the transformed region.

untransform-region *Generic Function*

`untransform-region` *transformation region*

Summary: This is exactly equivalent to:

`(transform-region (invert-transformation` *transformation*) *region*)

CLIM provides a default method for **`untransform-region`** on the **`transformation`** protocol class that does exactly this.

transform-position *Generic Function*

`transform-position` *transformation x y*

Summary: Applies the transformation *transformation* to the point whose coordinates are the real numbers *x* and *y*, and returns two values, the transformed **x** coordinate and the transformed **y** coordinate.

`transform-position` is the spread version of **`transform-region`** in the case where the region is a point.

untransform-position *Generic Function*

`untransform-position` *transformation x y*

Summary: This is exactly equivalent to:

`(transform-position (invert-transformation` *transformation*) *x y*)

CLIM provides a default method for **`untransform-position`** on the **`transformation`** protocol class that does exactly this.

transform-distance *Generic Function*

`transform-distance` *transformation dx dy*

Summary: Applies the transformation *transformation* to the distance represented by the real numbers *dx* and *dy*, and returns two values, the transformed *dx* and the transformed *dy*.

A distance represents the difference between two points. It does **not** transform like a point.

untransform-distance *Generic Function*

`untransform-distance` *transformation dx dy*

Summary: This is exactly equivalent to:

(transform-distance (invert-transformation *transformation***)** *dx* *dy***)**

CLIM provides a default method for **untransform-distance** on the **transformation** protocol class that does exactly this.

transform-rectangle*

Generic Function

transform-rectangle* *transformation* *x1* *y1* *x2* *y2*

Summary: Applies the transformation *transformation* to the rectangle specified by the four coordinate arguments, which are real numbers. The arguments *x1*, *y1*, *x2*, and *y*2 are canonicalized in the same way as for **make-bounding-rectangle**. Returns four values that specify the minimum and maximum points of the transformed rectangle in the order *min-x*, *min-y*, *max-x*, and *max-y*.

It is an error if *transformation* does not satisfy **rectilinear-transformation-p**.

transform-rectangle* is the spread version of **transform-region** in the case where the transformation is rectilinear and the region is a rectangle.

untransform-rectangle*

Generic Function

untransform-rectangle* *transformation* *x1* *y1* *x2* *y2*

Summary: This is exactly equivalent to:

(transform-rectangle* (invert-transformation *transformation***)** *x1* *y1* *x2* *y2***)**

CLIM provides a default method for **untransform-rectangle*** on the **transformation** protocol class that does exactly this.

4 Text Styles

4.1 Conceptual Overview of Text Styles

CLIM's model for the appearance of text is that the application program should describe how the text should appear in high-level terms, and that CLIM will take care of the details of choosing a specific device font. This approach emphasizes portability.

You specify the appearance of text by giving it an abstract ***text style***. Each CLIM medium defines a mapping between these abstract style specifications and particular device-specific fonts. At run time, CLIM chooses an appropriate device font to represent the characters. However, some programmers may require direct access to particular device fonts. The text-style mechanism allows you to specify device fonts by name, thus trading portability for control.

A text style is a combination of three characteristics that describe how characters appear. Text style objects have components for ***family***, ***face***, and ***size***:

family

Characters of the same family have a typographic integrity, so that all characters of the same family resemble one another. One of **`:fix`**, **`:serif`**, **`:sans-serif`**, or **`nil`**.

face

A modification of the family, such as bold or italic. One of **`:roman`** (meaning normal), **`:bold`**, **`:italic`**, (**`:bold :italic`**), or **`nil`**.

size

The size of the character. One of the logical sizes (**`:tiny`**, **`:very-small`**, **`:small`**, **`:normal`**, **`:large`**, **`:very-large`**, **`:huge`**, **`:smaller`**, **`:larger`**), or a real number representing the size in printer's points, or **`nil`**.

Not all of these attributes need be specified for a given text style object. Text styles can be merged in much the same way as pathnames are merged; unspecified components in the style object (that is, components that have **`nil`** in them) may be filled in by the components of a "default" style object.

default-text-style *Variable*

Summary: This is the default text style used by all streams.

Note that the sizes **`:smaller`** and **`:larger`** are treated differently than the others, in that they are merged with the default text style size to produce a size that is discernibly smaller or larger. For example, a text style size of **`:larger`** would merge with a default text size of **`:small`** to produce the resulting size **`:normal`**.

A text style object is called fully specified if none of its components is **`nil`** and the size component is not a relative size (that is, neither **`:smaller`** nor **`:larger`**).

When text is rendered on a medium, the text style is mapped to some medium-specific description of the glyphs for each character. This description is usually that medium's concept of a font object. This mapping is mostly transparent to the application developer, but it is worth noting that not all text styles have mappings associated with them on all mediums. If the text style used does not have a mapping associated with it on the given medium, a special text style reserved for this case will be used.

undefined-text-style *Variable*

Summary: The text style that is used as a fallback if no mapping exists for some other text style when some text is about to be rendered on a display device (via **write-string** and **draw-string***, for example). This text style must be fully merged, and it must have a mapping for all display devices.

4.2 CLIM Text Style Objects

It is often useful to create a text style object that represents a style you wish to use frequently, rather than continually specifying the corresponding text style suboptions.

For example, if you want to write on a stream with a particular family, face, and size, you can create a text style object using **make-text-style**:

```
(clim:with-text-style
 ((clim:make-text-style :fix :bold :large) my-stream)
 (write-string "Here is a text-style example." my-stream))
```

```
⇒ Here is a text-style example.
```

Note that text style objects are interned. That is, two different invocations of **make-text-style** with the same combination of family, face and size will result in the same (in the sense of **eq**) text style object. For this reason, you should not modify text style objects.

text-style *Protocol Class*

Summary: The protocol class for text styles. If you want to create a new class that behaves like a text style, it should be a subclass of **text-style**. Subclasses of **text-style** must obey the text style protocol.

text-style-p *Function*

text-style-p *object*

Summary: Returns **t** if *object* is a text style; otherwise, it returns **nil**.

standard-text-style *Class*

Summary: An instantiable class that implements text styles. It is a subclass of **text-style**. This is the class that **make-text-style** instantiates. Members of this class are immutable.

make-text-style *Function*

make-text-style *family face size*

Summary: Returns an object of class **standard-text-style** with a family of *family*, a face of *face*, and a size of *size*.

family is one of **:fix**, **:serif**, **:sans-serif**, or **nil**.

face is one of **:roman**, **:bold**, **:italic**, **(:bold :italic)**, or **nil**.

size is a real number representing the size in printer's points, one of the logical sizes (**:normal**, **:tiny**, **:very-small**, **:small**, **:large**, **:very-large**, **:huge**), a relative size (**:smaller** or **:larger**), or **nil**.

You can use text style suboptions to specify characteristics of a text style object. Each text style suboption has a reader function which returns the current value of that component from a text style object. The suboptions are listed as follows.

:text-family *Option*

text-style-family *Generic Function*

`text-style-family` *text-style*

Summary: Specifies the family of the text style *text-style*.

:text-face *Option*

text-style-face *Generic Function*

`text-style-face` *text-style*

Summary: Specifies the face of the text style *text-style*.

:text-size *Option*

text-style-size *Generic Function*

`text-style-size` *text-style*

Summary: Specifies the size of the text style *text-style*.

4.3 CLIM Text Style Functions

The following functions can be used to parse, merge, and create text-style objects, as well as to read the components of the objects.

parse-text-style *Generic Function*

`parse-text-style` *style-spec*

Summary: Returns a text-style object. *style-spec* may be a text-style object or a device font, in which case it is returned as is, or it may be a list of the family, face, and size (that is, a "style spec"), in which case it is "parsed" and a text-style object is returned.

This function is for efficiency, since a number of common functions that take a style object as an argument can also take a style spec, in particular **`draw-text`**.

merge-text-styles *Generic Function*

`merge-text-styles` *style1 style2*

Summary: Merges the text styles *style1* with *style2*; that is, returns a new text style that is the same as *style1*, except that unspecified components in *style1* are filled in from *style2*. For convenience, the two arguments may be also be style specs.

When merging the sizes of two text styles, if the size from *style1* is a relative size, the resulting size is either the next smaller or next larger size than is specified by *style2*. The ordering of sizes, from smallest to largest, is **`:tiny`**, **`:very-small`**, **`:small`**, **`:normal`**, **`:large`**, **`:very-large`**, and **`:huge`**.

Merging font faces is also possible. For example, merging bold and italic faces results in a bold-italic face. When the faces are mutually exclusive, the face specified by *style1* prevails.

text-style-components *Generic Function*

`text-style-components` *text-style*

Summary: Returns the components of *text-style* as three values (family, face, and size).

text-style-family

Generic Function

`text-style-family` *text-style*

Summary: Returns the family component of *text-style*.

text-style-face

Generic Function

`text-style-face` *text-style*

Summary: Returns the face component of *text-style*.

text-style-size

Generic Function

`text-style-size` *text-style*

Summary: Returns the size component of *text-style*.

text-style-ascent

Generic Function

`text-style-ascent` *text-style medium*

Summary: The ascent (an integer) of *text-style* as it would be rendered on medium *medium*.

Summary: The ***ascent*** of a text style is the ascent of the medium's font corresponding to *text-style*. The ascent of a font is the distance between the top of the tallest character in that font and the baseline.

text-style-descent

Generic Function

`text-style-descent` *text-style medium*

Summary: The descent (an integer) of *text-style* as it would be rendered on medium *medium*.

The ***descent*** of a text style is the descent of the medium's font corresponding to *text-style*. The descent of a font is the distance between the baseline and the bottom of the lowest descending character (usually "y," "q," "p," or "g").

text-style-height

Generic Function

`text-style-height` *text-style medium*

Summary: Returns the height (an integer) of the "usual character" in *text-style* on medium *medium*.

The ***height*** of a text style is the sum of its ascent and descent.

text-style-width

Generic Function

`text-style-width` *text-style medium*

Summary: Returns the width (an integer) of the "usual character" in *text-style* on medium *medium*.

text-style-fixed-width-p

Generic Function

`text-style-fixed-width-p` *text-style medium*

Summary: Returns **`t`** if *text-style* will map to a fixed-width font on medium *medium*; otherwise, it returns **`nil`**.

The methods for this generic function will typically specialize both the *text-style* and *port* arguments. CLIM provides a "trampoline" for this generic function for mediums and output sheets which will simply call the method for the port.

text-size *Generic Function*

`text-size` *medium string* **`&key`** *text-style* **`(`***start* **`0)`** *end*

Summary: Computes the "cursor motion" in device units that would take place if *string* (which may be either a string or a character) were output to the medium *medium* starting at the position (0, 0).

Five values are returned: the total width of the string in device units, the total height of the string in device units, the final *x* cursor position (which is the same as the width if there are no **`#\Newline`** characters in the string), the final *y* cursor position (which is 0 if the string has no **`#\Newline`** characters in it, and is incremented by the line height of *medium* for each **`#\Newline`** character in the string), and the string's baseline.

text-style specifies what text style is to be used when doing the output, and defaults to **`medium-merged-text-style`** of the medium. *text-style* must be a fully specified text style. *start* and *end* may be used to specify a substring of *string*.

Programmers needing to account for kerning or the ascent or descent of the text style should measure the size of the bounding rectangle of the text rendered on *medium*.

All mediums and output sheets implement a method for this generic function.

4.4 Text Style Binding Forms

CLIM provides several forms with which you can establish a binding of a text style or a text-style component. The extent of the binding is the dynamic extent of the particular binding form.

with-text-style *Macro*

`with-text-style (`*medium text-style***`) &body`** *body*

Summary: Binds the current text style of the medium *medium* to correspond to the new text style. *text-style* may either be a text style object or a style spec (that is, a list of a family, a face, and a size). *body* is executed with the new text style in effect.

The *medium* argument is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

`with-text-style` expands into a call to **`invoke-with-text-style`** and supplies a function that executes *body* as the *continuation* argument to **`invoke-with-text-style`**.

invoke-with-text-style *Generic Function*

`invoke-with-text-style` *medium continuation text-style*

Summary: Binds the current text style of the medium *medium* to correspond to the new text style, and calls the function *continuation* with the new text style in effect. *textstyle* may either be a text style object or a style spec (that is, a list of a family, a face, and a size). *continuation* is a function of one argument, the medium; it has dynamic extent.

medium can be a medium, a sheet that supports the sheet output protocol, or a stream that outputs to such a sheet. All classes that obey the medium protocol implement a method for **`invoke-with-text-style`**.

The following macros are "convenience" forms of **`with-text-style`** that expand into calls to **`invoke-with-text-style`**.

The *medium* argument of these macros is not evaluated, and must be a symbol that is bound to a sheet or medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

with-text-face *Macro*

with-text-face (*medium face***) &body** *body*

Summary: Binds the current text face of *medium* to correspond to the new text face *face*, within the *body*. *face* is one of **:roman**, **:bold**, **:italic**, (**:bold :italic**), or **nil**.

with-text-family *Macro*

with-text-family (*medium family***) &body** *body*

Summary: Binds the current text family of *medium* to correspond to the new text family *family*, within the *body*. *family* is one of **:fix**, **:serif**, **:sans-serif**, or **nil**.

with-text-size *Macro*

with-text-size (*medium size***) &body** *body*

Summary: Binds the current text size of *medium* to correspond to the new text size *size*, within the *body*.

4.5 Controlling Text Style Mappings

Text styles are mapped to fonts using the **text-style-mapping** function, which takes a port and a text style, and returns a font object. All ports implement methods for the following generic functions, for all classes of text style.

The objects used to represent a font mapping are unspecified and are likely to vary from port to port. For instance, a mapping might be some sort of font object on one type of port, or might simply be the name of a font on another. Part of initializing a port is to define the mappings between text styles and font names for the port's host window system.

text-style-mapping *Generic Function*

text-style-mapping *port text-style*

Summary: Returns the font mapping that will be used when rendering characters in the text style *text-style* on any medium on the port *port*. If there is no mapping associated with *text-style* on *port*, then some other object will be returned that corresponds to the "unmapped" text style.

(setf text-style-mapping) *Generic Function*

(setf text-style-mapping) *mapping port text-style*

Summary: Sets the text style mapping for *port* and *text-style* to *mapping*. *port* and *text-style* are as for **text-style-mapping**. *mapping* is either a font name or a list of the form (**:style** *family face size*); in the latter case, the given style is translated at run time into the font represented by the specified style.

make-device-font-text-style *Function*

make-device-font-text-style *port font-description* **&rest** *attributes*

Summary: Returns a text style object that will be mapped directly to the specified device font when text is output to the display device with this style. Device font styles do not merge with any other kind of style. As the specified font is device-specific, the use of this function may result in non-portable applications.

port is the port that the font is going to be used on.

make-device-font-text-style first use *font-description* and *attributes* to construct a **gp:font-description** as follows:

If *font-description* is a **gp:font-description** object, it is used as is and *attributes* is ignored.

If *font-description* is a string, it should be a family name, and a **gp:font-description** is created by executing:

```
(apply 'gp:make-font-description
        :family font-description
        atributes)
```

If *font-description* is **nil**, a **gp:font-description** is created by executing:

```
(apply 'gp:make-font-description attributes)
```

make-device-font-text-style tries to find a device font that matches the **gp:font-description**. If it is successful, it returns a **text-style** that maps to this device font. If it is not successful, it return **nil**.

The **gp:font-description** objects are described in the *CAPI User Guide and Reference Manual*. See the section "Portable font descriptions" in the chapter "Drawing - Graphics Ports", and **gp:make-font-description** in the GRAPHICS-PORTS Reference Entries chapter.

This code creates a device font text style and applies it to a string of characters.

```
(let ((my-device-font
(make-device-font-text-style
(port my-sheet)
(gp:make-font-description :family "courier"
:size 14
:weight :medium
:slant :italic))))
(draw-text* my-sheet "This appears in the specified device font."
10 10 :text-style my-device-font))
```

5 Drawing in Color

5.1 Conceptual Overview of Drawing With Color

This chapter describes the **:ink** drawing option and the simpler values that can be supplied for that option, such as colors.

To draw in color, you supply the **:ink** drawing option to CLIM's drawing functions (see Chapter 2, "Drawing Graphics in CLIM," for details). **:ink** can take as its value:

- a color
- the constant **+foreground-ink+**
- the constant **+background-ink+**
- a flipping ink

The drawing functions work by selecting a region of the drawing plane and painting it with color. The region is clipped by the current **:clipping-region** drawing option in effect, and is then transformed by the current **:transformation** drawing option (see **3 The CLIM Drawing Environment** for the rules controlling these options). The shape can be a graphical area (such as a rectangle or an ellipse), a path (such as a line segment or the outline of an ellipse), or the letter forms of text. Any viewports or dataports attached to this drawing plane are updated accordingly. The **:ink** drawing option is never affected by the **:transformation** drawing option nor by the sheet transformation; this ensures that stipple patterns on adjacent sheets join seamlessly.

Along with its drawing plane, a medium has a ***foreground*** and a ***background***. The foreground is the default ink when the **:ink** drawing option is not specified. The background is drawn all over the drawing plane before any output is drawn. You can erase by drawing the background over the region to be erased. You can change the foreground or background at any time. This changes the contents of the drawing plane. The effect is as if everything on the drawing plane is erased, the background is drawn on the entire drawing plane, and then everything that was ever drawn (provided it was saved in the output history) is redrawn using the new foreground and background.

5.1.1 Color Objects

A ***color*** in CLIM is an object representing the intuitive definition of color: white, black, red, pale yellow, and so forth. The visual appearance of a single point is completely described by its color.

A color can be specified by three real numbers between 0 and 1 inclusive, giving the amounts of red, green, and blue. Three 0's mean black; three 1's mean white. A color can also be specified by three numbers giving the intensity, hue, and saturation. A totally unsaturated color (a shade of gray) can be specified by a single real number between 0 and 1, giving the amount of white.

You can obtain a color object by calling one of **make-rgb-color**, **make-ihs-color**, or **make-gray-color**, or by using one of the predefined colors listed in **5.3 Predefined Color Names in LispWorks CLIM** or . Specifying a color object as the **:ink** drawing option, the foreground, or the background causes CLIM to use that color in the appropriate drawing operations.

---

color *Protocol Class*

Summary: The **color** class is the protocol class for a color. If you want to create a new class that behaves like a color, it should be a subclass of **color**. Subclasses of **color** must obey the color protocol.

All of the standard instantiable color classes provided by CLIM are immutable.

colorp *Function*

`colorp` *object*

Summary: Returns **`t`** if *object* is a color; otherwise, it returns **`nil`**.

5.1.2 Rendering

When CLIM renders the graphics and text in the drawing plane onto a real display device, physical limitations of the display device force the visual appearance to be an approximation of the drawing plane. Colors that the hardware does not support might be approximated by using a different color or by using a stipple pattern. Even primary colors such as red and green can't be guaranteed to have distinct visual appearance on all devices, so if device independence is desired, it is best to use **`make-contrasting-inks`** (which produces designs of different appearances) rather than a fixed palette of colors.

The line style and text style respectively control the region of the display device that is colored when a path or text is rendered.

5.2 CLIM Operators for Drawing in Color

The following functions create colors. These functions produce objects that have equivalent effects and are indistinguishable when drawn; the only difference is in how the color components are specified. Whether these functions use the specified values exactly or approximate them because of limited color resolution is unspecified. Whether these functions create a new object or return an existing object with equivalent color component values is also unspecified.

make-rgb-color *Function*

`make-rgb-color` *red green blue*

Summary: Returns a member of the class **`color`**. The *red*, *green*, and *blue* arguments are real numbers between 0 and 1 (inclusive) that specify the values of the corresponding color components.

make-ihs-color *Function*

`make-ihs-color` *intensity hue saturation*

Summary: Returns a member of class **`color`**. The *intensity* argument is a real number between 0 and $\sqrt{3}$ (inclusive). The *hue* and *saturation* arguments are real numbers between 0 and 1 (inclusive).

make-gray-color *Function*

`make-gray-color` *luminance*

Summary: Returns a member of class **`color`**. *luminance* is a real number between 0 and 1 (inclusive). On a black-on-white display device, 0 means black, 1 means white, and the other values are shades of gray. On a white-on-black display device, 0 means white, 1 means black, and the other values are shades of gray.

make-contrasting-inks *Function*

`make-contrasting-inks` *n* **`&optional`** *k*

Summary: If *k* is not supplied, this returns a vector of *n* designs with recognizably different appearance. Elements of the vector are guaranteed to be acceptable values for the **`:ink`** argument to the drawing functions, and will not include **`+foreground-ink+`**, **`+background-ink+`**, or **`nil`**. Their class is otherwise unspecified. The vector is a fresh object that may be modified.

If *k* is supplied, it must be an integer between 0 and $n - 1$ (inclusive), in which case **`make-contrasting-inks`** returns the k^{th} design rather than returning a vector of designs.

CLIM supports at least 8 different contrasting inks. If *n* is greater than the number of contrasting inks, **`make-contrasting-inks`** signals an error.

The rendering of the design may be a color or a stippled pattern, depending on whether the output medium supports color.

contrasting-inks-limit *Generic Function*

`contrasting-inks-limit` *port*

Summary: Returns the number of contrasting colors (or stipple patterns if *port* is monochrome or grayscale) that can be rendered on any medium on the port *port*. All classes that obey the medium protocol implement a method for this generic function.

The following two functions comprise the color protocol. Both of them return the components of a color. All subclasses of **`color`** implement methods for these generic functions.

color-rgb *Generic Function*

`color-rgb` *color*

Summary: Returns three values, the *red*, *green*, and *blue* components of the color *color*. The values are real numbers between 0 and 1 (inclusive).

color-ihs *Generic Function*

`color-ihs` *color*

Summary: Returns three values, the *intensity*, *hue*, and *saturation* components of the color *color*. The first value is a real number between 0 and $\sqrt{3}$ (inclusive). The second and third values are real numbers between 0 and 1 (inclusive).

5.3 Predefined Color Names in LispWorks CLIM

The following color constants are provided in LispWorks CLIM: +black+, +white+, +red+, +blue+, +green+, +cyan+, +magenta+, and +yellow+. Other predefined colors are available through the facility of a palette. Application programs can define other colors.

5.4 Indirect Inks

Drawing with an ***indirect ink*** is the same as drawing another design named directly. For example, **`+foreground-ink+`** is a design that draws the medium's foreground design and is the default value of the **`:ink`** drawing option.

Indirect ink is a useful abstraction that enables your code to ignore the issue of what specific ink to use. It is also useful for output recording. For example, you can draw with **`+foreground-ink+`**, change to a different **`medium-foreground`**, and replay the output record; the replayed output will come out in the new color.

You can change the foreground or background design of a medium at any time. This changes the contents of the medium's drawing plane. The effect is as if everything on the drawing plane is erased, the background design is drawn onto the drawing plane, and then everything that was ever drawn (provided it was saved in the output history) is drawn over again, using the medium's new foreground and background.

If an infinite recursion is created using an indirect ink, an error is signaled when the recursion is created, when the design is used for drawing, or both. Two indirect inks have been defined:

+foreground-ink+ *Constant*

Summary: An indirect ink that uses the medium's foreground design.

+background-ink+ *Constant*

Summary: An indirect ink that uses the medium's background design.

5.5 Flipping Ink

Use "flipping ink" to exchange the colors of two inks. You can also use it to exchange the values of **`+foreground-ink+`** and **`+background-ink+`**. For an example of its use, see **5.6.1 Using Flipping Ink**.

+flipping-ink+ *Constant*

Summary: A flipping ink that flips **`+foreground-ink+`** and **`+background-ink+`**.

make-flipping-ink *Function*

`make-flipping-ink` *ink1 ink2*

Summary: Returns a design that interchanges occurrences of the two designs *ink1* and *ink2*.

Drawing a flipping ink over a background changes the color in the background that would have been drawn by *ink1* at that point into the color that would have been drawn by *ink2* at that point, and vice versa. The effect on any color other than the colors determined by those two inks is unspecified; however, drawing the same figure twice using the same flipping ink is guaranteed to be an "identity" operation. If either *ink1* or *ink2* is not solid, the consequences are unspecified. The purpose of flipping is to allow the use of **`(xor)`** operations for temporary changes to the display.

If *ink1* and *ink2* are equivalent, the result can be **`+nowhere+`**.

5.6 Examples of Simple Drawing Effects

To draw in the foreground color, use the default, or specify **`:ink +foreground-ink+`**.

To erase, specify **`:ink +background-ink+`**.

To draw in color, specify **`:ink +green+`**, **`:ink (make-rgb-color 0.6 0.0 0.4)`**, and so forth.

To draw an opaque gray, specify **`:ink (make-gray-color 0.25)`**. This will draw a shade of gray independent of the window's foreground color. On a non-color, non-grayscale display this will generally turn into a stipple.

To draw a stipple of little bricks, specify **`:ink bricks`**, where **`bricks`** is defined as:

```
(make-rectangular-tile
 (make-pattern #2a((0 0 0 0 1 0 0 0 0)
              (0 0 0 1 0 0 0 0)
              (0 0 0 1 0 0 0 0)
              (1 1 1 1 1 1 1 1)
              (0 0 0 0 0 0 0 1)
              (0 0 0 0 0 0 0 1)
              (0 0 0 0 0 0 0 1)
              (1 1 1 1 1 1 1 1))
 (list +background+ +foreground+)) 8 8)
```

To draw a tiled pattern, specify **`:ink (make-rectangular-tile (make-pattern`** *array colors***`))`**.

To draw a pixmap, use **`(draw-design (make-pattern`** *array colors***`)`** *medium***`)`**.

5.6.1 Using Flipping Ink

```
(defun cmd-rubberband ()
  (let ((x1 0)        ; x1, y1 represents the fix point
        (y1 0)
        (x2 0)        ; x2,y2 represents the point that is changing
        (y2 0)
        (mouse-button-press nil)
        ;; press to select pivot
        (stream (get-frame-pane *application-frame* 'main)))
    (tracking-pointer (stream)
                      (:pointer-button-press
                       (event x y )
                       (setf x1 x y1 y x2 x y2 y)
                       (draw-line* stream x1 y1 x2 y2
                                   :ink +flipping-ink+)
                       (setf mouse-button-press t))
                      (:pointer-motion
                       (window x y)
                       (when Mouse-button-press
                         ;;erase
                         (draw-line* stream x1 y1 x2 y2
                                     :ink +flipping-ink+)
                         ;; draw
                         (draw-line* stream x1 y1 x y
                                     :ink +flipping-ink+)
                         (setf x2 x y2 y)))
                      (:pointer-button-release
                       (event x y )
                       (cond
                        ((eq mouse-button-press t)
                         (return
                          (list x1 y1 x2 y2))))))))
```

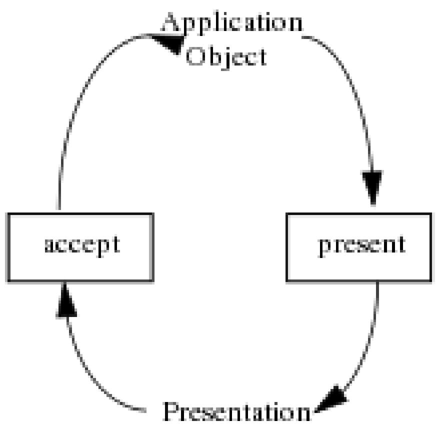
6 Presentation Types

6.1 Conceptual Overview of CLIM Presentation Types

6.1.1 User Interaction With Application Objects

In object-oriented programming systems, applications are built around internal objects that model something in the real world. For example, an application that models a university has objects representing students, professors, and courses. A CAD system for designing circuits has objects representing gates, resistors, and so on. A desktop publishing system has objects representing paragraphs, headings, and illustrations.

User Interaction With Application Objects



Application objects have to be presented to the user, and the user has to be able to interact with them. In CLIM, an interface enables the user to see visual representations of the application objects and, via these representations, operate on the application objects themselves.

A very basic part of designing a CLIM user interface is specifying how the user will interact with application objects. There are two directions of interaction: you must present application objects to the user as output, and you must accept input from the user that indicates application objects. This is done with two basic functions, **`present`** and **`accept`**, plus some related functions.

6.1.2 Presentations and Presentation Types

CLIM keeps track of the association between a visual representation of an object and the object itself. CLIM maintains this association in a data structure called a ***presentation***. A presentation embodies three things:

- The underlying application object.
- Its presentation type.
- Its visual representation.

In other words, a presentation is a special kind of output record that remembers not only output, but the object associated with the output and the semantic type associated with that object.

A ***presentation type*** can be thought of as a CLOS class that has some additional functionality pertaining to its roles in the user interface of an application. In defining a presentation type, the application programmer defines all of the user interface components of the entity:

- Its displayed representation, textual or graphical.
- Textual representation, for user input via the keyboard.
- Pointer sensitivity, for user input via the pointer.

In other words, the application programmer describes in one place all the information about an object necessary to display it to the user and interact with the user for object input.

6.1.3 Output With Its Semantics Attached

For example, a university application has a "student" application object. The user sees a visual representation of a student, which might be a textual representation, a graphical representation (such as a form with name, address, and student id number), or even an image of the face of the student. The presentation type of the student is "student"; that is, the semantic type of the object that appears on the screen is "student." Since the type of a displayed object is known, CLIM knows which operations are appropriate to perform on the displayed object. For example, when a student is displayed, it is possible to perform operations such as **`send-tuition-bill`** or **`show-transcript`**.

6.1.4 Input Context

Presentations are the basis of many of the higher-level application-building tools that use **`accept`** to get input and **`present`** to display output. A command that takes arguments as input specifies the presentation type of each argument. When a call to **`accept`** is made, CLIM establishes an "input-context" based on the presentation type. This input context is used to determine which presentations will be sensitive to mouse clicks. For instance, when a user gives the **`send-tuition-bill`** command, the input context is of type "student," so any students displayed—both those being displayed for the first time and those that have been displayed before—are sensitive. This is because presentations that have been output in previous user interactions retain their semantics; that is, CLIM has recorded the fact that a student has been displayed and has saved this information.

6.1.5 Inheritance

CLIM presentation types are designed to use inheritance, just as CLOS classes do. For example, a university might need to model "night-student," which is a subclass of "student." When the input context is looking for a student, night-students are sensitive because they are represented as a subtype of student.

The set of presentation types forms a type lattice, an extension of the Common Lisp CLOS type lattice. When a new presentation type is defined as a subtype of another presentation type, it inherits all the attributes of the supertype except those explicitly overridden in the definition.

6.1.6 Presentation Translators

You can define presentation translators to make the user interface of your application more flexible. For example, suppose the input context is expecting a command. In this input context, all displayed commands are sensitive, so the user can point to one to execute it. However, suppose the user points to another kind of displayed object, such as a student. In the absence of a presentation translator, the student is not sensitive because only commands can be entered to this input context.

In the presence of a presentation translator that translates from students to commands, however, both students and commands would be sensitive. When the student is highlighted, the middle pointer button might execute the command **`show-transcript`** for that student.

6.1.7 What the Application Programmer Does

By the time you get to the point of designing the user interface, you have probably designed the rest of the application and know what the application objects are. At this point, you need to do the following:

1. Decide what types of application objects will be presented to the user as output and accepted from the user as input.
2. For each type of application object that the user will see, assign a corresponding presentation type. In many cases, this means simply using a predefined presentation type. In other cases, you need to define a new presentation type yourself. Usually the presentation type is the same as the class of the application object.
3. Use the application-building tools to specify the windows, menus, commands, and other elements of the user interface. Most of these elements will use the presentation types of your objects.

6.2 How to Specify a CLIM Presentation Type

This section describes how to specify a CLIM presentation type. For a complete description of CLIM presentation types, options, and parameters, see **6.5 Predefined Presentation Types**.

Several CLIM operators take presentation types as arguments. You specify them using a presentation type specifier.

Most presentation type specifiers are also Common Lisp type specifiers. For example, the **`boolean`** presentation type is a Common Lisp type specifier. Not all presentation types are Common Lisp types, and not all Common Lisp types are presentation types (e.g., hash-tables), but there is a lot of overlap (e.g., commands, numbers, and strings).

A presentation type specifier appears in one of the following three patterns:

- *name*
- **`(`***name parameters*…**`)`**
- **`((`***name parameters*…**`)`** *options*…**`)`**

The first pattern, *name*, indicates a simple presentation type, which can be one of the predefined presentation types or a user-defined presentation type. Examples of the first pattern are:

`integer` A predefined presentation type.

`pathname` A predefined presentation type.

`boolean` A predefined presentation type.

`student` A user-defined presentation type.

The second pattern, **`(`***name parameters*…**`)`**, supports parameterized presentation types, which are analogous to parameterized Common Lisp types such as **`(integer 0 9)`** in method lambda lists. The function **`presentation-typep`** uses the parameters to check object membership in a type. Adding parameters to a presentation type specifier produces a subtype that contains some but not necessarily all of the objects that are members of the unparameterized type. Thus the parameters can turn off the sensitivity of some presentations that would otherwise be sensitive. The parameters state a restriction on the presentation type, so a parameterized presentation type is a specialization or a subset of the unparameterized presentation type of that name.

Examples of the second pattern are:

`(integer 0 10)` A parameterized type indicating an integer in the range of zero through ten.

`(string 25)` A parameterized type indicating a string whose length is 25.

`(member :yes :no :maybe)`

A parameterized type that can be one of the three given values: **`:yes`**, **`:no`**, and **`:maybe`**.

The third pattern, **`((`***name parameters...***`)`** *options...***`)`**, enables you to specify options that affect the use or appearance of the presentation, but not its semantic meaning. The options are keyword/value pairs, and are defined by the presentation type. All presentation types accept the **`:description`** option, which enables you to provide a string describing the presentation type. If provided, this option overrides the description specified in the **`define-presentation-type`** form, and also overrides the **`describe-presentation-type`** presentation method.

For example, you can use this form to specify an octal integer from 0 to 10:

```
((integer 0 10) :base 8)
```

While in theory some presentation type options may appear as an option in any presentation type specifier, currently the only such option is **`:description`**.

Each presentation type has a name, which is usually a symbol naming the presentation type. The name can also be a CLOS class object (but not a built-in class object); this usage provides the support for anonymous CLOS classes.

Every presentation type is associated with a CLOS class. If *name* is a class object or the name of a class, and that class is not a built-in class, that class is used as the associated class. Otherwise, **`define-presentation-type`** defines a class with the metaclass **`clim:presentation-type-class`** and superclasses determined by the presentation type definition. This class is not named *name*, since that could interfere with built-in Common Lisp types such as **`and`**, **`member`**, and **`integer`**. **`class-name`** of this class returns a list of the form **`(presentation-type`** *name***`)`**. **`clim:presentation-type-class`** is a subclass of **`standard-class`**.

Programmers are required to evaluate the **`defclass`** form first in the case when the same name is used in both a **`defclass`** and a **`define-presentation-type`**.

Every CLOS class (except for built-in classes) is a presentation type, as is its name. Unless it has been defined with **`define-presentation-type`**, it allows no parameters and no options.

Presentation type inheritance is used both to inherit methods ("what parser should be used for this type?"), and to establish the semantics for the type ("what objects are sensitive in this input context?"). Inheritance of methods is the same as in CLOS and thus depends only on the type name, not on the parameters and options.

During presentation method combination, presentation type inheritance arranges to translate the parameters of a subtype into a new set of parameters for its supertype, and translates the options of the subtype into a new set of options for the supertype.

6.3 Using CLIM Presentation Types for Output

Presentations for program output so that the objects presented will be acceptable to input functions. Suppose, for example, you present an object, such as **`5`**, as a TV channel. When a command that takes a TV channel as an argument is issued or when a presentation translation function is "looking for" such a thing, the system will make that object sensitive. Also, when a command that is looking for a different kind of object (such as a highway number), the object **`5`** is not sensitive, because that object represents a TV channel, not a highway number.

A presentation includes not only the displayed representation itself, but also the object presented and its presentation type. When a presentation is output to a CLIM window, the object and presentation type are "remembered"—that is, the object and type of the display at a particular set of window coordinates are recorded in the window's output history. Because this information remains available, previously presented objects are themselves available for input to functions for accepting objects.

An application can use the following operators to produce output that will be associated with a given Lisp object and declared to be of a specified presentation type. This output is saved in the window's output history as a presentation. Specifically, the presentation remembers the output that was performed (by saving the associated output record), the Lisp object associated with the output, and the presentation type specified at output time. The object can be any Lisp object.

6.3.1 CLOS Operators

CLOS provides these top-level facilities for presenting output. **with-output-as-presentation** is the most general operator, and **present** and **present-to-string** support common idioms.

with-output-as-presentation *Macro*

with-output-as-presentation (*stream object type* **&key** *modifier single-box allow-sensitive-inferiors record-type***)** **&body** *body*

Summary: The output of *body* to the extended output recording stream *stream* is used to generate a presentation whose underlying object is *object* and whose presentation type is *type*. Each invocation of this macro results in the creation of a presentation object in the stream's output history unless output recording has been disabled or **:allow-sensitive-inferiors nil** was specified at a higher level, in which case the presentation object is not inserted into the history. **with-output-as-presentation** returns the presentation corresponding to the output.

The *stream* argument must be a symbol that is bound to an extended output stream or output recording stream. If *stream* is **t**, ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

type is a presentation type specifier and may be an abbreviation.

modifier, which defaults to **nil**, is a function that describes how the presentation object might be modified. For example, it might be a function of one argument (the new value) that can be called in order to store a new value for *object* after a user somehow "edits" the presentation. *modifier* must have indefinite extent.

single-box is used to specify the **presentation-single-box** component of the resulting presentation. It can take on the values described under **presentation-single-box**.

When the boolean *allow-sensitive-inferiors* is **nil**, nested calls to **present** or **with-output-as-presentation** inside this one will not generate presentations. The default is **t**.

record-type specifies the class of the presentation output record to be created. It defaults to **standard-presentation**. This argument should only be supplied by a programmer if there is a new class of output record that supports the updating output record protocol.

All arguments of this macro are evaluated:

```
(with-output-as-presentation (stream #p"foo" 'pathname)
                             (princ "FOO" stream))
```

present *Function*

present *object* **&optional** *type* **&key** *stream view modifier acceptably for-context-type single-box allow-sensitive-inferiors sensitive record-type*

Summary: The *object* of presentation type *type* is presented to the extended output stream *stream* (which defaults to ***standard-output***), using the type's **present** method for the supplied view *view*. *type* is a presentation type specifier, and can be an abbreviation. It defaults to (**presentation-type-of** *object*). The other arguments and overall behavior of **present** are as for **stream-present**.

The returned value of **present** is the presentation object that contains the output corresponding to the object.

present expands any presentation type abbreviations (*type* and *for-context-type*), and then calls **stream-present** on *stream*, *object*, *type*, and the remaining keyword arguments.

stream-present *Generic Function*

stream-present *stream object type* **&key** *view modifier acceptably for-context-type single-box allow-sensitive-inferiors sensitive record-type*

Summary: **stream-present** is the per-stream implementation of **present**, analogous to the relationship between **write-char** and **stream-write-char**. All extended output streams and output recording streams implement a method for **stream-present**. The default method (on **standard-extended-output-stream**) is as follows.

The object *object* of type *type* is presented to the stream *stream* by calling the type's **present** method for the supplied view *view*. The returned value is the presentation containing the output corresponding to the object.

type is a presentation type specifier.

view is a view object that defaults to **stream-default-view** of *stream*.

for-context-type is a presentation type specifier that is passed to the **present** method for *type*, which can use it to tailor how the object will be presented. *for-context-type* defaults to *type*.

modifier, *single-box*, *allow-sensitive-inferiors*, and *record-type* are the same as for **with-output-as-presentation**.

acceptably defaults to **nil**, which requests the **present** method to produce text designed to be read by human beings. If *acceptably* is **t**, it requests the **present** method to produce text that is recognized by the **accept** method for *for-context-type*. This makes no difference to most presentation types.

The boolean *sensitive* defaults to **t**. If it is **nil**, no presentation is produced.

present-to-string *Function*

present-to-string *object* **&optional** *type* **&key** *view acceptably for-context-type string index*

Summary: Same as **present** inside **with-output-to-string**. If *string* is supplied, it must be a string with a fill pointer. When *index* is supplied, it is used as an index into *string*. *view*, *acceptably*, and *for-context-type* are as for **present**.

The first returned value is the string. When *string* is supplied, a second value is returned, the updated *index*.

6.3.2 Additional Functions for Operating on Presentations in CLIM

The following functions can be used to examine or modify presentations:

presentation *Protocol Class*

Summary: The protocol class that corresponds to a presentation and is a subclass of **output-record**. If you want to create a new class that behaves like a presentation, it should be a subclass of **presentation**. Subclasses of **presentation** obey the presentation protocol.

presentationp *Function*

presentationp *object*

Summary: Returns **t** if and only if *object* is of type **presentation**.

presentation-object *Generic Function*

presentation-object *presentation*

Summary: Returns the object represented by the presentation *presentation*.

(setf presentation-object) *Generic Function*

(setf presentation-object) *object presentation*

Summary: Changes the object associated with the presentation *presentation* to *object*.

presentation-type *Generic Function*

`presentation-type` *presentation*

Summary: Returns the presentation type of the presentation *presentation*.

(setf presentation-type) *Generic Function*

`(setf presentation-type)` *type presentation*

Summary: Changes the type associated with the presentation *presentation* to *type*.

presentation-single-box *Generic Function*

`presentation-single-box` *presentation*

Summary: Returns the "single box" attribute of the presentation *presentation*, which controls how the presentation is highlighted and when it is sensitive. This will be one of four values:

- **`nil`** (the default)—if the pointer is pointing at a visible piece of the output that was drawn as part of the presentation, then it is considered to be pointing at the presentation. The presentation is highlighted by highlighting each visible part of the output that was drawn as part of the presentation.
- **`t`**—if the pointer is inside the bounding rectangle of the presentation, it is considered to be pointing at the presentation. The presentation is highlighted by drawing a thin border around the bounding rectangle.
- **`:position`**—like **`t`** for determining whether the pointer is pointing at the presentation, but like **`nil`** for highlighting.
- **`:highlighting`**—like **`nil`** for determining whether the pointer is pointing at the presentation, but like **`t`** for highlighting.

(setf presentation-single-box) *Generic Function*

`(setf presentation-single-box)` *single-box presentation*

Summary: Changes the "single box" attribute of the presentation *presentation* to *single-box*.

presentation-modifier *Generic Function*

`presentation-modifier` *presentation*

Summary: Returns the "modifier" associated with the presentation *presentation*. The modifier is some sort of object that describes how the presentation object might be modified. For example, it might be a function of one argument (the new value) that can be called in order to store a new value for *object* after a user somehow "edits" the presentation.

standard-presentation *Class*

Summary: The output record class that represents presentations. **`present`** normally creates output records of this class. Members of this class are mutable.

:object

:type

:view

:single-box

:modifier *Initargs*

All presentation classes must handle these five initargs, which are used to specify, respectively, the object, type, view, single-box, and modifier components of a presentation.

6.4 Using CLIM Presentation Types for Input

The primary means for getting input from the end user is **accept**. Characters typed in at the keyboard in response to a call to **accept** are parsed, and the application object they represent is returned to the calling function. (The parsing is done by the **accept** method for the presentation type.) Alternatively, if a presentation of the type specified by the **accept** call has previously been displayed, the user can click on it with the pointer and **accept** returns it directly (that is, no parsing is required).

Examples:

```
=>(clim:accept 'string)

Enter a string: abracadabra

"abracadabra"

=>(clim:accept 'string)

Enter a string [default abracadabra]: abracadabra

"abracadabra"
```

In the first call to **accept**, **abracadabra** was typed at the keyboard. In the second call to **accept**, the user clicked on the keyboard-entered string of the first function. In both cases, the string object **"abracadabra"** was returned.

Typically, not all objects are acceptable as input. Only an object of the presentation type specified in the current **accept** function (or one of its subtypes) can be input. In other words, the **accept** function establishes the current input context. For example, if the call to **accept** specifies an integer presentation type, only an entered or displayed integer is acceptable. Numbers displayed as integer presentations would, in this input context, be sensitive, but those displayed as part of some other kind of presentation, such as a file pathname, would not. In this manner, **accept** controls the input context and the sensitivity of displayed presentations.

It is possible, however, to click on a presentation of a type different from the current input context and invoke a presentation translator that would produce a type acceptable to the input context. For example, you could make a presentation of a file pathname translate to an integer—say, its length—if you want. It is very common to translate to a command that operates on a presented object. For more information on presentation translators, see **6.5 Predefined Presentation Types**.

We said previously that the range of acceptable input is typically restricted, but how restricted is up to you, the programmer. Using compound presentation types like **and** and **or**, as well as other predefined or specially devised presentation types, gives you a high degree of flexibility and control over the input context.

CLIM provides the following top-level operators for accepting typed input. The most general operator is **with-input-context**, and **accept** and **accept-from-string** support common idioms.

Note that, in general, CLIM **accept** operators do not insert newlines. If you want each call to **accept** to appear on a new line, use **terpri**.

input-context *Variable*

Summary: The current input context. This will be a list, each element of which corresponds to a single call to **with-input-context**. The first element of the list is the context established by the most recent call to **with-input-context**, and the last element is the least recent call to **with-input-context**. This ordering of input contexts is called "nesting".

The exact format of the elements in the list is unspecified, but will typically be a list of a presentation type and a tag that corresponds to the point in the control structure of CLIM at which the input context was established.

input-context and the elements in it may have dynamic extent.

with-input-context *Macro*

with-input-context (*type* **&key** *override***) (&optional** *object-var type-var event-var options-var***)** *form* **&body** *pointer-cases*

Summary: Establishes an input context of presentation type *type*; this is done by binding ***input-context*** to reflect the new input context. When the boolean *override* is **nil** (the default), this invocation of **with-input-context** adds its context presentation type to the current context. In this way an application can solicit more than one type of input at the same time. Alternatively, when *override* is **t**, it overrides the current input context rather than nesting inside the current input context.

type can be a presentation type abbreviation.

After establishing the new input context, *form* is evaluated. If no pointer gestures are made by the user during the evaluation of *form*, the values of *form* are returned. Otherwise, one of the *pointer-cases* is executed (based on the presentation type of the object that was clicked on) and its value is returned. (See the descriptions of **call-presentation-menu** and **throw-highlighted-presentation**.) *pointer-cases* is constructed like a **typecase** statement clause list whose keys are presentation types; the first clause whose key satisfies the condition (**presentation-subtypep** *type key*) is the one that is chosen.

During the execution of one of the *pointer-cases*, *object-var* is bound to the object that was clicked on (the first returned value from the presentation translator that was invoked), *type-var* is bound to its presentation type (the second returned value from the translator), and *event-var* is bound to the pointer button event that was used. *options-var* is bound to any options that a presentation translator might have returned (the third value from the translator), and will be either **nil** or a list of keyword-value pairs. *object-var*, *type-var*, *event-var*, and *options-var* must all be symbols.

type, *stream*, and *override* are evaluated, but the others are not:

```
(with-input-context ('pathname)
                    (path)
                    (read)
                    (pathname
                     (format t
                             "~&The pathname ~A was clicked on."
                             path)))
```

accept *Function*

accept *type* **&key** *stream view default default-type provide-default insert-default replace-input history prompt prompt-mode display-default query-identifier activation-gestures additional-activation-gestures delimiter-gestures additional-delimiter-gestures*

Summary: Requests input of type *type* from the stream *stream*, which defaults to ***query-io***. **accept** returns two values, the object representing the input and its presentation type. *type* is a presentation type specifier, and can be an abbreviation. The other arguments and overall behavior of **accept** are as for **accept-1**.

accept first expands any presentation type abbreviations (*type*, *default-type*, and *history*), handles the interactions between the default, default type, and presentation history, prompts the user by calling **prompt-for-accept**, and then calls **stream-accept** on *stream*, *type*, and the remaining keyword arguments.

Note: The reason **accept** is specified as a three-function "trampoline" is to allow close tailoring of the behavior of **accept**. **accept** itself is the function that should be called by application programmers. **stream-accept** exists so that CLIM implementors can specialize on a per-stream basis. (For example, the behavior of **accepting-values** can be implemented by creating a special class of stream that turns calls to **accept** into fields of a dialog.) **accept-1** is provided as a convenient function for the **stream-accept** methods to call when they require the default behavior.

stream-accept

Generic Function

stream-accept *stream type* **&key** *view default default-type provide-default insert-default replace-input history prompt prompt-mode display-default query-identifier activation-gestures additional-activation-gestures delimiter-gestures additional-delimiter-gestures*

Summary: **stream-accept** is the per-stream implementation of **accept**, analogous to the relationship between **read-char** and **stream-read-char**. All extended input streams implement a method for **stream-accept**. The default method (on **standard-extended-input-stream**) simply calls **accept-1**.

The arguments and overall behavior of **stream-accept** are as for **accept-1**.

accept-1

Function

accept-1 *stream type* **&key** *view default default-type provide-default insert-default replace-input history prompt prompt-mode display-default query-identifier activation-gestures additional-activation-gestures delimiter-gestures additional-delimiter-gestures*

Summary: Requests input of type *type* from the stream *stream*. *type* must be a presentation type specifier. *view* is a view object that defaults to **stream-default-view** of *stream*. **accept-1** returns two values, the object representing the input and its presentation type. (If **frame-maintain-presentation-histories** is true for the current frame, then the returned object is also pushed on to the presentation history for that object.)

accept-1 establishes an input context via **with-input-context**, and then calls the **accept** presentation method for *type* and *view*. **accept** allows input editing when called on an interactive stream; see **16.1 Input Editing** for a discussion of input editing. The call to **accept** will be terminated when the **accept** method returns or the user clicks on a sensitive presentation. The typing of an activation and delimiter character is typically one way in which a call to an **accept** method is terminated.

A top-level **accept** satisfied by keyboard input discards the terminating keyboard gesture (which will be either a delimiter or an activation gesture). A nested call to **accept** leaves the terminating gesture unread.

If the user clicked on a matching presentation, **accept-1** will insert the object into the input buffer by calling **presentation-replace-input** on the object and type returned by the presentation translator, unless either the boolean *replace-input* is **nil** or the presentation translator returned an **:echo** option of **nil**. *replace-input* defaults to **t**, but this default is overridden by the translator explicitly returning an **:echo** option of **nil**.

If *default* is supplied, then it and *default-type* are returned as values from **accept-1** when the input is empty. *default-type* must be a presentation type specifier. If *default* is not supplied and *provide-default* is **t** (the default is **nil**), then the default is determined by taking the most recent item from the presentation type history specified by *history*. If *insert-default* is **t** and there is a default, the default will be inserted into the input stream by calling **presentation-replace-input**. It will be editable.

history must be either **nil**, meaning that no presentation type history will be used, or a presentation type (or abbreviation) that names a history to be used for the call to **accept**. *history* defaults to *type*.

prompt can be **t**, which prompts by describing the type, **nil**, which suppresses prompting, or a string, which is displayed as a prompt (via **write-string**). The default is **t**, which produces **Enter a type:** in a top-level call to **accept** or "(*type*)" in a nested call to **accept**.

If the boolean *display-default* is **t**, the default is displayed (if one was supplied). If *display-default* is **nil**, the default is not displayed. *display-default* defaults to **t** if *prompt* was provided; otherwise, it defaults to **nil**.

prompt-mode can be **:normal** (the default) or **:raw**, which suppresses putting a colon after the prompt and/or default in a top-level **accept** and suppresses putting parentheses around the prompt and/or default in a nested **accept**.

query-identifier is used within **accepting-values** to identify the field within the dialog.

activation-gestures is a list of gesture names that will override the current activation gestures, which are stored in

`*activation-gestures*`. *additional-activation-gestures* can be supplied to add activation gestures without overriding the current ones. See **16.2 Activation and Delimiter Gestures** for a discussion of activation gestures.

delimiter-gestures is a list of gesture names that will override the current delimiter gestures, which are stored in **`*delimiter-gestures*`**. *additional-delimiter-gestures* can be supplied to add delimiter gestures without overriding the current ones. See **16.2 Activation and Delimiter Gestures** for a discussion of delimiter gestures.

accept-from-string *Function*

`accept-from-string` *type string* **`&key`** *view default default-type start end*

Summary: Like **`accept`**, except that the input is taken from *string*, starting at the position specified by *start* and ending at *end*. *view*, *default*, and *default-type* are as for **`accept`**.

`accept-from-string` returns an object and a presentation type (as in **`accept`**), but also returns a third value, the index at which input terminated.

prompt-for-accept *Generic Function*

`prompt-for-accept` *stream type view* **`&rest`** *accept-args* **`&allow-other-keys`**

Summary: Called by **`accept`** to prompt the user for input of presentation type *type* on the stream *stream* for the view *view*. *accept-args* are all of the keyword arguments supplied to **`accept`**. The default method (on **`standard-extended-input-stream`**) simply calls **`prompt-for-accept-1`**.

prompt-for-accept-1 *Function*

`prompt-for-accept-1` *stream type* **`&key`** *default default-type display-default prompt prompt-mode* **`&allow-other-keys`**

Summary: Prompts the user for input of presentation type *type* on the stream *stream*.

If the boolean *display-default* is **`t`**, then the default is displayed; otherwise it is not. When the default is being displayed, *default* and *default-type* are taken as the object and presentation type of the default to display. *display-default* defaults to **`t`** if *prompt* is non-nil; otherwise, it defaults to **`nil`**.

If *prompt* is **`nil`**, no prompt is displayed. If it is a string, that string is displayed as the prompt. If *prompt* is **`t`** (the default), the prompt is generated by calling **`describe-presentation-type`** to produce a prompt of the form **`Enter a type:`** in a top-level call to **`accept`**, or "(*type*)" in a nested call to **`accept`**.

prompt-mode can be **`:normal`** (the default) or **`:raw`**, which suppresses putting a colon after the prompt and/or default in a top-level **`accept`** and suppresses putting parentheses around the prompt and/or default in a nested **`accept`**.

6.5 Predefined Presentation Types

This section documents predefined CLIM presentation types, presentation type options, and parameters. For more information on how to use these presentation types, see **6.2 How to Specify a CLIM Presentation Type**.

Note that any presentation type with the same name as a Common Lisp type accepts the same parameters as the Common Lisp type (and additional parameters in a few cases).

6.5.1 Basic Presentation Types

These basic presentation types correspond to the Common Lisp types of the same name.

t *Presentation Type*

Summary: The supertype of all other presentation types.

nil *Presentation Type*

Summary: The subtype of all other presentation types. This has no printed representation, and is useful only in writing "context independent" translators, that is, translators whose *to-type* is **nil**.

null *Presentation Type*

Summary: The presentation type that represents "nothing". The single object associated with this type is **nil**, and its printed representation is **None**.

boolean *Presentation Type*

Summary: The presentation type that represents **t** or **nil**. The textual representation is **Yes** and **No** respectively.

symbol *Presentation Type*

Summary: The presentation type that represents a symbol.

keyword *Presentation Type*

Summary: The presentation type that represents a symbol in the keyword package. It is a subtype of **symbol**.

blank-area *Presentation Type*

Summary: The type that represents all the places in a window where there is no presentation that is applicable in the current input context. CLIM provides a single "null presentation" as the object associated with this type.

null-presentation *Variable*

Summary: The null presentation, which occupies all parts of a window in which there are no applicable presentations. This will have a presentation type of **blank-area**.

6.5.2 Numeric Presentation Types

The following presentation types represent the Common Lisp numeric types of the same name.

number *Presentation Type*

Summary: The presentation type that represents a general number. It is the supertype of all the number types described here.

complex *Presentation Type*

Summary: The presentation type that represents a complex number.

rational *Presentation Type*

rational &optional *low high*

Summary: The presentation type that represents either a ratio or an integer between *low* and *high*. Options to this type are *base* and *radix*, which are the same as for the **integer** type.

integer *Presentation Type*

integer &optional *low high*

Summary: The presentation type that represents an integer between *low* and *high*. Options to this type are *base* (default **10**) and *radix* (default **nil**), which correspond to ***print-base*** and ***print-radix***, respectively. It is a subtype of **rational**.

ratio *Presentation Type*

`ratio &optional` *low high.*

The presentation type that represents a ratio between *low* and *high*. Options to this type are *base* and *radix*, which are the same as for the **`integer`** type. It is a subtype of **`rational`**.

float *Presentation Type*

`float &optional` *low high.*

The presentation type that represents a floating point number between *low* and *high*.

6.5.3 Character and String Presentation Types

These two presentation types can be used for reading and writing characters and strings.

character *Presentation Type*

Summary: The presentation type that represents a Common Lisp character object.

string *Presentation Type*

`string &optional` *length*

Summary: The presentation type that represents a string. If *length* is specified, the string must have exactly that many characters.

6.5.4 Pathname Presentation Types

pathname *Presentation Type*

Summary: The presentation type that represents a pathname.

The options are *default-version,* which defaults to **`:newest`**, *default-type*, which defaults to **`nil`**, and *merge-default,* which defaults to **`t`**. If *merge-default* is **`nil`**, **`accept`** returns the exact pathname that was entered; otherwise, **`accept`** merges against the default and *default-version*. If no default is supplied, it defaults to **`*default-pathname-defaults*`**. **`pathname`** has a default preprocessor that merges the options into the default.

6.5.5 One-Of and Some-Of Presentation Types

The "one-of" and "some-of" presentation types can be used to accept and present one or more items from a set of items. The set of items can be specified as a "rest" argument, a sequence, or an alist.

This table summarizes single ("one-of") and multiple ("some-of") selection presentation types. Each row represents a type of presentation. Columns contain the associated single and multiple selection presentation types.

One-Of and Some-Of Selection Presentation Types

Arguments	Single	Multiple
most general	completion	subset-completion
&rest elements	member	subset
sequence	member-sequence	subset-sequence
alist	member-alist	subset-alist

completion *Presentation Type*

`completion` *sequence* **`&key`** *test value-key*

Summary: The presentation type that selects one from a finite set of possibilities, with "completion" of partial inputs. Several types are implemented in terms of the **`completion`** type, including **`token-or-type`**, **`null-or-type`**, **`member`**, **`member-sequence`**, and **`member-alist`**.

sequence is a list or vector whose elements are the possibilities. Each possibility has a printed representation, called its name, and an internal representation, called its value. **`accept`** reads a name and returns a value. **`present`** is given a value and outputs a name.

test is a function that compares two values for equality. The default is **`eql`**.

value-key is a function that returns a value, given an element of *sequence*. The default is **`identity`**.

The following presentation type options are available:

- *name-key* is a function that returns a name as a string, given an element of *sequence*. The default is a function that behaves as follows according to the type of the element:

string	Returns the string.
null	Returns **`"nil"`**.
cons	Returns **`string`** of the car.
symbol	Returns **`string-capitalize`** of its name.
otherwise	Returns **`princ-to-string`** of it.

- *documentation-key* is a function that returns either **`nil`** or a descriptive string, given an element of *sequence*. The default always returns **`nil`**.
- *test*, *value-key*, *name-key*, and *documentation-key* must have indefinite extent.
- *partial-completers* is a possibly empty list of characters that delimit portions of a name that can be completed separately. The default is a list of one character, **`#\Space`**.

member *Presentation Abbreviation*

`member &rest` *elements*

Summary: The presentation type that specifies one of *elements*. The options are the same as for **`completion`**.

member-sequence *Presentation Abbreviation*

`member-sequence` *sequence* **`&key`** *test*

Summary: Like **`member`**, except that the set of possibilities is the sequence *sequence*. The parameter *test* and the options are the same as for **`completion`**.

member-alist *Presentation Abbreviation*

`member-alist` *alist* **`&key`** *test*

Summary: Like **`member`**, except that the set of possibilities is the alist *alist*. Each element of *alist* is either an atom, as in **`member-sequence`**, or a list whose car is the name of that possibility and whose cdr is one of the following:

- The value (which must not be a cons).
- A list of one element, the value.
- A property list that can contain the following properties:

`:value` The value.

`:documentation` A descriptive string.

The *test* parameter and the options are the same as for **`completion`** except that *value-key* and *documentation-key* default to functions that support the specified alist format.

subset-completion *Presentation Type*

`subset-completion` *sequence* **`&key`** *test value-key*

Summary: The type that selects one or more from a finite set of possibilities, with "completion" of partial inputs. The parameters and options are the same as for **`completion`**, plus the additional options *separator* and *echo-space*, which are as for the **`sequence`** type. The subset types that follow are implemented in terms of the **`subset-completion`** type.

subset *Presentation Abbreviation*

`subset &rest` *elements*

Summary: The presentation type that specifies a subset of *elements*. Values of this type are lists of zero or more values chosen from the possibilities in *elements*. The printed representation is the names of the elements separated by commas. The options are the same as for **`completion`**.

subset-sequence *Presentation Abbreviation*

`subset-sequence` *sequence* **`&key`** *test*

Summary: Like **`subset`**, except that the set of possibilities is the sequence *sequence*. The parameter *test* and the options are the same as for **`completion`**.

subset-alist *Presentation Abbreviation*

`subset-alist` *alist* **`&key`** *test*

Summary: Like **`subset`**, except that the set of possibilities is the alist *alist*.

6.5.6 Sequence Presentation Types

The following two presentation types can be used to accept and present a sequence of objects.

sequence *Presentation Type*

`sequence` *type*

Summary: The presentation type that represents a sequence of elements of type *type*. *type* can be a presentation type abbreviation. The printed representation of a **sequence** type is the elements separated by commas. **accept** returns a list.

The options to this type are *separator* and *echo-space*. *separator* is used to specify a character that will act as the separator between elements of the sequence; the default is the comma character `#\,`. *echo-space* is **t** or **nil**; when it is **t** (the default) a space will be automatically inserted into the input buffer when the user types a separator character.

sequence-enumerated *Presentation Type*

sequence-enumerated &rest *types*

Summary: **sequence-enumerated** is like **sequence**, except that the type of each element in the sequence is individually specified.The elements of *types* can be presentation type abbreviations. **accept** returns a list.

The options to this type are *separator* and *echo-space*, which are as for the **sequence** type.

6.5.7 Constructor Presentation Types

or *Presentation Type*

or &rest *types*

Summary: The presentation type that is used to specify one of several types, for example, **(or (member :all :none) integer).** The elements of *types* can be presentation type abbreviations. **accept** returns one of the possible types as its second value, not the original **or** presentation type specifier.

and *Presentation Type*

and &rest *types*

Summary: The type that is used for "multiple inheritance." **and** is frequently used in conjunction with **satisfies**, for example: **(and integer (satisfies oddp))**. The elements of *types* can be presentation type abbreviations.

The **and** type has special syntax that supports the two "predicates," **satisfies** and **not**. **satisfies** and **not** cannot stand alone as presentation types and cannot be first in *types*. **not** can surround either **satisfies** or a presentation type.

The first type in *types* is the type whose methods will be used during calls to **accept** and **present**.

6.5.8 Compound Presentation Types

The following compound presentation types are provided because they implement some common idioms.

token-or-type *Presentation Abbreviation*

token-or-type *tokens type*

Summary: A compound type that is used to select one of a set of special tokens, or an object of type *type*. *tokens* is anything that can be used as the *sequence* parameter to **member-alist**; typically it is a list of symbols.

null-or-type *Presentation Abbreviation*

null-or-type *type*

Summary: A compound type that is used to select **nil**, whose printed representation is the special token "None," or an object of type *type*.

type-or-string

Presentation Abbreviation

`type-or-string` *type*

Summary: A compound type that is used to select an object of type *type* or an arbitrary string, for example: **`(clim:type-or-string integer)`**. Any input that **`accept`** cannot parse as the representation of an object of type *type* is returned as a string.

6.5.9 Command and Form Presentation Types

The command and form presentation types are complex types provided primarily for use by the top-level interactor of an application.

expression

Presentation Type

Summary: The presentation type used to represent any Lisp object. The textual view of this type looks like what the standard **`print`** and **`read`** functions produce and accept. The standard **`print`** and **`read`** functions produce and accept the textual view of this type.

A separate presentation history for each instance of an application frame is maintained for the **`expression`** presentation type.

form

Presentation Type

Summary: The presentation type used to represent a Lisp form. This is a subtype of **`expression`** and is equivalent to it, except that some presentation translators produce **`quote`** forms.

command

Presentation Type

`command &key` *command-table*

Summary: The presentation type used to represent a command processor command and its arguments.

A separate presentation history for each instance of an application frame is maintained for the **`command`** presentation type.

command-name

Presentation Type

`command-name &key` *command-table*

Summary: The presentation type used to represent the name of a command processor command in the command table *command-table*.

command-or-form

Presentation Type

`command-or-form &key` *command-table*

Summary: The presentation type used to represent either a Lisp form or a command processor command and its arguments.

6.6 Functions That Operate on CLIM Presentation Types

These are some general-purpose functions that operate on CLIM presentation types.

describe-presentation-type

Function

`describe-presentation-type` *type* **`&optional`** *stream plural-count*

Summary: Describes the presentation type *type* on the *stream*, which defaults to **`*standard-output*`**. If *stream* is **`nil`**, a string containing the description is returned. *plural-count* is either **`nil`** (that is, the description should be the singular form of the name), **`t`** (meaning that the description should the plural form of the name), or an integer greater than zero (the number of items to be described). The default is **`1`**.

type can be a presentation type abbreviation.

presentation-type-name *Function*

`presentation-type-name` *type*

Summary: Returns the presentation type name of the presentation type specifier *type*. This function is provided as a convenience. It could be implemented as follows:

```
(defun presentation-type-name (type)
  (with-presentation-type-decoded (name) type name))
```

presentation-type-parameters *Function*

`presentation-type-parameters` *type-name* **`&optional`** *env*

Summary: Returns a lambda-list of the parameters specified when the presentation type or presentation type abbreviation whose name is *type-name* was defined. *type-name* is a symbol or a class. *env* is a macro-expansion environment, as in **`find-class`**.

presentation-type-options *Function*

`presentation-type-options` *type-name* **`&optional`** *env*

Summary: Returns the list of options specified when the presentation type or presentation type abbreviation whose name is *type-name* was defined. This does not include the standard options unless the presentation-type definition mentioned them explicitly. *type-name* is a symbol or a class. *env* is a macro-expansion environment, as in **`find-class`**.

presentation-typep *Function*

`presentation-typep` *object type*

Summary: Returns **`t`** if *object* is of the type specified by *type*, otherwise returns **`nil`**. *type* may not be a presentation type abbreviation. This is analogous to the Common Lisp **`typep`** function.

with-presentation-type-decoded *Macro*

`with-presentation-type-decoded (`*name-var* **`&optional`** *parameters-var options-var***`)`** *type* **`&body`** *body*

Summary: The specified variables are bound to the components of the presentation type specifier, the forms in *body* are executed, and the values of the last form are returned. *name-var*, if non-nil, is bound to the presentation type name. *parameters-var*, if non-nil, is bound to a list of the parameters. *options-var*, if non-nil, is bound to a list of the options. When supplied, *name-var*, *parameters-var*, and *options-var* must be symbols.

The *name-var*, *parameters-var*, and *options-var* arguments are not evaluated. *body* may have zero or more declarations as its first forms.

with-presentation-type-options *Macro*

`with-presentation-type-options (`*type-name type***`) &body`** *body*

Summary: Variables with the same name as each option in the definition of the presentation type are bound to the option values in *type*, if present, or else to the defaults specified in the definition of the presentation type. The forms in *body* are executed in the scope of these variables and the values of the last form are returned.

The value of the form *type* must be a presentation type specifier whose name is *type-name*. The *type-name* and *type* arguments are not evaluated. *body* may have zero or more declarations as its first forms.

with-presentation-type-parameters *Macro*

`with-presentation-type-parameters (`*type-name type***`) &body`** *body*

Summary: Variables with the same name as each parameter in the definition of the presentation type are bound to the parameter values in *type*, if present, or else to the defaults specified in the definition of the presentation type. The forms in *body* are executed in the scope of these variables and the values of the last form are returned.

The value of the form *type* must be a presentation type specifier whose name is *type-name*. The *type-name* and *type* arguments are not evaluated. *body* may have zero or more declarations as its first forms.

presentation-type-specifier-p *Function*

`presentation-type-specifier-p` *object*

Summary: Returns **`t`** if *object* is a valid presentation type specifier; otherwise, it returns **`nil`**.

presentation-type-of *Function*

`presentation-type-of` *object*

Summary: Returns a presentation type of which *object* is a member, in particular the most specific presentation type that can be conveniently computed and is likely to be useful to the programmer. This is often the class name of the class of the object.

`presentation-type-of` returns an expression when possible and **`t`** otherwise.

This is analogous to the Common Lisp **`type-of`** function.

presentation-subtypep *Function*

`presentation-subtypep` *type putative-supertype*

Summary: Answers the question "is the type specified by the presentation type specifier *type* a subtype of the type specified by the presentation type specifier *putative-supertype*?" **`presentation-subtypep`** returns two values, *subtypep* and *known-p*. When *known-p* is **`t`**, *subtypep* can be either **`t`** (meaning that *type* is definitely a subtype of *putative-supertype*) or **`nil`** (meaning that *type* is definitely not a subtype of *putative-supertype*). When *known-p* is **`nil`**, then *subtypep* must also be **`nil`**; this means that the answer cannot reliably be determined.

type may not be a presentation type abbreviation.

This is analogous to the Common Lisp **`subtypep`** function.

map-over-presentation-type-supertypes *Function*

`map-over-presentation-type-supertypes` *function type*

Summary: Calls the function *function* on the presentation type specifier *type* and each of its supertypes. *function* is called with two arguments, the name of a type and a presentation type specifier for that type with the parameters and options filled in. *function* has dynamic extent; its two arguments are permitted to have dynamic extent. The traversal of the type lattice is done in the order specified by the CLOS class precedence rules, and visits each type in the lattice exactly once.

presentation-type-direct-supertypes *Function*

`presentation-type-direct-supertypes` *type*

Summary: Returns a sequence of the names of all the presentation types that are direct supertypes of the presentation type specifier *type*, or **`nil`** if *type* has no supertypes. The consequences of modifying the returned sequence are unspecified.

find-presentation-type-class *Function*

`find-presentation-type-class` *name* **`&optional (`***errorp* **`t)`** *environment*

Summary: Returns the class corresponding to the presentation type named *name*, which must be a symbol or a class object. *errorp* and *environment* are as for **`find-class`**.

class-presentation-type-name *Function*

`class-presentation-type-name` *class* **`&optional`** *environment*

Summary: Returns the presentation type name corresponding to the class *class*. This is the inverse of **`find-presentation-type-class`**. *environment* is as for **`find-class`**.

default-describe-presentation-type *Function*

`default-describe-presentation-type` *description stream plural-count*

Summary: Performs the default actions for **`describe-presentation-type`**, notably pluralization and prepending an indefinite article if appropriate. *description* is a string or a symbol, typically the **`:description`** presentation type option or the **`:description`** option to **`define-presentation-type`**. *plural-count* is as for **`describe-presentation-type`**.

make-presentation-type-specifier *Function*

`make-presentation-type-specifier` *type-name-and-parameters* **`&rest`** *options*

Summary: A convenient way to assemble a presentation type specifier with only non-default options included. For a full description of this function, see the end of **7.2.1 Presentation Methods in CLIM**.

7 Defining a New Presentation Type

7.1 Conceptual Overview of Defining a New Presentation Type

CLIM's standard set of presentation types will be useful in many cases, but most applications will need customized presentation types to represent the objects modeled in the application.

In defining a presentation type, you define all the user interface components of the entity:

- A displayed representation, for example, textual or graphical.
- Pointer sensitivity for user input via the pointer.
- A textual representation for user input via the keyboard (optional).

In other words, in one place you provide all the information about an object necessary to display it to the user and to accept it as input from the user.

The set of presentation types forms a type lattice, an extension of the Common Lisp CLOS type lattice. When a new presentation type is defined as a subtype of another presentation type, it inherits all the attributes of the supertype except those explicitly overridden in the definition.

To define a new presentation type, you follow these steps:

1. Use the **`define-presentation-type`** macro.
   - Name the new presentation type.
   - Supply parameters that further restrict the type (if appropriate).
   - Supply options that affect the appearance of the type (if appropriate).
   - State the supertypes of this type, to make use of inheritance (if appropriate).
2. Define the CLIM presentation methods.
   - Specify how objects are displayed with a **`present`** presentation method. (You must define a **`present`** method, unless the new presentation type inherits a method that is appropriate for it.)
   - Specify how objects are parsed with an **`accept`** presentation method. (In most cases, you must define an **`accept`** method, unless the new presentation type inherits a method that is appropriate for it. If it will never be necessary to enter the object by typing its representation on the keyboard, you don't need to provide this method.)
   - Specify the type/subtype relationships of this type and its related types, if necessary, with **`presentation-typep`** and **`presentation-subtypep`** presentation methods. (You must define or inherit these methods when defining a presentation type that has parameters.)

7.1.1 CLIM Presentation Type Inheritance

Every presentation type is associated with a CLOS class. In the common case, the *name* of the presentation type is a class object or the name of a class, and that class is not a **`clos:built-in-class`**. In this case, the presentation type is associated with that CLOS class.

Otherwise, **define-presentation-type** defines a class with metaclass **clim:presentation-type-class** and superclasses determined by the presentation type definition. This class is not named *name*, since that could interfere with built-in Common Lisp types such as **and**, **member**, and **integer**. **clos:class-name** of this class returns a list (**presentation-type** *name*). **clim:presentation-type-class** is a subclass of **clos:standard-class**.

Note: If the same name is defined with both **clos:defclass** (or **defstruct**) and **define-presentation-type**, the **clos:defclass** (or **defstruct**) must be done first.

Every CLOS class (except for built-in classes) is a presentation type, as is its name. If it has not been defined with **define-presentation-type**, it allows no parameters and no options. As in CLOS, inheriting from a built-in class does not work unless you specify the same inheritance that the built-in class already has; you may want to do this in order to add presentation-type parameters to a built-in class.

If you define a presentation type that does not have the same name as a CLOS class, you must define a **presentation-typep** presentation method for it. The function (as opposed to the presentation method) **presentation-typep** uses **find-class** if the presentation type is piggybacking on a CLOS type. Otherwise it depends on the user-defined presentation method.

If you define a presentation type that has parameters, you must define a **presentation-subtypep** for it. As noted previously, CLOS does not allow you to parameterize types, so you must provide a **presentation-subtype** method even for presentation types based on CLOS classes.

Note that CLIM itself depends on these methods for its own presentation-based utilities.

If your presentation type has the same name as a class, does not have any parameters or options, does not have a history, and does not need a special description, you do not need to call **define-presentation-type**.

During method combination, presentation type inheritance is used both to inherit methods ("what parser should be used for this type?"), and to establish the semantics for the type ("what objects are sensitive in this context?"). Inheritance of methods is the same as in CLOS and thus depends only on the type name, not on the parameters and options.

Presentation type inheritance translates the parameters of the subtype into a new set of parameters for the supertype, and translates the options of the subtype into a new set of options for the supertype.

7.1.2 Defining an Accept for a Structure With Several Fields

The following code shows how to define an **accept** for a structure (instance) with several fields. That **accept** is then used within another similar **accept** call.

A presentation type called **ticket** is defined. The **accept** method has two recursive calls to **accept**, one to read the name of a candidate for president and another to read the name of the running mate. We provide two possible **accept** methods; in order to compare them, you will have to compile first one and then the other. The first reads the two names separated by a comma on the same line. The second reads the two names on separate lines, delimited by **RETURN**. They both do completion within the field. That is, if you do **(accept 'ticket :stream win)** with the first **accept** method, and type **"Bu,Qu<RETURN>"**, the screen appearance will be **"Bush,Quayle"** and the return value will be **(BUSH QUAYLE)**.

If you use the second **accept** method and type:

```
"Cl
Go
"
```

the window will contain:

```
"Clinton
Gore"
```

and the return value will be **(CLINTON GORE)**.

This example also demonstrates simple cross-field constraints by insisting that the two candidates be of the same party.

For key implementation details, read the comments in the code.

```
(in-package :clim-user)

(define-presentation-type ticket ())

(setf (get 'bush 'party) 'republican)
(setf (get 'quayle 'party) 'republican)
(setf (get 'clinton 'party) 'democrat)
(setf (get 'gore 'party) 'democrat)

;;; separated by comma version
(define-presentation-method accept ((type ticket) stream view &key &allow-other-keys)
  (declare (ignore view))
  (let ((president (accept '(member bush clinton) :stream stream :prompt nil
                           ;; add comma as a completing delimiter
                           :blip-characters '(#,))))
    ;; Make sure that the names were separated by a comma
    (unless (eql (read-gesture :stream stream) #,)
      (simple-parse-error "Ticket members must be separated by commas"))
    (let ((veep (accept '(member quayle gore) :stream stream :prompt nil)))
      ;; Validate party affiliations
      (unless (eql (get president 'party) (get veep 'party))
        (simple-parse-error "Ticket members must be of the same party"))
      (list president veep))))

;;; Separated by Return version
(define-presentation-method accept ((type ticket) stream view &key
                                   &allow-other-keys)
 (declare (ignore view))
 (let ((president (accept '(member bush clinton) :stream stream :prompt nil
                          ;; Remove Newline from activation characters
                          :activation-characters `()
                          ;; Add Newline as a delimiter, so that we get
                          ;; completion and move-to-next-field behavior
                          ;; when Return is typed.
                          :blip-characters `(#\Return #\Newline))))
   (unless (eql (read-gesture :stream stream) #\Newline)
     (simple-parse-error
      "Ticket members must be entered on separate lines"))
   (let ((veep (accept '(member quayle gore) :stream stream :prompt nil)))
     ;; Validate party affiliations
     (unless (eql (get president 'party) (get veep 'party))
       (simple-parse-error "Ticket members must be of the same party"))
     (list president veep))))
```

7.2 CLIM Operators for Defining New Presentation Types

define-presentation-type *Macro*

define-presentation-type *name parameters* **&key** *options inherit-from description history parameters-are-types*

Summary: Defines a presentation type whose name is the symbol or class *name* and whose parameters are specified by the lambda-list *parameters*. These parameters are visible within *inherit-from* and within the methods created with **define-presentation-method**. For example, the parameters are used by **presentation-typep** and **presentation-subtypep** methods to refine their tests for type inclusion.

options is a list of option specifiers. It defaults to **nil**. An option specifier is either a symbol or a list of the form (*symbol*

&optional default supplied-p presentation-type accept-options), where *symbol*, *default*, and *supplied-p* are as in a normal lambda-list. If *presentation-type* and *accept-options* are present, they specify how to accept a new value for this option from the user. *symbol* can also be specified in the (*keyword variable*) form allowed for Common Lisp lambda lists. *symbol* is a variable that is visible within *inherit-from* and within most of the methods created with **`define-presentation-method`**. The keyword corresponding to *symbol* can be used as an option in the third form of a presentation type specifier. An option specifier for the standard option **`:description`** is automatically added to *options* if an option with that keyword is not present; however, it does not produce a visible variable binding.

Unsupplied optional or keyword parameters default to **`*`** (as in **`deftype`**) if no default is specified in *parameters*. Unsupplied options default to **`nil`** if no default is specified in *options*.

inherit-from is a form that evaluates to a presentation type specifier for another type from which the new type inherits. *inherit-from* can access the parameter variables bound by the *parameters* lambda list and the option variables specified by *options*. If *name* is or names a CLOS class (other than a **`built-in-class`**), then *inherit-from* must specify the class's direct superclasses (using **`and`** to specify multiple inheritance). It is useful to do this when you want to parameterize previously defined CLOS classes.

If *inherit-from* is unsupplied, the default behavior is that if *name* is or names a CLOS class, then the type inherits from the presentation type corresponding to the direct superclasses of that CLOS class (using **`and`** to specify multiple inheritance). Otherwise, the type named by *name* inherits from **`standard-class`**.

description is a string or **`nil`**. This should be the term for an instance for the type being defined. If it is **`nil`** or unsupplied, a description is automatically generated; it will be a "prettied up" version of the type name, for example, **`small-integer`** would become **`"small integer"`**. You can also write a **`describe-presentation-type`** presentation method. *description* is implemented by the default **`describe-presentation-type`** method, so *description* only works in presentation types where that default method is not shadowed.

history can be **`t`** (the default), meaning that this type has its own history of previous inputs; **`nil`**, meaning that this type keeps no history; or the name of another presentation type whose history is shared by this type. More complex histories can be specified by writing a **`presentation-type-history`** presentation method.

If the boolean *parameters-are-types* is **`t`**, this means that the parameters to the presentation type are themselves presentation types. If they are not presentation types, *parameters-are-types* should be supplied as **`nil`**. Types such as **`and`**, **`or`**, and **`sequence`** will specify this as **`t`**.

Every presentation type must define or inherit presentation methods for **`accept`** and **`present`** if the type is going to be used for input and output. For presentation types that are only going to be used for input via the pointer, the **`accept`** need not be defined.

If a presentation type has *parameters*, it must define presentation methods for **`presentation-typep`** and **`presentation-subtypep`** that handle the parameters, or inherit appropriate presentation methods. In many cases it should also define presentation methods for **`describe-presentation-type`** and **`presentation-type-specifier-p`**.

There are certain restrictions on the *inherit-from* form, to allow it to be analyzed at compile time. The form must be a simple substitution of parameters and options into positions in a fixed framework. It cannot involve conditionals or computations that depend on valid values for the parameters or options; for example, it cannot require parameter values to be numbers. It cannot depend on the dynamic or lexical environment. The form will be evaluated at compile time with uninterned symbols used as dummy values for the parameters and options. In the type specifier produced by evaluating the form, the type name must be a constant that names a type, the type parameters cannot derive from options of the type being defined, and the type options cannot derive from parameters of the type being defined. All presentation types mentioned must be already defined. **`and`** can be used for multiple inheritance, but **`or`**, **`not`**, and **`satisfies`** cannot be used.

None of the arguments, except *inherit-from*, are evaluated.

7.2.1 Presentation Methods in CLIM

Use **define-presentation-method** to define presentation methods.

define-presentation-method *Macro*

define-presentation-method *name qualifiers** *specialized-lambda-list* **&body** *body*

Summary: Defines a presentation method for the function named *name* on the presentation type named in *specialized-lambda-list*.

specialized-lambda-list is a CLOS specialized lambda list for the method, and its contents vary depending on what *name* is. *qualifiers** is zero or more of the usual CLOS method qualifier symbols. **define-presentation-method** supports **standard** method combination (the **:before**, **:after**, and **:around** method qualifiers).

body defines the body of the method. *body* may have zero or more declarations as its first forms.

All presentation methods have an argument named *type* that must be specialized with the name of a presentation type. The value of *type* is a presentation type specifier, which can be for a subtype that inherited the method.

All presentation methods except those for **presentation-subtypep** have lexical access to the parameters from the presentation type specifier. Presentation methods for the functions **accept**, **present**, **describe-presentation-type**, **presentation-type-specifier-p**, and **accept-present-default** also have lexical access to the options from the presentation type specifier.

Presentation methods inherit and combine in the same way as ordinary CLOS methods. However, they do not resemble ordinary CLOS methods with respect to the *type* argument. The parameter specializer for *type* is handled in a special way, and presentation method inheritance arranges the type parameters and options seen by each method.

For example, consider three types **int**, **rrat**, and **num** defined as follows:

```
(define-presentation-type int (low high)
  :inherit-from `(rrat ,high ,low))

(define-presentation-method presentation-typep :around (object (type int))
  (and (call-next-method)
       (integerp object)
       (<= low object high)))

(define-presentation-type rrat (high low)
  :inherit-from `num)

(define-presentation-method presentation-typep :around (object
                                                        (type rrat))
  (and (call-next-method)
       (rationalp object)
       (<= low object high)))

(define-presentation-type num ())

(define-presentation-method presentation-typep (object (type num))
  (numberp object))
```

If the user were to evaluate the form **(presentation-typep** *x* **'(int 1 5))**, then the type parameters will be **(1 5)** in the **presentation-typep** method for **int**, **(5 1)** in the method for **rrat**, and **nil** in the method for **num**. The value for *type* will be **((int 1 5))** in each of the methods.

Following are the names of the various presentation methods defined by **define-presentation-method**, along with the lambda-list for each method. For all of the presentation methods, the *type* will always be specialized. Where appropriate, *view* may be specialized as well. The other arguments are not usually specialized.

accept *Presentation*

accept *type stream view* **&key** *default default-type*

Summary: This presentation method is responsible for "parsing" the representation of *type* for a particular view *view* on the stream *stream*.The **accept** method returns a single value (the object that was "parsed"), or two values, the object and its type (a presentation type specifier). The method's caller takes care of establishing the input context, defaulting, prompting, and input editing.

The **accept** method can specialize on the *view* argument in order to define more than one input view for the data.

Note that **accept** presentation methods can call the function **accept** recursively. In this case, the programmer should be careful to specify **nil** for **:prompt** and **:display-default** unless recursive prompting is really desired.

present *Presentation*

present *object type stream view* **&key** *acceptably for-context-type*

Summary: This presentation method is responsible for displaying the representation of *object* having type *type* for a particular view *view*; see the function **accept**.

The **present** method can specialize on the *view* argument in order to define more than one view of the data. For example, a spreadsheet program might define a presentation type for revenue, which can be displayed either as a number or a bar of a certain length in a bar graph. Typically, at least one canonical view should be defined for a presentation type.

describe-presentation-type *Presentation*

describe-presentation-type *type stream plural-count*

Summary: This presentation method is responsible for textually describing the type *type*. *stream* is a stream, and will not be **nil** as it can be for the **describe-presentation-type** function.

presentation-type-specifier-p *Presentation*

presentation-type-specifier-p *type*

Summary: This presentation method is responsible for checking the validity of the parameters and options for the presentation type *type*. The default method returns **t**.

presentation-typep *Presentation*

presentation-typep *object type*

Summary: This presentation method is called when the **presentation-typep** function requires type-specific knowledge. If the type name in the presentation type *type* is or names a CLOS class, the method is called only if *object* is a member of the class and *type* contains parameters. The method simply tests whether *object* is a member of the subtype specified by the parameters. For non-class types, the method is always called.

For example, the type method will not get called in **(presentation-typep 1.0 `(integer 10))** because 1.0 is not an integer. The method will get called by **(presentation-typep 10 `(integer 0 5))**.

presentation-subtypep *Presentation*

presentation-subtypep *type putative-supertype*

Summary: This presentation method is called when the **presentation-subtypep** function requires type-specific knowledge.

presentation-subtypep walks the type lattice (using **map-over-presentation-supertypes**) to determine whether or not the presentation type *type* is a subtype of the presentation type *putative-supertype*, without looking at the type parameters. When a supertype of *type* has been found whose name is the same as the name of *putative-supertype*, then the **subtypep** method for that type is called in order to resolve the question by looking at the type parameters (that is, if the **subtypep** method is called, *type* and *putative-supertype* are guaranteed to be the same type, differing only in their parameters). If *putative-supertype* is never found during the type walk, then **presentation-subtypep** will never call the **presentation-subtypep** presentation method for *putative-supertype*.

Unlike all other presentation methods, **presentation-subtypep** receives a *type* argument that has been translated to the presentation type for which the method is specialized; *type* is never a subtype. The method is only called if *putative-supertype* has parameters and the two presentation type specifiers do not have equal parameters. The method must return the two values that **presentation-subtypep** returns.

Since **presentation-subtypep** takes two type arguments, the parameters are not lexically available as variables in the body of a presentation method.

map-over-presentation-type-supertypes *Presentation*

map-over-presentation-type-supertypes *function type*

Summary: This method is called in order to apply *function* to the superclasses of the presentation type *type*.

accept-present-default *Presentation*

accept-present-default *type stream view default default-supplied-p present-p query-identifier*

Summary: This method specializes the kind of default that is to be presented to the user. It is called when **accept** turns into **present** inside **accepting-values**. The default method calls **present** or **describe-presentation-type**, depending on whether *default-supplied-p* is **t** or **nil**, respectively.

The boolean *default-supplied-p* will be **t** only in the case when the **:default** option was explicitly supplied in the call to **accept** that invoked **accept-present-default**.

present-p and *query-identifier* are arguments that are called internally by the accept-values mechanism that this method needs to handle. The form of *present-p* as it is handed down (internally) from **accepting-values** is a list of the presentation type of the accepting-values query (**accept-values-choice**) and the query object itself, e.g., **(list 'accept-values-choice** *av-query-object***)**. The value of *query-identifier* is an internal **accept-values** query identifier object.

presentation-type-history *Presentation*

presentation-type-history *type*

Summary: This method returns a history object for the presentation type *type*, or **nil** if there is none.

presentation-refined-position-test *Presentation*

presentation-refined-position-test (*record presentation-type x y***)**

Summary: This method is supplied when the user wants a more precise test of whether the supplied coordinate arguments (*x* and *y*) are "contained" by the *record* argument. Without this test, whether or not a position is within a record is determined by simply by seeing if the position is inside the bounding-rectangle of that record.

highlight-presentation *Presentation*

highlight-presentation *type record stream state*

Summary: This method is responsible for drawing a highlighting box around the presentation *record* on the output recording stream *stream*. *state* will be either **:highlight** or **:unhighlight**.

See **7.4 Advanced Topics** for more in-depth material relating to defining presentation methods.

7.2.2 CLIM Operators for Defining Presentation Type Abbreviations

You can define an abbreviation for a presentation type for the purpose of naming a commonly used cliche. The abbreviation is simply another name for a presentation type specifier.

Exported functions that call **expand-presentation-type-abbreviation** allow abbreviations.

- **accept**
- **accept-from-string**
- **with-output-as-presentation**
- **with-input-context**
- **present**
- **describe-presentation-type**
- **presentation-type-history**
- **presentation-default-preprocessor**
- **define-presentation-translator**

---

define-presentation-type-abbreviation *Macro*

define-presentation-type-abbreviation *name parameters equivalent-type* **&key** *options*

Summary: Defines a presentation type that is an abbreviation for the presentation type specifier that is the value of *equivalent-type*.

Where presentation type abbreviations are allowed, *equivalent-type* and abbreviations are exactly equivalent and can be used interchangeably.

name must be a symbol and must not be the name of a CLOS class.

The *equivalent-type* form might be evaluated at compile time if presentation type abbreviations are expanded by compiler optimizers. Unlike *inherit-from*, *equivalent-type* can perform arbitrary computations and is not called with dummy parameter and option values. The type specifier produced by evaluating *equivalent-type* can be a real presentation type or another abbreviation. If the type specifier does not include the standard option **:description**, the option is automatically copied from the abbreviation to its expansion.

Note that you cannot define any presentation methods on a presentation type abbreviation. If you need methods, use **define-presentation-type** instead.

define-presentation-type-abbreviation is used to name a commonly used cliche. For example, a presentation type to read an octal integer might be defined as:

```
(define-presentation-type-abbreviation octal-integer
  (&optional low high)
  `((integer ,low ,high) :base 8
    :description "octal integer"))
```

None of the arguments, except *equivalent-type*, is evaluated.

When writing presentation type abbreviations, it is sometimes useful to let CLIM include or exclude defaults for parameters and options. In some cases, you may also find it necessary to "expand" a presentation type abbreviation. The following three functions are useful in these circumstances.

expand-presentation-type-abbreviation-1 *Function*

expand-presentation-type-abbreviation-1 *type* **&optional** *environment*

Summary: If the presentation type specifier *type* is a presentation type abbreviation, or is an **and**, **or**, **sequence**, or **sequence-enumerated** that contains a presentation type abbreviation, then **expand-presentation-type-abbreviation-1** expands the type abbreviation once and returns two values, the expansion and **t**. If *type* is not a presentation type abbreviation, then the values *type* and **nil** are returned. *env* is a macro -expansion environment, as in **macroexpand**.

expand-presentation-type-abbreviation *Function*

expand-presentation-type-abbreviation *type* **&optional** *environment*

Summary: **expand-presentation-type-abbreviation** is like **expand-presentation-type-abbreviation-1**, except that *type* is repeatedly expanded until all presentation type abbreviations have been removed.

make-presentation-type-specifier *Function*

make-presentation-type-specifier *type-name-and-parameters* **&rest** *options*

Summary: A convenient way to make a presentation type specifier including only non-default options. This is only useful for abbreviation expanders, not for the **:inherit-from** clause of **define-presentation-type**. *type-name-and-parameters* is a presentation type specifier that must be in the form of:

(*type-name parameters***\…)**

options is a list of alternating keywords and values that are added as options to the specifier. If a value is equal to *type-name*'s default, that option is omitted, producing a more concise presentation type specifier.

7.3 Using Views With CLIM Presentation Types

The **present** and **accept** presentation methods can define more than one view of the data. For example, a spreadsheet program might define a presentation type for revenue, which can be displayed either as a number or as a bar of a certain length in a bar graph. These two views might be implemented by specializing the view arguments for the **textual-menu-view** class and the user-defined **bar-graph-view** class. Typically, at least one canonical view should be defined for a presentation type. For example, the **present** method for the **textual-menu-view** view should be defined if the programmer wants to allow objects of that type to be displayed textually. A more concrete example is the dialog view of the **member** presentation type, which presents the choices in a "radio push-button" style.

CLIM currently supports textual, menu, and dialog views. Operators for views of CLIM presentation types are listed as follows.

view *Protocol Class*

Summary: The protocol class for view objects. If you want to create a new class that behaves like a view, it should be a subclass of **view**. Subclasses of **view** must obey the view protocol. All of the view classes are immutable.

viewp *Function*

viewp *object*

Summary: Returns **t** if *object* is a view; otherwise, it returns **nil**.

stream-default-view *Generic Function*

`stream-default-view` *stream*

Summary: Returns the default view for the extended stream *stream*. **`accept`** and **`present`** get the default value for the *view* argument from this.

(setf stream-default-view) *Generic Function*

`(setf stream-default-view)` *view stream*

Summary: Changes the default view for *stream* to the view *view*.

textual-menu-view *Class*

Summary: The class that represents the default view used inside **`menu-choose`** for frame managers that are not using a gadget-type look and feel.

textual-dialog-view *Class*

Summary: The class that represents the default view used inside **`accepting-values`** dialogs for frame managers that are not using a gadget-type look and feel.

gadget-menu-view *Class*

Summary: The class that represents the default view used inside **`menu-choose`** for frame managers using a gadget-type look and feel.

gadget-dialog-view *Class*

Summary: This subclass of **`gadget-view`** represents the default view used inside **`accepting-values`** dialogs for frame managers that are using a gadget-type look and feel.

pointer-documentation-view *Class*

Summary: The class that represents the default view that is used when computing pointer documentation.

+textual-menu-view+

+textual-dialog-view+

+gadget-menu-view+

+gadget-dialog-view+

+pointer-documentation-view+ *Constants*

Summary: These are objects of class **`textual-menu-view`**, **`textual-dialog-view`**, **`gadget-menu-view`**, **`gadget-dialog-view`**, and **`pointer-documentation-view`**, respectively.

7.4 Advanced Topics

Material in this section is advanced; most CLIM programmers can skip this section entirely. The following constructs apply to defining presentation types, discussed in **7.2 CLIM Operators for Defining New Presentation Types**.

presentation-default-preprocessor *Presentation*

`presentation-default-preprocessor` *default type* **`&key`** *default-type*

Summary: This method is responsible for taking the object *default* and coercing it to match the presentation type *type* (which is the type being accepted) and *default-type* (which is the presentation type of *default*). This is useful when you want to change the default gotten from the presentation type's history so that it conforms to parameters or options in *type* and *default-type*. The method returns two values, the new object to be used as the default, and a new presentation type, which should be at least as specific as *type*.

define-presentation-generic-function *Macro*

`define-presentation-generic-function` *generic-function-name presentation-function-name lambda-list* **`&rest`** *options*

Summary: Defines a generic function that will be used for presentation methods. *generic-function-name* is a symbol that names the generic function that will be used internally by CLIM for the individual methods. *presentation-function-name* is a symbol that names the function that programmers will call to invoke the method, and *lambda-list* and *options* are as for **`defgeneric`**.

There are some "special" arguments in *lambda-list* that the presentation type system knows about. The first argument in *lambda-list* must be either **`type-key`** or **`type-class`**; CLIM uses this argument to implement method dispatching. The second argument may be **`parameters`**, meaning that when the method is invoked, the type parameters will be passed to it. The third argument may be **`options`**, meaning that when the method is invoked, the type options will be passed to it. Finally, an argument named **`type`** must be included in *lambda-list*; when the method is called, *type* argument will be bound to the presentation type specifier.

For example, the **`present`** presentation generic function might be defined thus:

```
(define-presentation-generic-function present-method present
  (type-key parameters options object type stream view
            &key acceptably for-context-type))
```

None of the arguments are evaluated.

define-default-presentation-method *Macro*

`define-default-presentation-method` *name qualifiers** *specialized-lambda-list* **`&body`** *body*

Summary: Like **`define-presentation-method`**, except that it is used to define a default method that will be used only if there are no more specific methods.

funcall-presentation-generic-function *Macro*

`funcall-presentation-generic-function` *presentation-function-name* **`&rest`** *arguments*

Summary: Calls the presentation generic function named by *presentation-function-name* on the arguments *arguments*. *arguments* must match the arguments specified by the **`define-presentation-generic-function`** that were used to define the presentation generic function, excluding the **`type-key`**, **`type-class`**, **`parameters`**, and **`options`** arguments, which are filled in by CLIM.

`funcall-presentation-generic-function` is analogous to **`funcall`**.

The *presentation-function-name* argument is not evaluated.

To call the **`present`** presentation generic function, one might use the following:

```
(funcall-presentation-generic-function
 present object presentation-type stream view)
```

apply-presentation-generic-function *Macro*

`apply-presentation-generic-function` *presentation-function-name* **`&rest`** *arguments*

Summary: Like **`funcall-presentation-generic-function`**, except that

`apply-presentation-generic-function` is analogous to **`apply`**. The *presentation-function-name* argument is not evaluated.

8 Presentation Translators in CLIM

8.1 Conceptual Overview of Presentation Translators

CLIM provides a mechanism for "translating" between presentation types. In other words, within an input context for type A, the translator mechanism allows a programmer to have presentations of some other type B treated as though they were objects of type A.

You can define ***presentation translators*** to make the user interface of your application more flexible. For example, suppose the input context is expecting a command. In this input context, all displayed commands are sensitive, so the user can point to one to execute it. However, suppose the user points to another kind of displayed object, such as a student. In the absence of a presentation translator, the student is not sensitive because only commands can be entered to this input context.

If you used a presentation translator that translates from students to commands, however, both students and commands would be sensitive. When the student is highlighted, the middle pointer button might execute the command **`show-transcript`** for that student.

A presentation translator defines how to translate from one presentation type to another. In the previous scenario, the input context is **`command`**. A user-defined presentation translator states how to translate from the **`student`** presentation type to the **`command`** presentation type.

The concept of translating from an arbitrary presentation type to a command is so useful that CLIM provides the special **`define-presentation-to-command-translator`** macro for this purpose. You can think of these presentation-to-command translators as a convenience for the users; users can select the command and give the argument at the same time.

Note that presentation-to-command translators make it easier to write applications that give a "direct manipulation" feel to the user.

A presentation that appears on the screen can be ***sensitive***. This means that the presentation can be operated on directly by using the pointer. A sensitive presentation will be highlighted when the pointer is over it. (In rare cases, the highlighting of some sensitive presentations is turned off.)

Sensitivity is controlled by three factors:

- Input context type—a presentation type describes the type of input currently being accepted.
- Pointer location—the pointer is pointing at a presentation or a blank area on the screen.
- Modifier keys (**`CONTROL`**, **`META`**, and **`SHIFT`**)—these keys expand the space of available gestures beyond what is available from the pointer buttons.

Presentation translators link these three factors.

A presentation translator specifies the conditions under which it is applicable, a description to be displayed, and what to do when it is invoked by clicking the pointer.

A presentation is sensitive (and highlighted) if there is at least one applicable translator that could be invoked by clicking a button with the pointer at its current location and the modifier keys in their current state. If there is no applicable translator, there is no sensitivity and no highlighting.

Each presentation translator has two associated presentation types, its *from-presentation-type* and *to-presentation-type*, which are the primary factors in its applicability. Since a presentation translator translates an output presentation into an input presentation, a presentation translator is applicable if the type of the presentation at the pointer "matches" the *from-*

presentation-type and the input context type "matches" the *to-presentation-type*. (We define what "match" means in the next section.) Each presentation translator is attached to a particular pointer gesture, which is a combination of a pointer button and a set of modifier keys. Clicking the pointer button while holding down the modifier keys invokes the translator.

Note that a translator produces an input presentation consisting of an object and a presentation type to satisfy the program accepting input. The result of a translator might be returned from **`accept`**, or it might be absorbed by a parser and provide only part of the input. An input presentation is not actually represented as an object. Instead, a translator's body returns two values. The object is the first value. The presentation type is the second value; it defaults to the *to-presentation-type* if the body returns only one value.

8.2 Applicability of CLIM Presentation Translators

When CLIM is waiting for input (inside a **`with-input-context`**) it is responsible for determining what translators are applicable to which presentations in a given input context. This loop both provides feedback in the form of highlighting sensitive presentations and is responsible for calling the applicable translator when the user presses a pointer button.

`with-input-context` uses **`frame-find-innermost-applicable-presentation`** (via **`highlight-applicable-presentation`**) as its "input wait" handler, and **`frame-input-context-button-press-handler`** as its button press "event handler".

Given a presentation, an input context established by **`with-input-context`**, and a user gesture, translator matching proceeds as follows.

The set of candidate translators is initially those translators accessible in the command table in use by the current application. For more information, see **11.3 Command Objects**.

A translator "matches" if all of the following are true. Note that these tests are performed in the order listed.

- The presentation's type is **`presentation-subtypep`** of the translator's *from-presentation-type*, ignoring type parameters (for example, if *from-presentation-type* is **`number`** and the presentation's type is **`integer`** or **`float`**, or if *from-presentation-type* is **`(or integer string)`** and presentation's type is **`integer`**).
- The translator's *to-presentation-type* is **`presentation-subtypep`** of the input context type, ignoring type parameters.
- The translator's gesture either is **`t`** or is the same as the gesture that the user could perform with the current chord of modifier keys.
- The presentation's object is **`presentation-typep`** of the translator's *from-presentation-type*, if the *from-presentation-type* has parameters. The translator's tester returned a non-nil value. If there is no tester, the translator behaves as though the tester always returns **`t`**.
- If there are parameters in the input context type and the **`:tester-definitive`** option is not used in the translator, the value returned by the body of the translator must be **`presentation-typep`** of the input context type. In **`define-presentation-to-command-translator`** and **`define-presentation-action`**, the tester is always definitive.

The algorithm is somewhat more complicated in the case of nested presentations and nested input contexts. In this situation, the sensitive presentation is the smallest presentation that matches the *innermost* input context.

When there are several translators that match for the same gesture, the one with the highest **`:priority`** is chosen (see **`define-presentation-translator`**).

8.2.1 Input Contexts in CLIM

Roughly speaking, the current input context indicates what type of input CLIM is asking the user for. You can establish an input context in CLIM with the following constructs:

- **accept**
- **accept-from-string**
- **present** (with an **accept** inside).
- The command loop of an application.
- **with-input-context**

The input context designates a presentation type. However, the way to accept one type of object may involve accepting other types of objects as part of the procedure. (Consider the request to accept a complex number, which is likely to involve accepting two real numbers.) Such input contexts are called ***nested***. In the case of a nested input context, several different context presentation types can be available to match the *to-presentation-types* of presentation translators.

Each level of input context is established by a call to **accept**. The macro **with-input-context** also establishes a level of input context.

The most common cause of input context nesting is accepting compound objects. For example, you might define a command called **Show File**, which reads a sequence of pathnames. When reading the argument to the **Show File** command, the input context contains **pathname** nested inside of **(sequence clim:pathname)**. Acceptable keyboard input is a sequence of pathnames separated by commas. A presentation translator that translates to a **(sequence clim:pathname)** supplies the entire argument to the command, and the command processor moves on to the next argument. A presentation translator that translates to a pathname is also applicable. It supplies a single element of the sequence being built up, and the command processor awaits additional input for this argument, or the entry of a **SPACE** or **RETURN** to terminate the argument.

When the input context is nested, sensitivity considers only the innermost context type that has any applicable presentation translators for the currently pressed chord of modifier keys.

8.2.2 Nested Presentations in CLIM

Presentations can overlap on the screen, so there can be more than one presentation at the pointer location. Often when two presentations overlap, one is nested inside the other.

One cause of nesting is presentations of compound objects. For example, a sequence of pathnames has one presentation for the sequence, and another for each pathname.

When there is more than one candidate presentation at the pointer location, CLIM must decide which presentation is the sensitive one. It starts with the innermost presentation at the pointer location and works outwards through levels of nesting until a sensitive presentation is discovered. This is the innermost presentation that has any applicable presentation translators to any of the nested input context types for the currently pressed chord of modifier keys. Searching in this way ensures that a more specific presentation is sensitive. Note that nested input contexts are searched first, before nested presentations. For presentations that overlap, the most recently presented is searched first.

8.3 Pointer Gestures in CLIM

A ***gesture*** is an input action by the user, such as typing a character or clicking a pointer button. A pointer gesture refers to those gestures that involve using the pointer.

An ***event*** is a CLIM object that represents a gesture by the user. (The most important pointer events are those of class **pointer-button-event**.)

A ***gesture name*** is a symbol that names a gesture. CLIM defines the following gesture names (the corresponding gesture appears in parentheses) and their uses:

:select (left click) — For the most commonly used translator on an object. For example, use the **:select** gesture while reading an argument to a command to use the indicated object as the argument.

`:describe` (middle click)

For translators that produce a description of an object (such as showing the current state of an object). For example, use the **`:describe`** gesture on an object in a CAD program to display the parameters of that object.

`:menu` (right click) For translators that pop up a menu.

`:delete` (**`SHIFT`**-middle click)

For translators that delete an object.

`:edit` (**`META`**-right click)

For translators that edit an object.

The special gesture name **`nil`** is used in translators that are not directly invokable by a pointer gesture. Such a translator can be invoked only from a menu.

The special gesture name **`t`** means that the translator is available on every gesture.

You can use **define-gesture-name** (see **15.3 Gestures and Gesture Names**) to define your own pointer gesture name.

Note that with the exception of the **`define-gesture-name`** forms (which you can use to map gesture names to keys and buttons), the application is independent of which platform it runs on. It uses keywords to give names to gestures, rather than making references to specific pointer buttons and keyboard keys.

The following operators can be used to add or remove new pointer gesture names. **15 Extended Stream Input Facilities** for details about the pointer and gestures.

add-pointer-gesture-name *Function*

`add-pointer-gesture-name` *gesture-name button shifts* **`&key (`***action* **`:`***click***`) (`***unique* **`t)`**

Summary: Adds a pointer gesture named *gesture-name* (a symbol) for the pointer *button* being clicked on the pointer while the *shifts* shift keys are being held down on.

remove-pointer-gesture-name *Function*

`remove-pointer-gesture-name` *gesture-name*

Summary: Removes the pointer gesture named *gesture-name*.

8.4 CLIM Operators for Defining Presentation Translators

`define-presentation-translator` supports presentation translators in general, and **`define-presentation-to-command-translator`** supports a common idiom.

define-presentation-translator *Macro*

`define-presentation-translator` *name* **`(`***from-type to-type command-table* **`&key`** *gesture tester tester-definitive documentation pointer-documentation menu priority***`)`** *arglist* **`&body`** *body*

Summary: Defines a presentation translator named *name* that translates from objects of type *from-type* to objects of type *to-type*. *from-type* and *to-type* are presentation type specifiers, but must not include any presentation type options. *from-type* and *to-type* may be presentation type abbreviations.

command-table is a command table designator. The translator created by this invocation of **`define-presentation-translator`** will be stored in the command table *command-table*.

gesture is a gesture name that names a pointer gesture (described in **15.3 Gestures and Gesture Names**). The body of the translator will be run only if the translator is applicable and gesture used by the user matches the gesture name in the translator. *gesture* defaults to **`:select`**.

tester is either a function or a list of the form (*tester-arglist* . *tester-body*) where *tester-arglist* takes the same form as *arglist* and *tester-body* is the body of the tester. The tester must return either **`t`** or **`nil`**. If it returns **`nil`**, then the translator is definitely not applicable. If it returns **`t`**, then the translator might be applicable, and the body of the translator might be run (if *tester-definitive* is **`nil`**) in order to decide definitively whether the translator is applicable. If no tester is supplied, CLIM supplies a tester that always returns **`t`**.

When the boolean *tester-definitive* is **`t`**, the body of the translator is not run in order to decide whether the translator is applicable; that is, the tester is assumed to definitively decide whether the translator applies. The default is **`nil`**.

Both *documentation* and *pointer-documentation* are objects that will be used for documenting the translator. *pointer-documentation* will be used to generate documentation for the pointer documentation window; the documentation generated by *pointer-documentation* should be very brief, and computing it should be very fast and preferably not cons. *documentation* is used to generate such things as items in the **`:menu`** gesture menu. If the object is a string, the string itself will be used as the documentation. Otherwise, the object must be the name of a function or a list of the form (*doc-arglist* . *doc-body*) where *doc-arglist* takes the same form as *arglist*, but includes a named (keyword) *stream* argument as well, and *doc-body* is the body of the documentation function. The body of the documentation function should write the documentation to *stream*. The default for *documentation* is **`nil`**, meaning that there is no explicitly supplied documentation; in this case, CLIM is free to generate the documentation in other ways. The default for *pointer-documentation* is *documentation*.

menu must be **`t`** or **`nil`**. When it is **`t`**, the translator will be included in the **`:menu`** gesture menu if it matches. When it is **`nil`**, the translator will not be included in the **`:menu`** gesture menu. Other non-nil values are reserved for future extensions to allow multiple presentation translator menus.

priority is either **`nil`** (the default, which corresponds to 1) or an integer that represents the priority of the translator. When there are several translators that match for the same gesture, the one with the highest priority is chosen.

arglist, *tester-arglist*, and *doc-arglist* are argument lists that must "match" the "canonical" argument list **`(`***object* **`&key`** *presentation context-type frame event window x y amount***`)`**. In order to do so, there must be a single positional argument that corresponds to the presentation's object, and several named arguments that must match the canonical names listed previously (using **`string-equal`** to do the comparison).

In the body of the translator (or the tester), the positional *object* argument will be bound to the presentation's object. The named arguments *presentation* will be bound to the presentation that was clicked on, *context-type* will be bound to the presentation type of the context that actually matched, *frame* will be bound to the application frame that is currently active (usually **`*application-frame*`**), *event* will be bound to the pointer button event that the user used, *window* will be bound to the window stream from which the event came, *x* and *y* will be bound to the **`x`** and **`y`** positions within *window* that the pointer was at when the event occurred and *amount* will be bound to the amount of mouse wheel rotation (or 0 non-mouse wheel gestures). The special variable **`*input-context*`** will be bound to the current input context. Note that *context-type* and **`*input-context*`** will have dynamic extent, so programmers should not store without first copying them.

body is the body of the translator, and is run in the context of the application. *body* may have zero or more declarations as its first forms. It returns either one, two, or three values. The first value is an object that must be **`presentation-typep`** of *to-type*. The second value is a presentation type that must be **`presentation-subtypep`** of *to-type*. The first two returned values of *body* are in effect used as the returned values for the call to **`accept`** that established the matching input context.

The third value returned by *body* must either be **`nil`** or a list of options (as keyword-value pairs) that will be interpreted by **`accept`**. The only option defined so far is **`:echo`**, whose value must be either **`t`** (the default) or **`nil`**. If it is **`t`**, the object returned by the translator will be "echoed" by **`accept`**, which will use **`presentation-replace-input`** to insert the textual representation of the object into the input buffer. If it is **`nil`**, the object will not be echoed.

None of the arguments to **`define-presentation-translator`** are evaluated.

define-presentation-to-command-translator *Macro*

`define-presentation-to-command-translator` *name* **(***from-type command-name command-table* **`&key`** *gesture tester documentation pointer-documentation menu priority echo***)** *arglist* **`&body`** *body*

Summary: This resembles **`define-presentation-translator`**, except that the *to-type* will be derived to be the command named by *command-name* in the command table *command-table*. *command-name* is the name of the command that this translator will translate to.

The *echo* option is a boolean value (the default is **`t`**) that indicates whether the command line should be echoed when a user invokes the translator.

The other arguments to **`define-presentation-to-command-translator`** are the same as for **`define-presentation-translator`**. Note that the tester for command translators is always assumed to be definitive, so there is no **`:tester-definitive`** option. The default for *pointer-documentation* is the string *command-name* with dash characters replaced by spaces, and each word capitalized (as in **`add-command-to-command-table`**).

The body of the translator returns a list of the arguments to the command named by *command-name*. *body* is run in the context of the application. The returned value of the body, appended to the command name, is passed to **`execute-frame-command`**. *body* may have zero or more declarations as its first forms.

None of this macro's arguments are evaluated.

define-presentation-action *Macro*

`define-presentation-action` *name* **(***from-type to-type command-table* **`&key`** *gesture tester documentation pointer-documentation menu priority***)** *arglist* **`&body`** *body*

Summary: **`define-presentation-action`** is similar to **`define-presentation-translator`**, except that the body of the action is not intended to return a value, but instead affects some sort of application state.

A presentation action does not satisfy a request for input the way an ordinary translator does. Instead, an action is something that happens while waiting for input. After the action has been executed, the program continues to wait for the same input that it was waiting for prior to executing the action.

The other arguments to **`define-presentation-action`** are the same as for **`define-presentation-translator`**. Note that the tester for presentation actions is always assumed to be definitive.

None of the arguments to **`define-presentation-action`** are evaluated.

define-drag-and-drop-translator *Macro*

`define-drag-and-drop-translator` *name from-type to-type destination-type command-table* **`&key`** *gesture tester before-drag-tester documentation pointer-documentation menu priority feedback highlighting arglist* **`&body`** *body*

Summary: Defines a presentation translator named *name* that will be run when a presentation is dragged with the mouse and dropped on top of another presentation. The presentation types of the "dragged" (*from-type*) and "dropped on" (*to-type*) presentations are used to determine which translator (*destination-type*) is invoked. *from-type*, *to-type*, and *destination-type* are presentation type specifiers, but must not include any presentation type options. *from-type*, *to-type* and *destination-type* may be presentation type abbreviations.

The interaction style used by these translators is that a user points to a "from presentation" with the pointer, picks it up by pressing a pointer button matching *gesture*, drags the "from presentation" to a "to presentation" by moving the pointer, and then drops the "from presentation" onto the "to presentation." The dropping might be accomplished by either releasing the pointer button or clicking again, depending on the frame manager. When the pointer button is released, the translator whose *destination-type* matches the presentation type of the "to presentation" is chosen. For example, dragging a file to the TrashCan on a Macintosh could be implemented by a drag and drop translator.

When the user drags a "from presentation" over potential targets, the function or list specified by *tester* is invoked. This tester is identical to *tester* for **define-presentation-translator** except that it can take two additional arguments: *destination-object* and *destination-presentation*.

When the user points at a potential "from presentation" to drag, the function or list specified by *before-drag-tester* is invoked. The *before-drag-tester* takes the same arguments as *tester* for **define-presentation-translator**.

While the pointer is being dragged, the function specified by *feedback* is invoked to provide feedback to the user. The function is called with eight arguments: the application frame object, the "from presentation," the stream, the initial **x** and **y** positions of the pointer, the current **x** and **y** positions of the pointer, and a feedback state (either **:highlight** to draw feedback, or **:unhighlight** to erase it). The feedback function is called to draw some feedback the first time pointer moves, and is then called twice each time the pointer moves thereafter (once to erase the previous feedback, and then to draw the new feedback). It is called a final time to erase the last feedback when the pointer button is released. *feedback* defaults to **frame-drag-and-drop-feedback**.

When the "from presentation" is dragged over any other presentation that has a direct manipulation translator, the function specified by *highlighting* is invoked to highlight that object. The function is called with four arguments: the application frame object, the "to presentation" to be highlighted or unhighlighted, the stream, and a highlighting state (either **:highlight** or **:unhighlight**). *highlighting* defaults to **frame-drag-and-drop-highlighting**.

Note that it is possible for there to be more than one drag and drop translator that applies to the same *from-type*, *to-type*, and *gesture*. In this case, the exact translator that is chosen for use during the dragging phase is unspecified. If these translators have different feedback, highlighting, documentation, or pointer documentation, the exact behavior is unspecified.

The other arguments to **define-drag-and-drop-translator** are the same as for **define-presentation-translator**.

8.5 Examples of Defining Presentation Translators in CLIM

8.5.1 Defining a Translation from Floating Point Number to Integer

Here is an example that defines a presentation translator to accept an **integer** object from a **float** presentation. Users have the options of typing in a float or integer to the input prompt or clicking on any **float** or **integer** presentation.

```
(define-presentation-translator integer-to-float
  (integer float my-command-table
           :documentation "Integer as float"
           :gesture :select
           :tester ((object) (integerp object))
           :tester-definitive t)
  (object)
  (float object))

(clim:present most-positive-fixnum)

(clim:accept 'float)
```

8.5.2 Defining a Presentation-to-Command Translator

The following example defines the **delete-file** presentation-to-command translator:

```
(clim:define-presentation-to-command-translator
 delete-file
 (pathname com-delete-file my-command-table
           :documentation "Delete this file"
```

```
          :gesture :delete)
 (object)
 (list object))
```

8.5.3 Defining Presentation Translators for the Blank Area

You can also write presentation translators that apply to blank areas of the window, that is, areas where there are no presentations. Use **`blank-area`** as the *from-presentation-type*. There is no highlighting when such a translator is applicable, since there is no presentation to highlight. You can write presentation translators that apply in any context by supplying **`nil`** as the *to-presentation-type*.

When you are writing an interactive graphics routine, you will probably encounter the need to have commands available when the mouse is not over any object. To do this, you write a ***translator*** from the blank area.

The presentation type of the blank area is **`blank-area`**. You probably want the *:x* and *:y* arguments to the translator.

For example:

```
(clim:define-presentation-to-command-translator
 add-circle-here
 (clim:blank-area com-add-circle my-command-table
                  :documentation "Add a circle here.")
 (x y)
 `(,x ,y))
```

8.5.4 Defining a Presentation Action

Presentation actions are only rarely needed. Often a presentation-to-command translator is more appropriate. One example where actions are appropriate is when you wish to pop up a menu during command input. Here is how CLIM's general menu action could be implemented:

```
(clim:define-presentation-action
 presentation-menu
 (t nil clim:global-command-table
    :tester-definitive t :documentation "Menu"
    :menu nil :gesture :menu)
 (presentation frame window x y)
 (clim:call-presentation-menu presentation clim:*input-context*
                              frame window x y :for-menu t))
```

8.6 Advanced Topics

The material in this section is advanced; most CLIM programmers can skip to the next chapter. This section discusses low-level functions for CLIM presentation translators.

Some applications may wish to deal directly with presentation translators, for example, if you are tracking the pointer yourself and wish to locate sensitive presentations, or want to generate a list of applicable translators for a menu. The following functions are useful for finding and calling presentation translators directly.

find-presentation-translators *Function*

`find-presentation-translators` *from-type to-type command-table*

Summary: Returns a list of all of the translators in the command table *command-table* that translate from *from-type* to *to-type*, without taking into account any type parameters or testers. *from-type* and *to-type* are presentation type specifiers, and must not be abbreviations. *frame* must be an application frame.

test-presentation-translator *Function*

`test-presentation-translator` *translator presentation context-type frame window x y* **`&key`** *event modifier-state for-menu*

Summary: Returns **`t`** if the translator *translator* applies to the presentation *presentation* in input context type *context-type*, otherwise returns **`nil`**. (There is no *from-type* argument because it is derived from *presentation*.) *x* and *y* are the **`x`** and **`y`** positions of the pointer within the window stream *window*.

event and *modifier-state* are a pointer button event and modifier state (see **`event-modifier-key-state`**), and are compared against the translator's gesture. *event* defaults to **`nil`**, and *modifier-state* defaults to 0, meaning that no modifier keys are held down. Only one of *event* or *modifier-state* may be supplied.

If *for-menu* is **`t`**, the comparison against *event* and *modifier-state* is not done.

presentation, *context-type*, *frame*, *window*, *x*, *y*, and *event* are passed along to the translator's tester if and when the tester is called.

`test-presentation-translator` matches type parameters and calls the translator's tester. Under some circumstances, **`test-presentation-translator`** may also call the body of the translator to ensure that its value matches *to-type*.

find-applicable-translators *Function*

`find-applicable-translators` *presentation input-context frame window x y* **`&key`** *event modifier-state for-menu fastp*

Summary: Returns an object that describes the translators that definitely apply to the presentation *presentation* in the input context *input-context*. The result is a list whose elements are each of the form (*translator the-presentation context-type tag*) where *translator* is a presentation translator, *the-presentation* is the presentation that the translator applies to (and which can be different from *presentation* due to nesting of presentations), *context-type* is the context type in which the translator applies, and *tag* is a tag used internally by CLIM. *translator*, *the-presentation*, and *context-type* can be passed to such functions as **`call-presentation-translator`** and **`document-presentation-translator`**.

Since input contexts can be nested, **`find-applicable-translators`** must iterate over all the contexts in *input-context*. *window*, *x*, and *y* are as for **`test-presentation-translator`**. *event* and *modifier-state* (which default to **`nil`** and the current modifier state for *window*, respectively) are used to further restrict the set of applicable translators. (Only one of *event* or *modifier-state* may be supplied; it is unspecified what will happen if both are supplied.)

When *for-menu* is non-nil, the value of *for-menu* is matched against the presentation's menu specification, and only those translators that match are returned. *event* and *modifier-state* are disregarded in this case. *for-menu* defaults to **`nil`**.

When the boolean *fastp* is **`t`**, **`find-applicable-translators`** will simply return **`t`** if there are any translators. When *fastp* is **`nil`** (the default), the list of translators returned by **`find-applicable-translators`** must be in order of their "desirability"; that is, translators having more specific from-types and/or higher priorities must precede translators having less specific from-types and lower priorities.

The rules used for ordering the translators returned by **`find-applicable-translators`** are as follows (in order):

1. Translators with a higher "high order" priority precede translators with a lower "high order" priority. This allows programmers to set the priority of a translator in such a way that it always precedes all other translators.

2. Translators with a more specific "from type" precede translators with a less specific "from type".

3. Translators with a higher "low order" priority precede translators with a lower "low order" priority. This allows programmers to break ties between translators that translate from the same type.

4. Translators from the current command table precede translators inherited from superior command tables.

presentation-matches-context-type *Function*

presentation-matches-context-type *presentation context-type frame window x y* **&key** *event modifier-state*

Summary: Returns **t** if there are any translators that translate from the presentation *presentation*'s type to the input context type *context-type*; otherwise, it returns **nil**. (There is no *from-type* argument because it is derived from *presentation*.) *frame, window, x, y, event,* and *modifier-state* are as for **test-presentation-translator**.

If there are no applicable translators, **presentation-matches-context-type** will return **nil**.

call-presentation-translator *Function*

call-presentation-translator *translator presentation context-type frame event window x y*

Summary: Calls the function that implements the body of the translator *translator* on the presentation *presentation*'s object, and passes *presentation*, *context-type*, *frame*, *event*, *window*, *x*, and *y* to the body of the translator as well.

The returned values are the same as the values returned by the body of the translator, namely, the translated object and the translated type.

document-presentation-translator *Function*

document-presentation-translator *translator presentation context-type frame event window x y* **&key** *stream documentation-type*

Summary: Computes the documentation string for the translator *translator* and outputs it to the stream *stream*, which defaults to ***standard-output***. *presentation*, *context-type*, *frame*, *event*, *window*, *x*, and *y* are as for **test-presentation-translator**.

documentation-type must be either **:normal** or **:pointer**. If it is **:normal**, the usual translator documentation function is called. If it is **:pointer**, the translator's pointer documentation is called.

call-presentation-menu *Function*

call-presentation-menu *presentation input-context frame window x y* **&key** *for-menu label*

Summary: Finds all the applicable translators for the presentation *presentation* in the input context *input-context*, creates a menu that contains all of the translators, and pops up the menu from which the user can choose a translator. After the translator is chosen, it is called with the arguments supplied to **call-presentation-menu**, and the matching input context established by **with-input-context** is terminated.

window, *x*, *y*, and *event* are as for **find-applicable-translators**. *for-menu*, which defaults to **t**, is used to decide which of the applicable translators will go into the menu; only those translators whose **:menu** option matches *menu* will be included.

label is either a string to use as a label for the menu, or is **nil** (the default), meaning the menu will not be labelled.

The following functions are useful for finding an application presentation in an output history:

find-innermost-applicable-presentation *Function*

find-innermost-applicable-presentation *input-context window x y* **&key** *frame modifier-state event*

Summary: Given an input context *input-context*, an output recording window stream *window*, *x* and *y* positions *x* and *y*, returns the innermost presentation whose sensitivity region contains *x* and *y* that matches the innermost input context, using the translator matching algorithm described later. If there is no such presentation, this function will return **nil**.

event and *modifier-state* are a pointer button event and modifier state (see **event-modifier-key-state**). *event* defaults to **nil**, and *modifier-state* defaults to the current modifier state for *window*. Only one of *event* or *modifier-state* may be supplied; it is unspecified what will happen if both are supplied.

frame defaults to the current frame, **`*application-frame*`**.

The default method for **`frame-find-innermost-applicable-presentation`** will call this function.

throw-highlighted-presentation *Function*

`throw-highlighted-presentation` *presentation input-context button-press-event*

Summary: Given a presentation *presentation*, input context *input-context*, and a button press event (which contains the window, pointer, **`x`** and **`y`** position of the pointer within the window, the button pressed, and the modifier state), finds the translator that matches the innermost presentation in the innermost input context, then calls the translator to produce an object and a presentation type. Finally, the matching input context that was established by **`with-input-context`** will be terminated.

Note that it is possible that more than one translator having the same gesture may be applicable to *presentation* in the specified input context. In this case, the translator having the highest priority will be chosen. If there is more than one having the same priority, it is unspecified what translator will be chosen.

highlight-applicable-presentation *Function*

`highlight-applicable-presentation` *frame stream input-context* **`&optional`** *prefer-pointer-window*

Summary: This is the core of the "input wait" handler used by **`with-input-context`** on behalf of the application frame *frame*. It locates the innermost applicable presentation on *stream* in the input context *input-context*, unhighlighting presentations that are not applicable and highlighting the presentation that is applicable. Typically on entry to **`highlight-applicable-presentation`**, *input-context* will be the value of **`*input-context*`** and *frame* will be the value of **`*application-frame*`**.

prefer-pointer-window is a boolean. If it is **`t`** (the default), CLIM will highlight the applicable presentation on the same window that the pointer is located over. Otherwise, CLIM will highlight an applicable presentation on *stream*.

set-highlighted-presentation *Function*

`set-highlighted-presentation` *stream presentation* **`&optional`** *prefer-pointer-window*

Summary: Highlights the presentation *presentation* on *stream*. This must call **`highlight-presentation`** methods if that is appropriate.

unhighlight-highlighted-presentation *Function*

`unhighlight-highlighted-presentation` *stream* **`&optional`** *prefer-pointer-window*

Summary: Unhighlights any highlighted presentations on *stream*.

9 Defining Application Frames

9.1 Conceptual Overview of CLIM Application Frames

Application frames (or simply ***frames***) are the central abstraction defined by CLIM for presenting an application's user interface. Many of the other features and facilities provided by CLIM (for example, the generic command loop, gadgets, look-and-feel independence) can be conveniently accessed through the frame facility. Frames can be displayed as either top-level windows or regions embedded within the space of the user interfaces of other applications. In addition to controlling the screen real estate managed by an application, a frame keeps track of the Lisp state variables that contain the state of the application.

The contents of a frame is established by defining a hierarchy of ***panes***. CLIM panes are interactive objects that are analogous to the windows, gadgets, or widgets of other toolkits. Application builders can compose their application's user interface from a library of standard panes or by defining and using their own pane types. Application frames can use a number of different types of panes, including ***layout panes*** for organizing space, ***extended stream panes*** for presenting application-specific information, and ***gadget panes*** for displaying data and obtaining user input. Panes are described in greater detail in **10 Panes and Gadgets**.

Frames are managed by special applications called ***frame managers***. Frame managers control the realization of the look and feel of a frame. The frame manager interprets the specification of the application frame in the context of the available window system facilities, taking into account preferences expressed by the user. In addition, the frame manager takes care of attaching the pane hierarchy of an application frame to an appropriate place in a window hierarchy. The most common type of frame manager is one that allows the user to manipulate the frames of other applications. This type of application is typically called a desktop manager, or in X Windows terminology, a window manager. In many cases, the window manager will be a non-Lisp application. In these cases, the frame manager will act as a mediator between the Lisp application and the host desktop manager.

Some applications may act as frame managers that allow the frames of other applications to be displayed with their own frames. For example, a text editor might allow figures generated by a graphic editor to be edited in place by managing the graphics editor's frame within its own frame.

Application frames provide support for a standard interaction processing loop, like the Lisp "read-eval-print" loop, called a ***command loop***. The application programmer only has to write the code that implements the frame-specific commands and output display functions. A key aspect of the command loop is the separation of the specification of the frame's commands from the specification of the end-user interaction style.

The standard interaction loop consists of reading an input "sentence" (the command and all of its operands), executing the command, and updating the displayed information as appropriate.

To write an application that uses the standard interaction loop provided by CLIM, you need to:

- Define the presentation types that correspond to the user-interface entities of the application.
- Define the commands that correspond to the visible operations of the application, specifying the presentation types of the operands involved in each command.
- Define the set of frames and panes needed to support the application.
- Define the output display functions associated with each of the panes (possibly using other facilities such as the incremental redisplay).

In the case of a simple CAD program, the programmer would first define the appropriate presentation types, such as wires, input and output signals, gates, resistors, and so forth. She would then define the program's commands in terms of these types. For example, the "Connect" command might take two operands, one of type "component" and the other of type "wire." The programmer may wish to specify the interaction style for invoking each command, for example, direct manipulation via translators, or selection of commands from menus. After defining an application frame that includes a CLIM stream pane, the programmer then writes the frame-specific display routine that displays the circuit layout. Now the application is ready to go. The end-user selects a command (via a menu, command-line, or whatever), the top-level loop takes care of collecting the operands for that command (via a variety of user gestures), and then the application invokes the command. The command may affect the frame's "database" of information, which can in turn affect the output displayed by the redisplay phase.

Note that this definition of the standard interaction loop does not constrain the interaction style to be a command-line interface. The input sentence may be entered via single keystrokes, pointer input, menu selection, dialogs, or by typing full command lines.

9.2 Defining CLIM Application Frames

define-application-frame *Macro*

`define-application-frame` *name superclasses slots* **`&rest`** *options*

Summary: Defines a frame and CLOS class named by the symbol *name* that inherits from *superclasses* and has state variables specified by *slots*. *superclasses* is a list of superclasses that the new class will inherit from (as in **`defclass`**). When *superclasses* is **`nil`**, it behaves as though a superclass of **`standard-application-frame`** was supplied. *slots* is a list of additional slot specifiers, whose syntax is the same as the slot specifiers in **`defclass`**. Each instance of the frame will have slots as specified by these slot specifiers. These slots will typically hold any per-instance frame state.

options is a list of **`defclass`**-style options, and can include the usual **`defclass`** options, plus any of the following:

- **`:pane`** *form*, where *form* specifies the single pane in the application. The default is **`nil`**, meaning that there are either no panes or there are multiple panes. This is the simplest way to define a pane hierarchy. The **`:pane`** option cannot be used with the **`:panes`** and **`:layouts`** options. See **9.2.2 Using the :pane Option** for a complete description of the **`:pane`** option.
- **`:panes`** *form*, where *form* is an alist that specifies names and panes of the application. The default is **`nil`**, meaning that there are no named panes. The **`:panes`** and **`:pane`** options are mutually exclusive. See **9.2.3 Using the :panes and :layouts Options** for a complete description of the **`:panes`** option.
- **`:layouts`** *form*, where *form* specifies the layout. The default layout is to lay out all of the named panes in horizontal strips. The **`:layouts`** and **`:pane`** options are mutually exclusive. See **9.2.3 Using the :panes and :layouts Options** for a complete description of the **`:layouts`** option.
- **`:command-table`** *name-and-options*, where *name-and-options* is a list consisting of the name of the application frame's command table followed by some keyword-value pairs. The keywords can be **`:inherit-from`** or **`:menu`** (which are as in **`define-command-table`**). The default is to create a command table with the same name as the application frame.
- **`:menu-bar`** *form* is used to specify what commands will appear in a "menu bar." It typically specifies the top-level commands of the application. *form* is either **`nil`**, meaning there is no menu bar; **`t`**, meaning that the menu from frame's command table (from the **`:command-table`** option) should be used; a symbol that names a command table, meaning that that command table's menu should be used. The default is **`t`**.
- **`:disabled-commands`** *commands*, where *commands* is a list of command names that are initially disabled in the application frame.
- **`:command-definer`** *value*, where *value* either **`nil`**, **`t`**, or another symbol. When it is **`nil`**, no command-defining macro is defined. When it is **`t`**, a command-defining macro is defined, whose name is of the form **`define-`***name***`-command`**. When it is another symbol, the symbol names the command-defining macro. The default is **`t`**.

- **:top-level** *form*, where *form* is a list whose first element is the name of a function to be called to execute the top-level loop. The function must take at least one argument, the frame. The rest of the list consists of additional arguments to be passed to the function. The default function is **default-frame-top-level**.

The *name*, *superclasses*, and *slots* arguments are not evaluated. The values of each of the options are evaluated.

make-application-frame *Function*

make-application-frame *frame-name* **&rest** *options* **&key** *pretty-name frame-manager enable state left top right bottom width height save-under frame-class* **&allow-other-keys**

Summary: Makes an instance of the application frame of type *frame-class*. If *frame-class* is not supplied, it defaults to *frame-name*.

The size options *left*, *top*, *right*, *bottom*, *width*, and *height* can be used to specify the size of the frame.

options are passed as additional arguments to **make-instance**, after the *pretty-name*, *frame-manager*, *enable*, *state*, *save-under*, *frame-class*, and size options have been removed.

If *save-under* is **t**, then the sheets used to implement the user interface of the frame will have the "save under" property, if the host window system supports it.

If *frame-manager* is provided, then the frame is adopted by the specified frame manager. If the frame is adopted and either *enable* or *state* is provided, the frame is pushed into the given state. See **9.9 Frame Managers**.

Once a frame has been created, **run-frame-top-level** can be called to make the frame visible and run its top-level function.

application-frame *Variable*

Summary: The current application frame. The global value is CLIM's default application, which serves only as a repository for whatever internal state is needed by CLIM to operate properly. This variable is typically used in the bodies of commands to gain access to the state variables of the application frame, usually in conjunction with **with-slots** or **slot-value**.

with-application-frame *Macro*

with-application-frame (*frame***) &body** *body*

Summary: This macro provides lexical access to the "current" frame for use with the **:pane**, **:panes**, and **:layouts** options. *frame* is bound to the current frame within the context of one of those options.

frame is a symbol; it is not evaluated. *body* may have zero or more declarations as its first forms.

9.2.1 The Application Frame Protocol

application-frame *Protocol Class*

Summary: The protocol class that corresponds to an application frame. If you want to create a new class that behaves like an application frame, it should be a subclass of **application-frame.** Subclasses of **application-frame** must obey the application frame protocol.

All application frame classes are mutable.

application-frame-p *Function*

application-frame-p *object*

Summary: Returns **t** if *object* is an application frame; otherwise, it returns **nil**.

:name

:pretty-name

:command

:disabled

:panes

:menu-bar

:calling-frame

:state

:properties *Initargs*

Summary: All subclasses of **`application-frame`** must handle these initargs, which specify, respectively, the name, pretty name, command table, initial set of disabled commands, panes, menu bar, calling frame, state, and initial properties for the frame.

standard-application-frame *Class*

Summary: The standard class that implements application frames. By default, most application frame classes will inherit from this class, unless a non-nil value for *superclasses* is supplied to **`define-application-frame`**.

9.2.2 Using the :pane Option

The panes of a frame can be specified in one of two different ways. If the frame has a single layout and no need of named panes, then the **`:pane`** option can be used. Otherwise, if named panes or multiple layouts are required, the **`:panes`** and **`:layouts`** options can be used. Note that the **`:pane`** option cannot be used with **`:panes`** and **`:layouts`**. It is meaningful to define frames that have no panes at all; the frame will simply serve as a repository for state and commands.

The value of the **`:pane`** option is a form that is used to create a single (albeit arbitrarily complex) pane. For example:

```
(vertically ()
            (tabling ()
                     ((horizontally ()
                                    (make-pane 'toggle-button)
                                    (make-pane 'toggle-button)
                                    (make-pane 'toggle-button))
                      (make-pane 'text-field))
                     ((make-pane 'push-button :label "a button")
                      (make-pane 'slider)))
            (scrolling ()
                       (make-pane 'application-pane
                                  :display-function
                                  'a-display-function))
            (scrolling ()
                       (make-pane 'interactor-pane)))
```

9.2.3 Using the :panes and :layouts Options

If the **`:pane`** option is not used, a set of named panes can be specified with the **`:panes`** option. Optionally, **`:layouts`** can also be used to describe different layouts of the set of panes.

The value of the **`:panes`** option is an alist, each entry of which is of the form (*name* . *body*). *name* is a symbol that names the pane, and *body* specifies how to create the pane. *body* is either a list containing a single element that is itself a list, or a list consisting of a symbol followed by zero or more keyword-value pairs. In the first case, the *body* is a form exactly like the form used in the **:pane** option. In the second case, *body* is a ***pane abbreviation***, where the initial symbol names the type of pane, and the keyword-value pairs are pane options. For gadgets, the pane type is the class name of the abstract gadget (for example, **slider** or **push-button**). For CLIM extended stream panes, the following abbreviations are defined:

- **:interactor**—a pane of type **interactor-pane**
- **:application**—a pane of type **application-pane**
- **:command-menu**—a pane of type **command-menu-pane**
- **:pointer-documentation**—a pane suitable for displaying pointer documentation, if the host window system does not provide this.
- **:title**—a pane suitable for displaying the title of the application. If the host window system provides this, the title will be displayed with the window decorations supplied by the window manager, and the CLIM title pane will be omitted.
- **:accept-values**—a pane that can hold a "modeless" **accepting-values** dialog.

See **10 Panes and Gadgets** for more information on the individual pane and gadget classes and the options they support.

An example of the use of **:panes** is:

```
(:panes
 (buttons
  (horizontally ()
                (make-pane 'push-button :label "Press me")
                (make-pane 'push-button :label "Squeeze me")))
 (toggle toggle-button
        :label "Toggle me")
 (interactor :interactor
            :width 300 :height 300)
 (application :application
             :display-function 'another-display-function
             :incremental-redisplay t))
```

The value of the **:layouts** option is an alist, each entry of which is of the form (*name* . *layout*). *name* is a symbol that names the layout, and *layout* specifies the layout. *layout* is a form like the form used in the **:pane** option, with the extension to the syntax such that the name of a named pane can be used wherever a pane may appear. For example, assuming a frame that uses the **:panes** example, the following layouts could be specified:

```
(:layouts
 (default
   (vertically ()
               button toggle
               (scrolling () application)
               interactor))
 (alternate
  (vertically ()
              (scrolling () application)
              (scrolling () interactor)
              (horizontally ()
                            button toggle))))
```

9.2.4 Example of the :pane Option to define-application-frame

Here is an example of how to use the **:pane** option of **define-application-frame**:

```
(define-application-frame test-frame ()
  ()
  (:pane
```

```
(vertically ()
            (make-clim-interactor-pane
             :foreground +green+
             :background +red+)
            (make-pane 'push-button
                       :label "press me"
                       :background +black+
                       :foreground +purple+
                       :activate-callback
                       #'(lambda (button)
                           (frame-exit *application-frame*))
                       :text-style
                       (make-text-style :serif :roman 20)))))
```

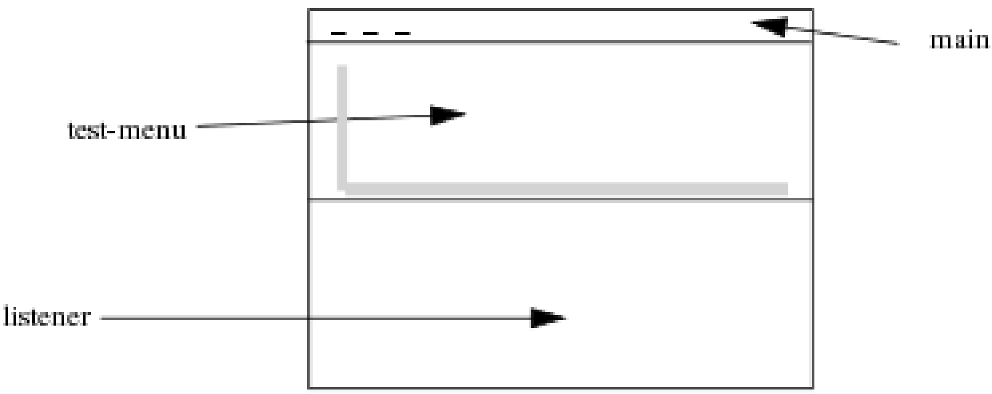
9.2.5 Examples of the :panes and :layout Options to define-application-frame

Here are some examples of how to use the **:panes** and **:layouts** options of **define-application-frame** to describe the appearance of your application.

We begin by showing **The Default Layout for the Graphic-Demo Example When No Explicit :layout Is Specified**, an example of how CLIM supplies a default layout when you don't explicitly specify one in your frame definition. The default layout is a single column of panes, in the order (top to bottom) that you specified them in the **:panes** option. Command menus are allocated only enough space to display their contents, while the remaining space is divided among the other types of panes equally.

```
(define-application-frame test () ()
  (:panes
   (main :application
         :incremental-redisplay NIL
         :display-function 'display-main)
   (test-menu :command-menu)
   (listener :interactor))
  (:layouts
   (:default
    (vertically () main test-menu listener)))
  (:command-table
   (test-menu
    :inherit-from (user-command-table)
    :menu
    (("EXIT" :command cmd-exit)))))
```

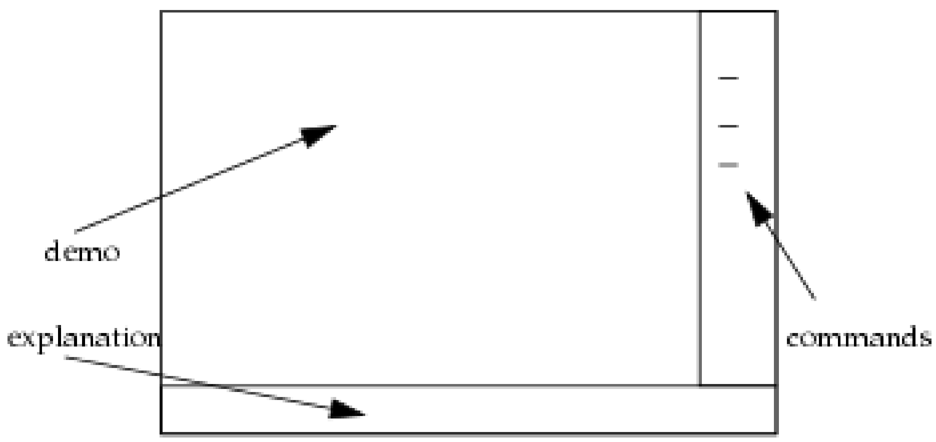
The Default Layout for the Graphic-Demo Example When No Explicit :layout Is Specified



Now we take the same example as before and in **The Layout for the Graphic-Demo Example With an Explicit :layout** add an explicit **:layout** option to the frame definition. The pane named **explanation** occupies the bottom sixth of the screen. The remaining five-sixths are occupied by the **demo** and **commands** panes, which lie side by side, with the command pane to the right. The commands pane is only as wide as is needed to display the command menu.

```
(define-application-frame graphics-demo () ()
  (:menu-bar nil)
  (:panes
   (commands :command-menu)
   (demo :application)
   (explanation :application :scroll-bars nil))
  (:layouts
   (:default (vertically ()
                        (:fill
                         (horizontally ()
                                       (:fill demo)
                                       (1/5 commands)))
                        (1/6 explanation)))))
```

The Layout for the Graphic-Demo Example With an Explicit :layout



Finally, here is a stripped-down version of the application frame definition for the CAD demo (in the file **<release-directory>/demo/cad-demo.lisp**) which implements an extremely simplistic computer-aided logic circuit design tool.

There are four panes defined for the application. The pane named **title** displays the string "Mini-CAD" and serves to remind the user which application is running. The pane named **menu** provides a menu of commands for the application. The pane named **design-area** is the actual "work surface" of the application on which various objects (logic gates and wires) can be manipulated. A pane named **documentation** is provided to inform the user about what actions can be performed using the pointing device (typically the mouse) and is updated based on what object is currently being pointed to.

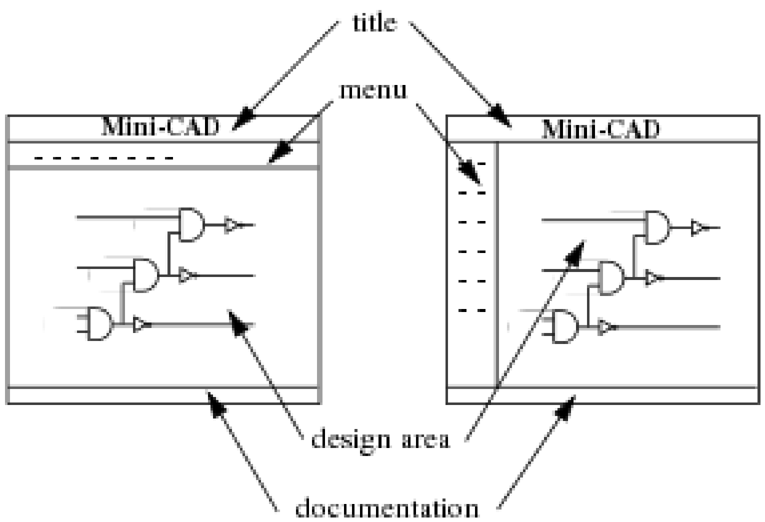
The application has two layouts, one named **main** and one named **other**. Both layouts have their panes arranged in vertical columns. At the top of both layouts is the **title** pane, which is of the smallest height necessary to display the title string "Mini-CAD." Both layouts have the **documentation** pane at the bottom.

The two layouts differ in the arrangement of the **menu** and **design-area** panes. In the layout named **main**, the **menu** pane appears just below the **title** pane and extends for the width of the screen. Its height will be computed so as to be sufficient to hold all the items in the menu. The **design-area** pane occupies the remaining screen real estate, extending from the bottom of the **menu** pane to the top of the **documentation** pane, and is as wide as the screen.

To see the layout named **other**, enter **(setf (frame-current-layout *application-frame*) :other)**. This differs from the **main** layout in the shape of the **design-area** pane. Here the implementor of the CAD demo realized that, depending on what was being designed, either a short, wide area or a narrower but taller area might be more appropriate. The **other** layout provides the narrower, taller alternative by rearranging the **menu** and **design-area** panes to be side by side (forming a row of the two panes). The **menu** and **design-area** panes occupy the space between the bottom of the **title** pane and the top of the **documentation** pane, with the **menu** pane to the left and occupying as much width as is necessary to display all the items of the menu and the **design-area** occupying the remaining width.

```
(define-application-frame cad-demo () ()
  (:menu-bar nil)
  (:panes
   (title :title :display-string "Mini-CAD")
   (menu :command-menu)
   (design-area :application)
   (documentation :pointer-documentation))
  (:layouts
   (:main (vertically ()
                     (1/8 title)
                     (1/8 menu)
                     (:fill design-area)
                     (1/8 documentation)))
   (:other (vertically ()
                      (1/8 title)
                      (:fill
                       (horizontally ()
                                    (1/4 menu)
                                    (:fill design-area)))
                      (1/8 documentation)))))
```

The Two Layouts of the Mini-CAD Demo



9.2.6 Using an :accept-values Pane in a CLIM Application Frame

Frame **:accept-values** panes are used when you want one of the panes of your application to be in the form of an **accepting-values** dialog.

There are several things to remember when using an **:accept-values** pane in your application frame:

- For an **:accept-values** pane to work, your frame's command table must inherit from the **accept-values-pane** command table.
- The **:display-function** option for an **accepting-values** pane will typically be something like:

  ```
  (clim:accept-values-pane-displayer
    :displayer my-acceptor-function)
  ```

  where **my-acceptor-function** is a function that you write. It contains calls to **accept** just as they would appear inside a **accepting-values** for a dialog. It takes two arguments, the frame and a stream. **my-acceptor-function** does not need to call **accepting-values** itself, since that is done automatically.

See **12 Menus and Dialogs** especially the function **`accept-values-pane-displayer`**.

- While inside the display function for an **`:accept-values`** pane, **`*application-frame*`** is *not* bound to your application. Instead, it is bound to an application that implements **`accepting-values`**. Therefore, you cannot use **`with-frame-state-variables`** in the display function for an **`:accept-values`** pane. Use **`with-slots`** on the frame argument instead.
- Don't use :**`display-after-commands`** with **`:accept-values`** panes, because the redisplay for those panes is managed at a slightly lower level for efficiency.

9.3 Initializing CLIM Application Frames

There are several ways to initialize an application frame:

1. The value of an application frame's slot can be initialized using the **`:initform`** slot option in the slot's specifier in the **`define-application-frame`** form. This technique is suitable if the slot's initial value does not depend on the values of other slots, calculations based on the values of initialization arguments, or other information that cannot be determined until after the application frame is created. See the macro **`clos:defclass`** to learn about slot-specifiers.
2. For initializations that depend on information which may not be available until the application frame has been created, an **`:after`** method can be defined for **`clos:initialize-instance`** on the application frame's class. Note that the special variable **`*application-frame*`** is not bound to the application, since the application is not yet running. The macro **`with-frame-state-variables`** cannot be used in this context, either. You may use **`clos:with-slots`**, **`clos:with-accessors`**, or any slot readers or accessors that have been defined.
3. A **`:before`** method for **`run-frame-top-level`** on the application's frame is probably the most versatile place to perform application frame initialization. This method will not be executed until the application starts running. **`*application-frame*`** will be bound to the application frame, and you can use **`with-frame-state-variables`** in this context.
4. If the application frame employs its own top-level function, then this function can perform initialization tasks at the beginning of its body. This top-level function may call **`default-frame-top-level`** to achieve the standard behavior for application frames.

Of course, these are only suggestions. There might be other techniques which might be more appropriate for your application. Of those listed, the **`:before`** method on **`run-frame-top-level`** is probably the best for most circumstances.

Although application frames are CLOS classes, do not use **`clos:make-instance`** to create them. To instantiate an application frame, always use **`make-application-frame`**. This function provides important initialization arguments specific to application frames that **`clos:make-instance`** does not. **`make-application-frame`** passes any keyword value pairs which it does not handle itself on to **`clos:make-instance`**, so it will respect any initialization options which you give it, just as **`clos:make-instance`** would.

Here is an example of how an application frame's behavior might be modified by inheritance from a superclass. Suppose we wanted our application to record all the commands that were performed while it was executing, because the program is for the financial industry, where it is important to keep audit trails for all transactions. As this is a useful functionality that might be added to any of a number of different applications, we will make it into a special class that implements the desired behavior. This class can then be used as a superclass for any application that needs to keep a log of its actions.

The class has an initialization option, **`:pathname`**, which specifies the name of the log file. It also has a slot named **`transaction-stream`** whose value is a stream opened to the log file when the application is running.

```
(defclass transaction-recording-mixin ()
  ((transaction-pathname :type pathname
                         :initarg :pathname
                         :reader transaction-pathname)
   (transaction-stream :accessor transaction-stream)))
```

We use an **:around** method on **run-frame-top-level**, which opens a stream to the log file and stores it in the **transaction-stream** slot. **unwind-protect** is used to clear the value of the slot when the stream is closed.

```
(defmethod clim:run-frame-top-level :around
  ((frame transaction-recording-mixin))
  (with-slots (transaction-pathname transaction-stream)
              frame (with-open-file (stream transaction-pathname
                                            :direction :output)
                      (unwind-protect
                          (progn (setq transaction-stream stream)
                                 (call-next-method))
                        (setq transaction-stream nil)))))
```

This is where the actual logging takes place. The command loop in **default-frame-top-level** calls **execute-frame-command** to execute a command. Here we add a **:before** method that will log the command.

```
(defmethod clim:execute-frame-command :before
  ((frame transaction-recording-mixin) command)
  (format (transaction-stream frame) "~&Command: ~a" command))
```

It is now an easy matter to alter the definition of an application to add the command logging behavior. Here is the definition of the puzzle application frame from the CLIM demos suite (from the file **<release-directory>/demo/puzzle.lisp**). We use the superclasses argument to specify that the **puzzle** application frame should inherit from **transaction-recording-mixin**. Because we are using the superclass argument, we must also explicitly include **application-frame**, which was included by default when the superclasses argument was empty.

```
(define-application-frame puzzle
  (transaction-recording-mixin application-frame)
  ((puzzle :initform (make-array '(4 4))
           :accessor puzzle-puzzle))
  (:default-initargs :pathname "puzzle-log.text")
  (:panes (title :title)
          (menu :command-menu)
          (display :application
                   :default-text-style '(:fix :bold :very-large)
                   :incremental-redisplay t
                   :display-function draw-puzzle)))
```

Also note the use of **(:default-initargs :pathname "puzzle-log.text")** to provide a default value for the log file name if the user does not specify one.

The user might run the application by executing the following:

```
(run-frame-top-level
 (make-application-frame 'puzzle
                         :width 400
                         :height 500
                         :pathname "my-puzzle-log.text"))
```

Here the **:pathname** initialization argument is used to override the default name for the log file (as was specified by the **:default-initargs** clause in the previously defined application frame) and to use the name **my-puzzle-log.text** instead.

9.4 Accessing Slots and Components of CLIM Application Frames

A call to the **define-application-frame** macro creates a subclass of the **standard-application-frame** class. CLIM application frames are instances of these generated subclasses. You explicitly specify accessors for the slots you have designated for storing application-specific state information. The use of the accessors is as for any other CLOS instance. Other CLIM defined components of **standard-application-frame** subclass instances are accessed via documented functions. Such components include frame-panes, command-tables, the top-level window, and layouts.

9.5 Running a CLIM Application

You can run a CLIM application using the functions **make-application-frame** and **run-frame-top-level**. Here is a code fragment that illustrates this technique:

```
(clim:run-frame-top-level
 (clim:make-application-frame
  'frame-name))
```

run-frame-top-level will not return until the application exits.

Note that ***application-frame*** is not bound until **run-frame-top-level** is invoked.

For more information, see **E.2 Functions for Operating on Windows Directly**.

9.6 Exiting a CLIM Application

You can exit an application and make the window disappear by using **frame-exit** or **disable-frame**.

9.7 Examples of CLIM Application Frames

This section contains examples of how to use CLIM application frames.

9.7.1 Defining a CLIM Application Frame

Here is an example of an application frame. This frame has three slots: **pathname**, **integer**, and **member**. It has two panes, an **:accept-values** pane named **avv** and an **:application** pane named **display**. It uses a command table named **dingus**, which will automatically be defined for it (see **define-command-table**) and which inherits from the **accept-values-pane** command table so that the accept-values pane will function properly.

```
(clim:define-application-frame dingus ()
  ((pathname :initform #p"foo")
   (integer :initform 10)
   (member :initform :one))
  (:panes
   (avv :accept-values
        :display-function '(clim:accept-values-pane-displayer
                            :displayer display-avv))
   (display :application :display-function 'draw-display
            :display-after-commands :no-clear))
  (:command-table (dingus :inherit-from (clim:accept-values-pane))))
```

The following is the display function for the **display** pane of the "dingus" application. It just prints out the values of the three slots defined for the application.

```
(defmethod draw-display ((frame dingus) stream)
```

```
  (with-slots (pathname integer member) frame
              (fresh-line stream)
              (clim:present pathname 'pathname :stream stream)
              (write-string ", " stream)
              (clim:present integer 'integer :stream stream)
              (write-string ", " stream)
              (clim:present member '(member :one :two :three)
                            :stream stream)
              (write-string "." stream)))
```

The following is the display function for the **avv** pane. It invokes **accept** for each of the application's slots so that the user can alter their values in the **avv** pane.

```
(defmethod display-avv ((frame dingus) stream)
  (with-slots (pathname integer member) frame
              (fresh-line stream)
              (setq pathname
                    (clim:accept 'pathname :prompt "A pathname"
                                 :default pathname :stream stream))
              (fresh-line stream)
              (setq integer
                    (clim:accept 'integer :prompt "An integer"
                                 :default integer :stream stream))
              (fresh-line stream)
              (setq member
                    (clim:accept '(member :one :two :three)
                                 :prompt "One, Two, or Three"
                                 :default member :stream stream))
              (fresh-line stream)
              (clim:accept-values-command-button
               (stream :documentation "You wolf")
               (write-string "Wolf whistle" stream)
               (beep))))
```

The following function will start up a new "dingus" application.

```
(defun run-dingus (root)
  (let ((dingus (clim:make-application-frame
                 'dingus :width 400 :height 400)))
    (clim:run-frame-top-level dingus)))
```

All this application does is allow the user to alter the values of the three application slots, **pathname**, **integer**, and **member,** using the **avv** pane. The new values will automatically be reflected in the **display** pane.

9.7.2 Constructing a Function as Part of Running an Application

You can supply an alternate top level (which initializes some things and then calls the regular top level) to construct a function as part of running the application. Note that when you use this technique, you can close the function over other pieces of the Lisp state that might not exist until application run time.

```
(clim:define-application-frame
 different-prompts ()
 ((prompt-state ...) ...)
 (:top-level (different-prompts-top-level)) ...)

(defmethod different-prompts-top-level
  ((frame different-prompts) &rest options)
  (flet ((prompt (stream frame)
                 (with-slots (prompt-state) frame
                             (apply
                              #'clim:default-frame-top-level frame
```

```
                                 :prompt #'prompt options)))
            ...)))
```

9.8 Application Frame Operators and Accessors

The following operators are used to define and instantiate application frames. They are discussed in detail in **9.2 Defining CLIM Application Frames**.

define-application-frame *Macro*

`define-application-frame` *name superclasses slots* **`&rest`** *options*

Summary: Defines an application frame. You can specify a *name* for the application class, the superclasses (if any), the *slots* of the application class, and *options*.

make-application-frame *Function*

`make-application-frame` *frame-name* **`&rest`** *options* **`&key`** *pretty-name frame-manager enable state left top right bottom width height save-under frame-class* **`&allow-other-keys`**

Summary: Makes an instance of the application frame of type *frame-class*. If *frame-class* is not supplied, it defaults to *frame-name*.

9.8.1 CLIM Application Frame Accessors

The following functions may be used to access and modify the state of the application frame itself, such as what the currently exposed panes are, what the current layout is, what command table is being used, and so forth.

application-frame *Variable*

Summary: The current application frame. The value is CLIM's default application. This variable is typically used in the bodies of commands and translators to gain access to the state variables of the application, usually in conjunction with **`clos:with-slots`** or **`clos:slot-value`**.

frame-name *Generic Function*

`frame-name` *frame*

Summary: Returns the name of the frame *frame*, which is a symbol.

frame-pretty-name *Generic Function*

`frame-pretty-name` *frame*

Summary: Returns the "pretty name" of the frame *frame*, which is a string.

(setf frame-pretty-name) *Generic Function*

`(setf frame-pretty-name)` *name frame*

Summary: Sets the pretty name of the frame *frame* to *name*, which must be a string.

frame-command-table *Generic Function*

`frame-command-table` *frame*

Summary: Returns the command table for the frame *frame*.

(setf frame-command-table) *Generic Function*

(setf frame-command-table) *command-table frame*

Summary: Sets the command table for the frame *frame* to *command-table*. Changing the frame's command table will redisplay the command menus (or menu bar) as needed. *command-table* is a command table designator.

frame-standard-input *Generic Function*

frame-standard-input *frame*

Summary: Returns the stream that will be used for ***standard-input*** for the frame *frame*. The default method (on **standard-application-frame**) returns the first named pane of type **interactor-pane** that is exposed in the current layout; if there is no such pane, the value returned by **frame-standard-output** is used.

frame-standard-output *Generic Function*

frame-standard-output *frame*

Summary: Returns the stream that will be used for ***standard-output*** for the frame *frame*. The default method (on **standard-application-frame**) returns the first named pane of type **application-pane** that is exposed in the current layout; if there is no such pane, it returns the first pane of type **interactor-pane** that is exposed in the current layout.

To redirect standard input or output, simply redefine the corresponding frame generic function. For example, the following form specifies the pane in **my-frame** named **output-pane** as the destination for standard output.

```
(defmethod frame-standard-output ((frame my-frame))
   (get-frame-pane frame 'output-pane))
```

frame-query-io *Generic Function*

frame-query-io *frame*

Summary: Returns the stream that will be used for ***query-io*** for the frame *frame*. The default method (on **standard-application-frame**) returns the value returned by **frame-standard-input**; if that is **nil**, it returns the value returned by **frame-standard-output**.

frame-error-output *Generic Function*

frame-error-output *frame*

Summary: Returns the stream that will be used for ***error-output*** for the frame *frame*. The default method (on **standard-application-frame**) returns the same value as **frame-standard-output**.

pointer-documentation-output *Variable*

Summary: This will be bound either to **nil** or to a stream on which pointer documentation will be displayed.

frame-pointer-documentation-output *Generic Function*

frame-pointer-documentation-output *frame*

Summary: Returns the stream that will be used for ***pointer-documentation-output*** for the frame *frame*. The default method (on **standard-application-frame**) returns the first pane of type **pointer-documentation-pane**. If this returns **nil**, no pointer documentation will be generated for this frame.

frame-calling-frame *Generic Function*

`frame-calling-frame` *frame*

Summary: Returns the application frame that invoked the frame *frame*.

frame-parent *Generic Function*

`frame-parent` *frame*

Summary: Returns the object that acts as the parent for the frame *frame*. This often, but not always, returns the same value as **`frame-manager`**.

frame-panes *Generic Function*

`frame-panes` *frame*

Summary: Returns the pane that is the top-level pane in the current layout of the frame *frame*'s named panes. This function returns objects that reveal CLIM's internal state; do not modify those objects.

frame-current-panes *Generic Function*

`frame-current-panes` *frame*

Summary: Returns a list of those named panes in the frame *frame*'s current layout. If there are no named panes (that is, the **`:pane`** option was used), only the single, top-level pane is returned. This function returns objects that reveal CLIM's internal state; do not modify those objects.

get-frame-pane *Generic Function*

`get-frame-pane` *frame pane-name*

Summary: Returns the CLIM stream pane in the frame *frame* whose name is *pane-name*.

find-pane-named *Generic Function*

`find-pane-named` *frame pane-name*

Summary: Returns the pane in the frame *frame* whose name is *pane-name*. This can return any type of pane, not just CLIM stream panes.

frame-top-level-sheet *Generic Function*

`frame-top-level-sheet` *frame*

Summary: Returns the sheet that is the top-level sheet for the frame *frame*. This is the sheet that has as its descendants all of the panes of *frame*.

frame-current-layout *Generic Function*

`frame-current-layout` *frame*

Summary: Returns the current layout for the frame *frame*. The layout is named by a symbol.

(setf frame-current-layout) *Generic Function*

`(setf frame-current-layout)` *layout frame*

Summary: Sets the layout of the frame *frame* to be the new layout specified by *new-layout*. *layout* must be a symbol that names one of the possible layouts.

Changing the layout of the frame causes a recomputation of what panes are used for the bindings of the standard stream variables (such as **`*standard-input*`**). After the new layout has been computed, the contents of each pane are displayed to the degree necessary to ensure that all output is visible.

layout-frame *Generic Function*

`layout-frame` *frame* **`&optional`** *width height*

Summary: Resizes the frame and lays out the current pane hierarchy using the layout specified by **`frame-current-layout`**, according to the layout protocol described in **10.2.4 The Layout Protocol**. This function is automatically invoked on a frame when it is adopted, after its pane hierarchy has been generated.

If *width* and *height* are provided, then this function resizes the frame to the specified size. It is an error to provide just *width*. If no optional arguments are provided, this function resizes the frame to the preferred size of the top-level pane as determined by the space composition pass of the layout protocol.

In either case, after the frame is resized, the space allocation pass of the layout protocol is invoked on the top-level pane.

9.8.2 Operators for Running CLIM Applications

The following functions are used to start up an application frame, exit from it, and control the "read-eval-print" loop of the frame (for example, redisplay the panes of the frame, and read, execute, enable, and disable commands).

run-frame-top-level *Generic Function*

`run-frame-top-level` *frame*

Summary: Runs the top-level function for the frame *frame*. The default method on **`application-frame`** simply invokes the top-level function for the frame (which defaults to **`default-frame-top-level`**).

run-frame-top-level *Around Method*

`run-frame-top-level (`*frame application-frame***`)`**

Summary: The **`:around`** method of **`run-frame-top-level`** on the **`application-frame`** class establishes the initial dynamic bindings for the application, including (but not limited to) binding **`*application-frame*`** to *frame*, binding **`*input-context*`** to **`nil`**, resetting the delimiter and activation gestures, and binding **`*input-wait-test*`**, **`*input-wait-handler*`**, and **`*pointer-button-press-handler*`** to **`nil`**.

default-frame-top-level *Generic Function*

`default-frame-top-level` *frame* **`&key`** *command-parser command-unparser partial-command-parser prompt*

Summary: The default top-level function for application frames, this runs a "read-eval-print" loop that displays a prompt, calls **`read-frame-command`** and then **`execute-frame-command`**, and finally redisplays all the panes that need it. See **11.9 The CLIM Command Processor** for further details.

`default-frame-top-level` also establishes a simple restart for **`abort`** and binds the standard stream variables as follows. **`*standard-input*`** will be bound to the value returned by **`frame-standard-input`**. **`*standard-output*`** will be bound to the value returned by **`frame-standard-output`**. **`*query-io*`** will be bound to the value returned by **`frame-query-io`**. **`*error-output*`** will be bound to the value returned by **`frame-error-output`**. It is unspecified what **`*terminal-io*`**, **`*debug-io*`**, and **`*trace-output*`** will be bound to.

prompt is either a string to use as the prompt (defaulting to **`Command:`**) or a function of two arguments, a stream and the frame.

command-parser, *command-unparser*, and *partial-command-parser* are the same as for **`read-command`**. *command-*

parser defaults to **`command-line-command-parser`** if there is an interactor; otherwise, it defaults to **`menu-only-command-parser`**. *command-unparser* defaults to **`command-line-command-unparser`**. *partial-command-parser* defaults to **`command-line-read-remaining-arguments-for-partial-command`** if there is an interactor; otherwise, it defaults to **`menu-only-read-remaining-arguments-for-partial-command`**. **`default-frame-top-level`** binds **`*command-parser*`**, **`*command-unparser*`**, and **`*partial-command-parser*`** to the values of *command-parser*, *command-unparser*, and *partial-command-parser*.

read-frame-command *Generic Function*

`read-frame-command` *frame stream*

Summary: Reads a command from the stream *stream* on behalf of the frame *frame*. The returned value is a command object.

The default method (on **`standard-application-frame`**) for **`read-frame-command`** simply calls **`read-command`**, supplying *frame*'s current command table as the command table.

execute-frame-command *Generic Function*

`execute-frame-command` *frame command*

Summary: Executes the command *command* on behalf of the frame *frame*. *command* is a command object, that is, a cons of a command name and a list of the command's arguments.

The default method (on **`standard-application-frame`**) for **`execute-frame-command`** simply applies the **`command-name`** of *command* to **`command-arguments`** of *command*.

command-enabled *Generic Function*

`command-enabled` *command-name frame*

Summary: Returns **`t`** if the command named by *command-name* is presently enabled in the frame *frame*; otherwise, it returns **`nil`**. If *command-name* is not accessible to the command table being used by *frame*, **`command-enabled`** returns **`nil`**.

Whether or not a particular command is currently enabled is stored independently for each instance of an application frame; this status can vary between frames that share a single command table.

(setf command-enabled) *Generic Function*

`(setf command-enabled)` *enabled command-name frame*

Summary: If *enabled* is **`nil`**, this disables the use of the command named by *command-name* while in the frame *frame*. If *enabled* is **`t`**, the use of the command is enabled. After the command has been enabled (or disabled), **`note-command-enabled`** (or **`note-command-disabled`**) is invoked on the frame manager in order to update the appearance of the interface.

If *command-name* is not accessible to the command table being used by *frame*, using **`setf`** on **`command-enabled`** does nothing.

display-command-menu *Generic Function*

`display-command-menu` *frame stream* **`&key`** *command-table initial-spacing max-width max-height n-rows n-columns* **`(`***cell-align-x* **`:`***left***`)`** **`(`***cell-align-y* **`:`***top***`)`**

Summary: Displays the menu associated with the specified command table on *stream* by calling **`display-command-table-menu`**. If *command-table* is not supplied, it defaults to **`(frame-command-table`** *stream***`)`**. This function is generally used as the display function for panes that contain command menus.

initial-spacing, *max-width*, *max-height*, *n-rows*, *n-columns*, *cell-align-x*, and *cell-align-y* are as for

formatting-item-list.

frame-exit *Restart*

Summary: The restart that is invoked when **frame-exit** is called.

frame-exit *Generic Function*

frame-exit *frame*

Summary: Exits from the frame *frame*. The default method (on **standard-application-frame**) invokes the **frame-exit** restart.

panes-need-redisplay *Generic Function*

panes-need-redisplay *frame*

pane-needs-redisplay *Generic Function*

pane-needs-redisplay *frame pane*

Summary: **panes-need-redisplay** indicates that all the panes in the frame *frame* should be redisplayed the next time around the command loop. **pane-needs-redisplay** causes only the pane *pane* within *frame* to be redisplayed; in this case, *pane* is either a pane or the name of a named pane.

redisplay-frame-pane *Generic Function*

redisplay-frame-pane *frame pane* **&key** *force-p*

Summary: Causes the pane *pane* within the frame *frame* to be redisplayed immediately. *pane* is either a pane or the name of a named pane. When the boolean *force-p* is **t**, the maximum level of redisplay is forced and the pane is displayed "from scratch".

redisplay-frame-panes *Generic Function*

redisplay-frame-panes *frame* **&key** *force-p*

Summary: **redisplay-frame-panes** causes all of the panes in the frame *frame* to be redisplayed immediately by calling **redisplay-frame-pane** on each of the panes in *frame* that are visible in the current layout. When the boolean *force-p* is **t**, the maximum level of redisplay is forced and the pane is displayed "from scratch".

frame-replay *Generic Function*

frame-replay *frame stream* **&optional** *region*

Summary: Replays the contents of *stream* in the frame *frame* within the region specified by the region *region*, which defaults to the viewport of *stream*.

notify-user *Generic Function*

notify-user *frame message* **&key** *associated-window title documentation exit-boxes style text-style*

Summary: Notifies the user of some event on behalf of the frame *frame*.

This function provides a look-and-feel independent way for applications to communicate messages to the user. For example, a frame manager might provide a top-level message window for each frame, or it might pop up an alert box.

frame is a CLIM application frame, *message* is a message string, *associated-window* is the window with which the notification will be associated, *title* is a title string to include in the notification, *documentation* is not implemented in the current version of CLIM, *exit-boxes* indicates what sort of exit boxes should appear in the notification, *style* is the style in which to display the notification, and *text-style* is the text style in which to display the notification.

frame-manager-notify-user *Generic Function*

`frame-manager-notify-user` *frame message* **`&key`** *associated-window title documentation exit-boxes style text-style*

Summary: The generic function used by **`notify-user`**. The default method on **`standard-frame-manager`** will display a dialog or an alert box that contains the message and has exit boxes that will allow the user to dismiss the notification.

frame is a CLIM application frame, *message* is a message string, *associated-window* is the window with which the notification will be associated, *title* is a title string to include in the notification, *documentation* is not implemented in the current version of CLIM, *exit-boxes* indicates what sort of exit boxes should appear in the notification, *style* is the style in which to display the notification, and *text-style* is the text style in which to display the notification.

frame-properties *Generic Function*

`frame-properties` *frame property*

(setf frame-properties) *Generic Function*

`(setf frame-properties)` *value frame property*

Summary: Frame properties can be used to associate frame specific data with frames without adding additional slots to the frame's class. CLIM may use frame properties internally to store information for its own purposes.

9.9 Frame Managers

Frames may be ***adopted*** by a frame manager, which involves invoking a protocol for generating the pane hierarchy of the frame. This protocol provides for selecting pane types for abstract gadget panes based on the style requirements imposed by the frame manager. That is, the frame manager is responsible for the look and feel of a frame. Each frame manager is associated with one specific port. However, a single port may have multiple frame managers managing various frames associated with the port.

After a frame is adopted it can be in any of the three following states: ***enabled***, ***disabled***, or ***shrunk***. An enabled frame is visible unless it is occluded by other frames or the user is browsing outside of the portion of the frame manager's space that the frame occupies. A shrunken frame provides a cue or handle for the frame, but generally will not show the entire contents of the frame. For example, the frame may be iconified, or an item for the frame may be placed in a special suspended frame menu. A disabled frame is not visible, nor is there any user-accessible handle for enabling the frame.

Frames may also be ***disowned***, which involves releasing the frame's panes as well as all associated foreign resources.

frame-manager *Protocol Class*

Summary: The protocol class that corresponds to a frame manager. If you want to create a new class that behaves like a frame manager, it should be a subclass of **`frame-manager`**. Subclasses of **`frame-manager`** must obey the frame manager protocol.

There are no advertised standard frame manager classes. Each port implements one or more frame managers that correspond to the look and feel for the port.

frame-manager-p *Function*

`frame-manager-p` *object*

Summary: Returns **`t`** if *object* is a frame manager; otherwise, it returns **`nil`**.

9.9.1 Finding Frame Managers

Most frames need to deal directly with frame managers only to the extent that they need to find a frame manager into which they can insert themselves. Since frames will usually be invoked by some user action that is handled by a frame manager, finding an appropriate frame manager is usually straightforward.

Some frames will support the embedding of other frames within themselves. Such frames not only use frames but also act as frame managers. In this case, the embedded frames are mostly unaware that they are nested within other frames, but only know that they are controlled by a particular frame manager.

The **`find-frame-manager`** function provides a flexible means for locating a frame manager to adopt an application's frames. There are a variety of ways that the user or the application can influence where an application's frame is adopted:

- An application can establish an application default frame manager using **`with-frame-manager`**. A frame's top-level loop automatically establishes the frame's frame manager.
- The programmer or user can influence what frame manager is found by setting **`*default-frame-manager*`** or **`*default-server-path*`**.

---

find-frame-manager *Function*

`find-frame-manager &rest` *options* **`&key`** *port* **`&allow-other-keys`**

Summary: Finds an appropriate frame manager that conforms to the options, including the *port* argument. Furthermore, CLIM applications may set up dynamic contexts that affect what **`find-frame-manager`** will return.

port defaults to the value returned by **`find-port`** applied to the remaining options.

A frame manager is found using the following rules in the order listed:

1. If a current frame manager has been established via an invocation of **`with-frame-manager`**, as is the case within a frame's top-level, and that frame manager conforms to the options, it is returned. The exact definition of "conforming to the options" varies from one port to another, but it may include such things as matching the console number, color or resolution properties, and so forth. If the options are empty, then any frame manager will conform.
2. If **`*default-frame-manager*`** is bound to a currently active frame manager and it conforms to the options, it is returned.
3. If *port* is **`nil`**, a port is found and an appropriate frame manager is constructed using **`*default-server-path*`**.

---

default-frame-manager *Variable*

Summary: This variable provides a convenient point for allowing a programmer or user to override the frame manager type that would normally be selected. Most users will not set this variable, since they can set **`*default-server-path*`** to indicate which host window system they want to use and are willing to use whatever frame manager is the default for the particular port. However, some users may want to use a frame manager that isn't the typical frame manager. For example, a user may want to use both an OpenLook frame manager and a Motif frame manager on a single port.

---

with-frame-manager *Macro*

`with-frame-manager (`*frame-manager***`) &body`** *body*

Summary: Generates a dynamic context that causes all calls to **`find-frame-manager`** to return *frame-manager* if the *where* argument passed to it conforms to *frame-manager*. Nested calls to **`with-frame-manager`** shadow outer contexts. *body* may have zero or more declarations as its first forms.

9.9.2 Frame Manager Operators

frame-manager *Generic Function*

`frame-manager` *frame*

Summary: Returns *frame*'s current frame manager if it is adopted; otherwise, it returns **`nil`**.

(setf frame-manager) *Generic Function*

`(setf frame-manager)` *frame-manager frame*

Summary: Changes the frame manager of *frame* to *frame-manager*. In effect, the frame is disowned from its old frame manager and is adopted into the new frame manager. Transferring a frame preserves its **`frame-state`**; for example, if the frame was previously enabled, it will be enabled in the new frame manager.

frame-manager-frames *Generic Function*

`frame-manager-frames` *frame-manager*

Summary: Returns a list of all the frames being managed by *frame-manager*. This function returns objects that reveal CLIM's internal state; do not modify those objects.

adopt-frame *Generic Function*

`adopt-frame` *frame-manager frame*

disown-frame *Generic Function*

`disown-frame` *frame-manager frame*

Summary: These functions insert or remove a frame from a frame manager's control. These functions allow a frame manager to allocate and deallocate resources associated with a frame. For example, removing a frame from a frame manager that is talking to a remote server allows it to release all remote resources used by the frame.

frame-state *Generic Function*

`frame-state` *frame*

Summary: Returns one of **`:disowned`**, **`:enabled`**, **`:disabled`**, or **`:shrunk`**, indicating the current state of *frame*.

enable-frame *Generic Function*

`enable-frame` *frame*

disable-frame *Generic Function*

`disable-frame` *frame*

shrink-frame *Generic Function*

`shrink-frame` *frame*

Summary: These functions force a frame into the enabled, disabled, or shrunken states. A frame in the enabled state may be visible if it is not occluded or placed out of the user's focus of attention. A disabled frame is never visible. A shrunk frame is accessible to the user for re-enabling, but may be represented in some abbreviated form, such as an icon or a menu item.

These functions call **`note-frame-state-changed`** to notify the frame manager that the state of the frame changed.

note-frame-state-changed *Generic Function*

note-frame-state-changed *frame-manager frame new-state*

Summary: Notifies the frame manager *frame-manager* that the frame *frame* has changed its state to *state*.

generate-panes *Generic Function*

generate-panes *frame-manager frame*

Summary: This function is invoked by a standard method of **adopt-frame**. It is the responsibility of the frame implementor to provide a method that invokes **setf** on **frame-panes** on the frame with a value of type **pane**. **define-application-frame** automatically supplies a **generate-panes** method if either the **:pane** or **:panes** option is used in the **define-application-frame**.

find-pane-for-frame *Generic Function*

find-pane-for-frame *frame-manager frame*

Summary: This function is invoked by a standard method of **adopt-frame**. It must return the root pane of the frame's layout. It is the responsibility of the frame implementor to provide a method that constructs the frame's top-level pane. **define-application-frame** automatically supplies a a method for this function if either the **:pane** or **:panes** option is used.

note-command-enabled *Generic Function*

note-command-enabled *frame-manager frame command-name*

note-command-disabled *Generic Function*

note-command-disabled *frame-manager frame command-name*

Summary: Notifies the frame manager *frame-manager* that the command named by *command-name* has been enabled or disabled (respectively) in the frame *frame*. The frame manager can update the appearance of the user interface as appropriate, for instance, by "graying out" a newly disabled command from a command menu or menu bar.

9.10 Advanced Topics

The material in this section is advanced; most CLIM programmers can skip to the next section. It describes the functions that interface application frames to the presentation type system. All classes that inherit from **application-frame** must inherit or implement methods for all of these functions. **9.8 Application Frame Operators and Accessors**.

frame-maintain-presentation-histories *Generic Function*

frame-maintain-presentation-histories *frame*

Summary: Returns **t** if the frame *frame* maintains histories for its presentations; otherwise, it returns **nil**. The default method (on **standard-application-frame**) returns **t** if and only if the frame has at least one interactor pane.

frame-find-innermost-applicable-presentation *Generic Function*

frame-find-innermost-applicable-presentation *frame input-context stream x y* **&key** *event*

Summary: Locates and returns the innermost applicable presentation on the window *stream* whose sensitivity region contains the point (*x*, *y*), on behalf of the frame *frame* in the input context *input-context*. *event* defaults to **nil**, and is as for **find-innermost-applicable-presentation**.

The default method (on **standard-application-frame**) simply calls

find-innermost-applicable-presentation.

frame-input-context-button-press-handler *Generic Function*

frame-input-context-button-press-handler *frame stream button-press-event*

Summary: This function handles user pointer events on behalf of the frame *frame* in the input context ***input-context***. *stream* is the window on which *button-press-event* took place.

The default implementation (on **standard-application-frame**) unhighlights any highlighted presentations, finds the applicable presentation by calling **frame-find-innermost-applicable-presentation-at-position**, and then calls **throw-highlighted-presentation** to execute the translator on that presentation that corresponds to the user's gesture.

If **frame-input-context-button-press-handler** is called when the pointer is not over any applicable presentation, **throw-highlighted-presentation** must be called with a presentation of ***null-presentation***.

frame-document-highlighted-presentation *Generic Function*

frame-document-highlighted-presentation *frame presentation input-context window x y stream*

Summary: This function produces pointer documentation on behalf of the frame *frame* in the input context *input-context* on the window *window* at the point (*x*, *y*). The documentation is displayed on the stream *stream*.

The default method (on **standard-application-frame**) produces documentation that corresponds to calling **document-presentation-translator** on all of the applicable translators in the input context *input-context*. *presentation*, *window*, *x*, *y*, and *stream* are as for **document-presentation-translator**.

Typical pointer documentation consists of a brief description of each translator that is applicable to the specified presentation in the specified input context, given the current modifier state for the window. For example, the following documentation might be produced when the pointer is pointing to the Lisp expression **'(1 2 3)** when the input context is **form**:

```
Left: '(1 2 3); Middle: (DESCRIBE '(1 2 3)); Right: Menu
```

frame-drag-and-drop-feedback *Generic Function*

frame-drag-and-drop-feedback *frame presentation stream initial-x initial-y new-x new-y state*

Summary: The default feedback function for translators defined by **define-drag-and-drop-translator**, which provides visual feedback during the dragging phase of such translators on behalf of the frame *frame*. *presentation* is the presentation being dragged on the stream *stream*. The pointing device was initially at the position specified by *initial-x* and *initial-y*, and is at the position specified by *new-x* and *new-y* when **frame-drag-and-drop-feedback** is invoked. (Both positions are supplied for "rubber-banding," if that is the sort of desired feedback.) *state* will be either **:highlight**, meaning that the feedback should be drawn, or **:unhighlight**, meaning that the feedback should be erased.

frame-drag-and-drop-highlighting *Generic Function*

frame-drag-and-drop-highlighting *frame presentation stream state*

Summary: The default highlighting function for translators defined by **define-drag-and-drop-translator**, which is invoked when a "to object" should be highlighted during the dragging phase of such translators on behalf of the frame *frame*. *presentation* is the presentation over which the pointing device is located on the stream *stream*. *state* will be either **:highlight**, meaning that the highlighting for the presentation should be drawn, or **:unhighlight**, meaning that the highlighting should be erased.

10 Panes and Gadgets

10.1 Panes

CLIM panes are similar to the gadgets or widgets of other toolkits. They can be used to compose the top-level user interface of applications as well as auxiliary components such as menus and dialogs. The application programmer provides an abstract specification of the pane hierarchy, which CLIM uses in conjunction with user preferences and other factors to select a specific "look and feel" for the application. In many environments, a CLIM application can use the facilities of the host window system toolkit via a set of ***adaptive panes***, allowing a portable CLIM application to take on the look and feel of a native application user interface.

Panes are rectangular objects that are implemented as special sheet classes. An application will typically create a tree of panes that divide up the application frame's screen space. Panes can be structurally classified according to their location in pane hierarchies. Panes that can have child panes are called ***composite panes***; those that cannot are called ***leaf panes***. Composite panes are used to provide a mechanism for spatially organizing ("laying out") other panes. Some leaf panes implement gadgets that have some appearance and react to user input by invoking application code. Another kind of leaf pane, known as an ***extended stream pane***, provides an area of the application's screen real estate for the presentation of text and graphics.

Abstract panes are panes that are defined only in terms of their programmer interface, or behavior. The protocol for an abstract pane (that is, the specified set of initialization options, accessors, and callbacks) is designed to specify the pane in terms of its overall purpose, rather then in terms of its specific appearance or particular interactive details. This abstract definition allows multiple implementations of the abstract pane to define their own specific look and feel individually. CLIM can then select the appropriate pane implementation based on factors outside of the application domain, such as user preferences or the look and feel of the host operating environment. A subset of the abstract panes, the adaptive panes, have been defined to integrate well across all CLIM operating platforms.

CLIM provides a general mechanism for automatically selecting the particular implementation of an abstract pane selected by an application based on the current frame manager. The application programmer can override the selection mechanism by using the name of a specific pane implementation in place of the abstract pane name when specifying the application frame's layout. By convention, the name of the basic, portable implementation of an abstract pane class can be determined by adding the suffix **`-pane`** to the name of the abstract class.

10.1.1 Basic Pane Construction

Applications typically define the hierarchy of panes used in their frames with the **`:pane`** or **`:panes`** options of **`define-application-frame`**. These options generate the body of methods on functions that are invoked when the frame is being adopted into a particular frame manager, so the frame manager can select the specific implementations of the abstract panes.

There are two basic interfaces for constructing a pane: **`make-pane`** of an abstract pane class name, or **`make-instance`** of a "concrete" pane class. The former approach is generally preferable, since it results in more portable code. However, in some cases the programmer may wish to instantiate panes of a specific class (such as an **`hbox-pane`** or a **`vbox-pane`**). In this case, using **`make-instance`** directly circumvents the abstract pane selection mechanism. However, the **`make-instance`** approach requires the application programmer to know the name of the specific pane implementation class that is desired, and so is inherently less portable. By convention, all of the concrete pane class names, including those of the implementations of abstract pane protocol specifications, end in **`-pane`**.

Using **`make-pane`** instead of **`make-instance`** invokes the "look and feel" realization process to select and construct a pane.

Normally this process is implemented by the frame manager, but it is possible for other "realizers" to implement this process. **make-pane** is typically invoked using an abstract pane class name, which by convention is a symbol in the CLIM package that does not include the **-pane** suffix. (This naming convention distinguishes the names of the abstract pane protocols from the names of classes that implement them.) Programmers, however, are allowed to pass any pane class name to **make-pane**, in which case the frame manager will generally instantiate that specific class.

pane
Protocol Class

Summary: The protocol class that corresponds to a pane, a subclass of **sheet**. A pane is a special kind of sheet that implements the pane protocols, including the layout protocols. If you want to create a new class that behaves like a pane, it should be a subclass of **pane**. Subclasses of **pane** must obey the pane protocol.

All of the subclasses of **pane** are mutable.

panep
Function

panep *object*

Summary: Returns **t** if *object* is a pane; otherwise, it returns **nil**.

basic-pane
Class

Summary: The basic class on which all CLIM panes are built, a subclass of **pane**. This class is an abstract class, intended only to be subclassed, not instantiated.

make-pane
Function

make-pane *abstract-class-name* **&rest** *initargs*

Summary: Selects a class that implements the behavior of the abstract pane *abstract-class-name* and constructs a pane of that class. **make-pane** must be used either within the dynamic scope of a call to **with-look-and-feel-realization**, or within the **:pane** or **:panes** options of a **define-application-frame** (which implicitly invokes **with-look-and-feel-realization**).

make-pane-1
Generic Function

make-pane-1 *realizer frame abstract-class-name* **&rest** *initargs*

Summary: The generic function that is invoked by a call to **make-pane**. The object that realizes the pane, *realizer*, is established by **with-look-and-feel-realization**. Usually *realizer* is a frame manager, but it could be another object that implements the pane realization protocol. *frame* is the frame for which the pane will be created, and *abstract-class-name* is the type of pane to create.

with-look-and-feel-realization
Macro

with-look-and-feel-realization (*realizer frame***) &body** *forms*

Summary: Establishes a dynamic context that installs *realizer* as the object responsible for realizing panes. All calls to **make-pane** within the context of **with-look-and-feel-realization** result in **make-pane-1** being invoked on *realizer*. This macro can be nested dynamically; inner uses shadow outer uses. *body* may have zero or more declarations as its first forms.

realizer is usually a frame manager, but in some cases *realizer* may be some other object. For example, within the implementation of a pane that uses its own subpanes to achieve its functionality, this form might be used with *realizer* being the pane itself.

10.1.2 Pane Initialization Options

The following options must be accepted by all pane classes.

:foreground
:background *Options*

Summary: These options specify the default foreground and background inks for a pane. Client code should be cautious about passing values for these two options, since the desktop's look and feel or the user's preferences should usually determine these values.

:text-style *Option*

Summary: This option specifies the default text style that should be used for any sort of pane that supports text output. Panes that do not support text output ignore this option. Client code should be cautious about passing values for this option, since the desktop's look and feel or the user's preferences should usually determine this value.

:name *Option*

Summary: This option specifies the name of the pane. It defaults to **`nil`**.

10.1.3 Pane Properties

---

pane-frame *Generic Function*

`pane-frame` *pane*

Summary: Returns the frame that "owns" the pane. **`pane-frame`** can be invoked on any pane in a frame's pane hierarchy, but it can only be invoked on "active" panes, that is, those panes that are currently adopted into the frame's pane hierarchy.

---

pane-name *Generic Function*

`pane-name` *pane*

Summary: Returns the name of the pane.

---

pane-foreground *Generic Function*

`pane-foreground` *pane*

Summary: Returns the foreground ink of the pane.

---

pane-background *Generic Function*

`pane-background` *pane*

Summary: Returns the background ink of the pane.

10.2 Layout Panes

This section describes the various layout panes provided by CLIM and the protocol that these panes obey.

The layout panes described in this section are all composite panes that are responsible for positioning their children according to various layout rules. Layout panes can be selected in the same way as other panes by using **`make-pane`** or **`make-instance`**. For convenience and readability of pane layouts, many of these panes also provide a macro that expands into a **`make-pane`** form, passing a list of the panes created in the body of the macro as the **`:contents`** argument. For example, you can express a layout of a vertical column of two label panes either as:

```
(make-instance 'vbox-pane
               :contents (list
                          (make-instance 'label-pane :text "One")
                          (make-instance 'label-pane :text "Two")))
```

or as:

```
(vertically ()
            (make-instance 'label-pane :text "One")
            (make-instance 'label-pane :text "Two"))
```

10.2.1 Layout Pane Options

:contents *Option*

Summary: All layout pane classes accept the **`:contents`** options, which specifies the child panes to be laid out.

:width

:max-width

:min-width

:height

:max-height

:min-height *Options*

Summary: These options control the space requirement parameters for laying out the pane. The **`:width`** and **`:height`** options specify the preferred horizontal and vertical sizes. The **`:max-width`** and **`:max-height`** options specify the maximum amount of space that may be consumed by the pane, and give CLIM's pane layout engine permission to grow the pane beyond the preferred size. The **`:min-width`** and **`:min-height`** options specify the minimum amount of space that may be consumed by the pane, and give CLIM's pane layout engine permission to shrink the pane below the preferred size.

If either the **`:max-width`** or the **`:min-width`** option is not supplied, it defaults to the value of the **`:width`** option. If either the **`:max-height`** or the **`:min-height`** option is not supplied, it defaults to the value of the **`:height`** option.

`:max-width`, **`:min-width`**, **`:max-height`**, and **`:min-height`** can also be specified as a relative size by supplying a list of the form **`(`***number* **`:relative)`**. In this case, the number indicates the number of device units that the pane is willing to stretch or shrink.

The values of these options are specified in the same way as the **`:x-spacing`** and **`:y-spacing`** options to **`formatting-table`**. (Note that **`:character`** and **`:line`** may only be used on those panes that display text, such as a **`clim-stream-pane`** or a **`label-pane`**.)

+fill+ *Constant*

Summary: Use this constant as a value to any of the relative size options. It indicates that pane's willingness to adjust an arbitrary amount in the specified direction.

:align-x

:align-y *Options*

Summary: The **`:align-x`** option is one of **`:right`**, **`:center`**, or **`:left`**. The **`:align-y`** option is one of **`:top`**,

:center, or **:bottom**. These specify how child panes are aligned within the parent pane. These have the same semantics as for **formatting-cell**.

:x-spacing

:y-spacing

:spacing *Options*

Summary: These spacing options apply to **hbox-pane**, **vbox-pane**, **table-pane**, and indicate the amount of horizontal and vertical spacing (respectively) to leave between the items in boxes or rows and columns in table. The values of these options are specified in the same way as the **:x-spacing** and **:y-spacing** options to **formatting-table**. **:spacing** specifies both the **x** and **y** spacing at once.

10.2.2 Layout Pane Classes

hbox-pane *Composite Pane*

horizontally *Macro*

horizontally (&rest *options* **&key** *spacing* **&allow-other-keys) &body** *contents*

Summary: The **hbox-pane** class lays out all its child panes horizontally from left to right. The **horizontally** macro is a convenient interface for creating an **hbox-pane**.

contents is one or more forms that are the child panes. Each form in *contents* is of the form:

- A pane—the pane is inserted at this point and its space requirements are used to compute the size.
- A number—the specified number of device units should be allocated at this point.
- The symbol **+fill+** —an arbitrary amount of space can be absorbed at this point in the layout.
- A list whose first element is a number and whose second element evaluates to a pane—if the number is less than 1, then it means that percentage of excess space or deficit should be allocated to the pane. If the number is greater than or equal to 1, then that many device units are allocated to the pane. For example:

```
(horizontally ()
              (1/3 (make-pane 'label-button-pane))
              (2/3 (make-pane 'label-button-pane)))
```

would create a horizontal stack of two button panes. The first button takes one-third of the space, and the second takes two-thirds of the space.

vbox-pane *Composite Pane*

vertically *Macro*

vertically (&rest *options* **&key** *spacing* **&allow-other-keys) &body** *contents*

Summary: The **vbox-pane** class lays out all of its child panes vertically, from top to bottom. The **vertically** macro serves as a convenient interface for creating an **vbox-pane**.

contents is as for **horizontally**.

table-pane *Composite Pane*

tabling *Macro*

tabling (&rest *options***) &body** *contents*

Summary: This pane lays out its child panes in a two-dimensional table arrangement. Each column of the table is specified by an extra level of list in *contents*. For example:

```
(tabling ()
  ((make-pane 'label :text "Red")
   (make-pane 'label :text "Green")
   (make-pane 'label :text "Blue"))
  ((make-pane 'label :text "Intensity")
   (make-pane 'label :text "Hue")
   (make-pane 'label :text "Saturation")))
```

spacing-pane *Composite Pane*

spacing *Macro*

spacing (&rest *options* **&key** *thickness* **&allow-other-keys) &body** *contents*

Summary: This pane reserves some margin space around a single child pane. The space requirement keys that are passed in indicate the requirements for the surrounding space, not including the requirements of the child.

outlined-pane *Composite Pane*

outlining *Macro*

outlining (&rest *options* **&key** *thickness* **&allow-other-keys) &body** *contents*

Summary: This layout pane puts an outline of thickness *thickness* around its contents.

Use the **:background** option to control the ink used to draw the background.

bboard-pane *Composite Pane*

Summary: A pane that allows its children to be any size and lays them out wherever they want to be (for example, a desktop manager).

scroller-pane *Composite Pane*

scrolling *Macro*

scrolling (&rest *options***) &body** *contents*

Summary: Creates a composite pane that allows the single child specified by *contents* to be scrolled. *options* may include a **:scroll-bar** option. The value of this option may be **t** (the default), which indicates that both horizontal and vertical scroll bars should be created; **:vertical**, which indicates that only a vertical scroll bar should be created; or **:horizontal**, which indicates that only a horizontal scroll bar should be created.

The pane created by the **scrolling** includes a **scroller-pane** that has as children the scroll bars and a ***viewport***. The viewport of a pane is the area of the window's drawing plane that is currently visible to the user. The viewport has as its child the specified contents.

hrack-pane
vrack-pane *Composite Panes*

Summary: Similar to the **hbox-pane** and **vbox-pane** classes, except that these ensure that all children are the same size in the minor dimension. In other words, these panes are used to create stacks of same-sized items, such as menu items.

An **hrack-pane** is created when the **:equalize-height** option to **horizontally** is **t**. A **vrack-pane** is created when the **:equalize-width** option to **vertically** is **t**.

Note: hrack-pane and *vrack-pane* are available only in Liquid CL CLIM.

restraining-pane *Composite Pane*

restraining *Macro*

restraining (&rest *options***) &body** *contents*

Summary: Wraps the contents with a pane that prevents changes to the space requirements for *contents* from causing re-layout of panes outside the restraining context. This prevents the size constraints of the child from propagating up beyond this point.

Note: restraining-pane and *restraining* are available only in Liquid CL CLIM.

10.2.3 Composite Pane Generic Functions

pane-viewport *Generic Function*

pane-viewport *pane*

Summary: Returns the pane's viewport, if one exists.

pane-viewport-region *Generic Function*

pane-viewport-region *pane*

Summary: If a viewport for the pane exists, the viewport's region is returned.

pane-scroller *Generic Function*

pane-scroller *pane*

Summary: Checks to see whether a pane has an associated scroller pane, and returns it if it does.

scroll-extent *Generic Function*

scroll-extent *pane x y*

Summary: If the *pane* argument has an associated viewport, it resets the viewport to display the portion of the underlying stream starting at (*x*, *y*).

10.2.4 The Layout Protocol

The layout protocol is triggered by **layout-frame**, which is called when a frame is adopted by a frame manager.

CLIM uses a two-pass algorithm to lay out a pane hierarchy. In the first pass (called ***space composition***), the top-level pane is asked how much space it requires. This may in turn lead to the same question being asked recursively of all the panes in the hierarchy, with the answers being composed to produce the top-level pane's answer. Each pane answers the query by returning a ***space requirement*** (or **space-requirement**) object, which specifies the pane's desired width and height, as well as its willingness to shrink or grow along its width and height.

In the second pass (called ***space allocation***), the frame manager attempts to obtain the required amount of space from the host window system. The top-level pane is allocated the space that is actually available. Each pane, in turn, allocates space recursively to each of its descendants in the hierarchy according to the pane's rules of composition.

For many types of panes, the application programmer can indicate the space requirements of the pane at creation time by using the space requirement options, as well as by calling the **change-space-requirements** function. Panes are used to display application-specific information, so the application can determine how much space should normally be given to them.

Other pane types automatically calculate their space needs based on the information they have to present. For example, the space requirement for a label pane is a function of the text to be displayed.

A composite pane calculates its space requirement based on the requirements of its children and its own particular rule for arranging them. For example, a pane that arranges its children in a vertical stack would return as its desired height the sum of the heights of its children. Note, however, that a composite pane is not required by the layout protocol to respect the space requests of its children; in fact, composite panes are not even required to ask their children.

Space requirements are expressed for each of the two dimensions as a preferred size, a minimum size below which the pane cannot be shrunk, and a maximum size above which the pane cannot be grown. (The minimum and maximum sizes can also be specified as relative amounts.) All sizes are specified as a real number indicating the number of device units (such as pixels).

space-requirement *Protocol Class*

Summary: The protocol class of all space requirement objects. There are one or more subclasses of **space-requirement** with implementation-dependent names that implement space requirements. The exact names of these classes is explicitly unspecified. If you want to create a new class that behaves like a space requirement, it should be a subclass of **space-requirement**. Subclasses of **space-requirement** must obey the space requirement protocol.

All the instantiable space requirement classes provided by CLIM are immutable.

make-space-requirement *Function*

make-space-requirement &key (*width* **0) (***max-width* **0) (***min-width* **0) (***height* **0) (***max-height* **0) (***min-height* **0)**

Summary: Constructs a space requirement object with the given characteristics **:width**, **:height**, and so on.

space-requirement-width *Function*

space-requirement-width *space-req*

(setf space-requirement-width) *Function*

(setf space-requirement-width) *size space-req*

space-requirement-max-width *Function*

space-requirement-max-width *space-req*

(setf space-requirement-max-width) *Function*

(setf space-requirement-max-width) *size space-req*

space-requirement-min-width *Function*

space-requirement-min-width *space-req*

(setf space-requirement-min-width) *Function*

(setf space-requirement-min-width) *size space-req*

space-requirement-height *Function*

space-requirement-height *space-req*

(setf space-requirement-height) *Function*

`(setf space-requirement-height)` *size space-req*

space-requirement-max-height *Function*

`space-requirement-max-height` *space-req*

(setf space-requirement-max-height) *Function*

`(setf space-requirement-max-height)` *size space-req*

space-requirement-min-height *Function*

`space-requirement-min-height` *space-req*

(setf space-requirement-min-height) *Function*

`(setf space-requirement-min-height)` *size space-req*

Summary: These read or modify the components of the space requirement *space-req*.

space-requirement-components *Generic Function*

`space-requirement-components` *space-req*

Summary: Returns the components of the space requirement *space-req* as six values: the width, minimum width, maximum width, height, minimum height, and maximum height.

space-requirement-combine *Function*

`space-requirement-combine` *function sr1 sr2*

Summary: Returns a new space requirement, each component of which is the result of applying the function *function* to each of the components of the two space requirements *sr1* and *sr2*.

function is a function of two arguments, both of which are real numbers. It has dynamic extent.

space-requirement+ *Function*

`space-requirement+` *sr1 sr2*

Summary: Returns a new space requirement whose components are the sum of each of the components of the two space requirements *sr1* and *sr2*.

space-requirement+* *Function*

`space-requirement+*` *space-req* **`&key`** *width max-width min-width height max-height min-height*

Summary: Returns a new space requirement whose components are the sum of each of the components of *space-req* added to the appropriate keyword argument (for example, the width component of *space-req* is added to *width*). This is intended to be a more efficient, spread version of **`space-requirement+`**.

change-space-requirements *Generic Function*

`change-space-requirements` *pane* **`&key`** *resize-frame* **`&rest`** *space-req-keys*

Summary: This function can be invoked to indicate that the space requirements for *pane* have changed. Any of the options that applied to the pane at creation time can be passed into this function as well.

resize-frame determines whether the frame should be resized to accommodate the new space requirement of the hierarchy. If *resize-frame* is **`t`**, then **`layout-frame`** will be invoked on the frame. If *resize-frame* is **`nil`**, then the frame may or may not get resized depending on the pane hierarchy and the **`:resize-frame`** option that was supplied to **`define-application-frame`**.

note-space-requirements-changed *Generic Function*

`note-space-requirements-changed` *sheet pane*

Summary: This function is invoked whenever *pane*'s space requirements have changed. *sheet* must be the parent of *pane*. Invoking this function essentially means that *compose-space* will be reinvoked on *pane*, and it will reply with a space requirement that is not equal to the reply that was given on the last call to *compose-space*.

This function is automatically invoked by **`change-space-requirements`** in the cases that **`layout-frame`** isn't invoked. In the case that **`layout-frame`** is invoked, it isn't necessary to call **`note-space-requirements-changed`**, since a complete re-layout of the frame will be executed.

changing-space-requirements *Macro*

`changing-space-requirements (&key` *resize-frame layout***`) &body`** *body*

Summary: This macro supports batching the invocation of the layout protocol by calls to **`change-space-requirements`**. Within the body, all calls to **`change-space-requirements`** change the internal structures of the pane and are recorded. When the body is exited, the layout protocol is invoked appropriately. *body* may have zero or more declarations as its first forms.

compose-space *Generic Function*

`compose-space` *pane*

Summary: During the space composition pass, a composite pane will typically ask each of its children how much space it requires by calling **`compose-space`**. They answer by returning **`space-requirement`** objects. The composite will then form its own space requirement by composing the space requirements of its children according to its own rules for laying out its children.

allocate-space *Generic Function*

`allocate-space` *pane width height*

Summary: During the space allocation pass, a composite pane will arrange its children within the available space and allocate space to them according to their space requirements and its own composition rules by calling **`allocate-space`** on each of the child panes. *width* and *height* are the width and height of *pane* in device units.

10.3 Extended Stream Panes

In addition to the various layout panes and gadgets, an application usually needs some space to display textual and graphic output as well as to receive application-specific input from the user. For example, a paint program needs a "canvas" pane for displaying the picture and handling "mouse strokes." This can be accomplished in CLIM through the use of ***extended stream panes***.

This section describes the basic CLIM extended stream pane types. Programmers are free to customize pane behavior by defining subclasses of these pane classes. Writing methods to change the repaint or event-handling behavior is a possible starting place.

10.3.1 Extended Stream Pane Options

CLIM extended stream panes accept the **:foreground**, **:background**, and **:text-style** options as well as those options applicable to layout panes. The space requirement options (**:width**, **:height**, and so forth) can also take a size specification of **:compute**, which causes CLIM to run the display function for the pane and make the pane large enough to hold the output of the display function.

In addition to those listed previously, CLIM extended stream frames accept the following options:

:display-after-commands *Option*

Summary: This specifies how the display function will be run. If **t**, the "print" part of the read-eval-print loop runs the display function; this is the default for most pane types. If **nil**, you are responsible for implementing the display after commands.

Do not use **:display-after-commands** with **accept-values** panes, as the redisplay for those panes is managed at a slightly lower level for efficiency. Avoid code such as the following:

```
(in-package :clim-user)

(define-application-frame test-frame () ()
  (:command-table (test-frame :inherit-from
                              (clim:accept-values-pane)))
  (:command-definer t)
  (:panes
   (test-input-pane :accept-values :display-function
                    '(clim:accept-values-pane-displayer
                      :displayer test-input)
                    ;; THIS WILL NOT WORK
                    :display-after-commands t)
   (dummy :application)
   (menu :command-menu
         :display-function '(display-command-menu :n-rows 1))
   (mouse :pointer-documentation))
  (:layouts (:default
            (vertically ()
                        menu test-input-pane DUMMY mouse))))

(defmethod test-input ((frame test-frame) stream)
  (accept 'integer :stream stream :prompt "prompt" :default 1)
  (terpri stream)
  (accept 'integer :stream stream :prompt "foo" :default 1)
  (terpri stream))

(defun test-it (&key (port (find-port)))
  (run-frame-top-level
   (make-application-frame 'test-frame
                           :frame-manager
                           (find-frame-manager :port port))))
```

:display-function *Option*

Summary: This specifies a function to be called in order to display the contents of a CLIM stream pane. CLIM's default top-level function, **default-frame-top-level**, will invoke the pane's display function at the appropriate time (see the **:display-time** option). The value of this option is either the name of a function to invoke, or a cons whose car is the name of a function and whose cdr is additional arguments to the function. The function will be invoked on the frame, the pane, and the additional function arguments, if any. The default for this option is **nil**.

:display-time *Option*

Summary: This tells CLIM when the pane's display function should be run. If it is **:command-loop**, CLIM erases the pane's contents and runs the display function after each time a frame command is executed. If it is **`t`**, the pane is displayed once but not again until **`pane-needs-redisplay`** is called on the pane. If it is **`nil`**, CLIM waits until it is explicitly requested, either via **`pane-needs-redisplay`** or **`redisplay-frame-pane`**. The default value varies according to the pane type.

:display-string *Option*

Summary: For **`title-pane`**s only, you can use this option instead of **`:display-function`** to specify a constant string to be displayed in the **`title-pane`**.

:incremental-redisplay *Option*

Summary: When **`t`**, the redisplay function will initially be executed inside of an invocation to **`updating-output`** and the resulting output record will be saved. Subsequent calls to **`redisplay-frame-pane`** will simply use **`redisplay`** to redisplay the pane. The default for this option is **`nil`**.

:text-margin *Option*

Summary: This specifies the default text margin, that is, how much space is left around the inside edge of the pane. The default for **`:text-margin`** is the width of the window.

:vertical-spacing *Option*

Summary: This specifies the default vertical spacing for the pane, that is, how much space there is between each text line. The default for **`:vertical-spacing`** is 2.

:end-of-line-action *Option*

Summary: This specifies the end-of-line action to be used. The default is **`:wrap`**. (The other possible value is **`:allow`**.)

:end-of-page-action *Option*

Summary: This specifies the end-of-page action to be used. The default is **`:scroll`**. (The other possible value is **`:allow`**.)

:output-record *Option*

Summary: This names the output record class to be used for the output history of the pane. The default is **`standard-tree-output-history`**.

:draw
:record *Options*

Summary: These options specify whether the pane should initially allow drawing and output recording, respectively. The default for both options is **`t`**.

10.3.2 Extended Stream Pane Classes

clim-stream-pane *Leaf Pane*

Summary: This class implements a pane that supports the CLIM graphics, extended input and output, and output recording protocols. Any extended stream panes used will most commonly be subclasses of this class.

The five following panes classes are subclasses of **`clim-stream-pane`**. Fundamentally, these panes have the same capabilities; however, by convention, the different pane classes have distinct roles. For instance, interactor panes are used for standard input, whereas application panes, by default, specify the destination for standard output.

interactor-pane

Leaf Pane

Summary: The pane class that implements "interactor" panes. The default method for **frame-standard-input** will return the first pane of this type.

The default for **:display-time** is **nil** and for **:scroll-bars** is **:vertical**.

application-pane

Leaf Pane

Summary: The pane class that implements "application" panes. The default method for **frame-standard-output** will return the first pane of this type.

The default for **:display-time** is **:command-loop** and for **:scroll-bars** is **t**.

command-menu-pane

Leaf Pane

Summary: The pane class that implements command menu panes that are not menu bars. The default display function for panes of this type is **display-command-menu**.

For **command-menu-pane**, the default for **:display-time** is **:command-loop**, the default for **:incremental-redisplay** is **t**, and the default for **:scroll-bars** is **t**.

title-pane

Leaf Pane

Summary: The pane class that implements a title pane. The default display function for panes of this type is **display-title**. If the title to be displayed will not change, it can be supplied using the option **:display-string** described in **10.3.1 Extended Stream Pane Options**. If neither **:display-function** or **:display-string** is supplied, the title will be taken from **frame-pretty-name** (see **9.9.1 Finding Frame Managers**).

The default for **:display-time** is **t** and for **:scroll-bars** is **nil**.

pointer-documentation-pane

Leaf Pane

Summary: The pane class that implements the pointer documentation pane.

The default for **:display-time** is **nil** and for **:scroll-bars** is **nil**.

10.3.3 Making CLIM Extended Stream Panes

Most CLIM extended stream panes will contain more information than can be displayed in the allocated screen space, so scroll bars are nearly always desirable. CLIM therefore provides a convenient form for creating composite panes that include a CLIM stream pane, scroll bars, labels, and so forth. For window stream pane functions, see **13.7 CLIM Window Stream Pane Functions**.

make-clim-stream-pane

Function

make-clim-stream-pane &rest *options* **&key** *type label scroll-bars* **&allow-other-keys**

Summary: Creates a pane of type *type*, which defaults to **clim-stream-pane**. If *label* is supplied, it is a string used to label the pane. *scroll-bars* may be **t** to indicate that both vertical and horizontal scroll bars should be included, **:vertical** (the default) to indicate that vertical scroll bars should be included, or **:horizontal** to indicate that horizontal scroll bars should be included.

The other options may include all the valid CLIM extended stream pane options.

make-clim-interactor-pane

Function

make-clim-interactor-pane &rest *options*

Summary: Like **`make-clim-stream-pane`**, but the type is forced to be **`interactor-pane`**.

make-clim-application-pane *Function*

`make-clim-application-pane &rest` *options*

Summary: Like **`make-clim-stream-pane`**, but the type is forced to be **`application-pane`**.

10.4 Defining A New Pane Type: Leaf Panes

To define a gadget pane implementation, first define the appearance and layout behavior of the gadget, next define the callbacks, and last define the specific user interactions that trigger the callbacks.

For example, to define an odd new kind of button that displays itself as a circle and is activated whenever the mouse is moved over it, proceed as follows:

```
;; A new kind of button
(defclass sample-button-pane (gadget-pane) ())

;; An arbitrary size parameter
(defparameter *sample-button-radius* 10)

;; Define the sheet's repaint method to draw the button.
(defmethod handle-repaint ((button sample-button-pane) region
                           &key medium &allow-other-keys)
  (let ((radius *sample-button-radius*)
        (half (round *sample-button-radius* 2)))
    ;; Larger circle with small one in the center.
    (draw-circle* medium radius radius radius :filled nil)
    (draw-circle* medium radius radius half :filled t)))

;;; Define the pane's compose-space method to always request the
;;; fixed size of the pane.
(defmethod compose-space ((pane sample-button-pane))
  (make-space-requirement :width (* 2 *sample-button-radius*)
                          :height (* 2 *sample-button-radius*)))
```

The previous code is enough to allow you to instantiate the button pane in an application frame. It will fit in with the space composition protocol of, for example, an **`hbox-pane`**. It will display itself as two nested circles.

The next step is to define the callbacks supported by this gadget, and the user interaction that triggers them. The resulting pane is a ***leaf pane***.

```
;; This default method is defined so that the callback can be invoked
;; on an arbitrary client value without error.
(defmethod value-change-callback
  ((button sample-button-pane) client id value)
  (declare (ignore client id value)))

;; This event processing method defines the rather odd interaction
;; style of this button, to wit: it triggers the activate callback
;; whenever the mouse moves into it.
(defmethod enter-region
  ((pane sample-button-pane) &key &allow-other-keys)
  (value-change-callback pane
                         (gadget-client pane) (gadget-id pane) nil))
```

10.5 Gadgets

Gadgets are panes that implement such common toolkit components as push buttons or scroll bars. Each gadget class has a set of associated generic functions that serve the same role that callbacks serve in traditional toolkits. (A callback is a function that informs an application that one of its gadgets has been used.) For example, a push button has an "activate" callback function that is invoked when its button is "pressed;" a scroll bar has a "value changed" callback that is invoked after its indicator has been moved.

The gadget definitions specified by CLIM are abstract; that is, the gadget definition does not specify the exact user interface of the gadget, but only specifies the semantics that the gadget should provide. For instance, it is not defined whether the user clicks on a push button with the mouse, or moves the mouse over the button and then presses some key on the keyboard to invoke the "activate" callback. Each toolkit implementation will specify the look and feel of their gadgets. Typically, the look and feel will be derived directly from the underlying toolkit.

Each of CLIM's abstract gadgets has at least one standard implementation that is written using the facilities provided solely by CLIM itself. The gadgets' appearances are achieved via calls to the CLIM graphics functions, and their interactive behavior is defined in terms of the CLIM input event processing mechanism. Since these gadget implementations are written entirely in terms of CLIM, they are portable across all supported CLIM host window systems. Furthermore, since the specific look and feel of each such gadget is "fixed" in CLIM Lisp code, the gadget implementation will look and behave the same in all environments.

10.5.1 Abstract Gadgets

The push button and slider gadgets alluded to previously are ***abstract gadgets***. The callback interface to all of the various implementations of the gadget is defined by the abstract class. In the **`:panes`** clause of **`define-application-frame`**, the abbreviation for a gadget is the name of the abstract gadget class.

At pane creation time (that is, **`make-pane`**), the frame manager resolves the abstract class into a specific implementation class; the implementation classes specify the detailed look and feel of the gadget. Each frame manager will keep a mapping from abstract gadgets to an implementation class; if the frame manager does not implement its own gadget for the abstract gadget classes in the following sections, it will use the portable class provided by CLIM. Since every implementation of an abstract gadget class is a subclass of the abstract class, they all share the same programmer interface.

10.5.1.1 Using Gadgets

Every gadget has a ***client*** that is specified when the gadget is created. The client is notified via the callback mechanism when any important user interaction takes place. Typically, a gadget's client will be an application frame or a composite pane. Each callback generic function is invoked on the gadget, its client, the gadget id, and other arguments that vary depending on the callback.

For example, the argument list for **`activate-callback`** looks like (*gadget client gadget-id*). Assuming the programmer has defined an application frame called **`button-test`** that has a CLIM stream pane in the slot **`output-pane`**, she could write the following method:

```
(defmethod activate-callback
  ((button push-button) (client button-test) gadget-id)
  (with-slots (output-pane) client
             (format output-pane
                     "The button ~S was pressed, client ~S, id ~S."
                     button client gadget-id)))
```

One problem with this example is that it differentiates on the class of the gadget, not on the particular gadget instance. That is, the same method will run for every push button that has the **`button-test`** frame as its client.

One way to distinguish between the various gadgets is via the ***gadget id***, which is also specified when the gadget is created.

The value of the gadget id is passed as the third argument to each callback generic function. In this case, if we have two buttons, we might install **start** and **stop** as the respective gadget ids and then use **eql** specializers on the gadget ids. We could then refine the previous method as:

```
(defmethod activate-callback
  ((button push-button) (client button-test)
   (gadget-id (eql 'start)))
  (start-test client))

(defmethod activate-callback
  ((button push-button) (client button-test)
   (gadget-id (eql 'stop)))
  (stop-test client))

;; Create the start and stop push buttons
(make-pane 'push-button
           :label "Start"
           :client frame :id 'start)
(make-pane 'push-button
           :label "Stop"
           :client frame :id 'stop)
```

Another way to distinguish between gadgets is to specify explicitly what function should be called when the callback is invoked. This is done by supplying an appropriate initarg when the gadget is created. The previous example could then be written as follows:

```
;; No callback methods needed; just create the push buttons.
(make-pane 'push-button
           :label "Start"
           :client frame :id 'start
           :activate-callback
           #'(lambda (gadget)
               (start-test (gadget-client gadget))))

(make-pane 'push-button
           :label "Stop"
           :client frame :id 'stop
           :activate-callback
           #'(lambda (gadget)
               (stop-test (gadget-client gadget))))
```

10.5.1.2 Implementing Gadgets

The following shows how a push button gadget might be implemented.

```
;; A PUSH-BUTTON uses the ACTIVATE-CALLBACK, and has a label.
;; This is the abstract class
(defclass push-button (action-gadget labelled-gadget) ())

;; Here is a concrete implementation of a PUSH-BUTTON.
;; The "null" frame manager create a pane of type PUSH-BUTTON-PANE when
;; asked to create a PUSH-BUTTON.
(defclass push-button-pane
  (push-button leaf-pane space-requirement-mixin)
  ((show-as-default :initarg :show-as-default
                    :accessor push-button-show-as-default)
   (armed :initform nil)))

;; General highlight-by-inverting method
(defmethod highlight-button ((pane push-button-pane) medium)
  (with-bounding-rectangle* (left top right bottom) (sheet-region pane)
                            (draw-rectangle*
```

```
                                medium left top right bottom
                                :ink +flipping-ink+ :filled t)))

;; Compute the amount of space required by a PUSH-BUTTON-PANE
(defmethod compose-space ((pane push-button-pane) &key width height)
  (multiple-value-bind (width height)
      (compute-gadget-label-size pane)
    (make-space-requirement :width width :height height)))

;; This gets invoked to draw the push button.
(defmethod repaint-sheet ((pane push-button-pane) region)
  (declare (ignore region))
  (with-sheet-medium (medium pane)
                   (let ((text (gadget-label pane))
                         (text-style (slot-value pane 'text-style))
                         (armed (slot-value pane 'armed))
                         (region (sheet-region pane)))
                     (multiple-value-call #'draw-rectangle*
                       medium (bounding-rectangle*
                               (sheet-region pane))
                       :filled nil)
                     (draw-textmedium
                      text
                      (clim-utils::bounding-rectangle-center region)
                      :text-style text-style
                      :align-x ':center
                      :align-y ':top)
                     (when (eql armed ':button-press)
                       (highlight-button pane medium)))))

;; When we enter the push button's region, arm it.
(defmethod handle-event ((pane push-button-pane)
                         (event pointer-enter-event))
  (with-slots (armed) pane
              (unless armed
                (setf armed t)
                (armed-callback
                 pane (gadget-client pane) (gadget-id pane)))))

;; When we leave the push button's region, disarm it.
(defmethod handle-event ((pane push-button-pane)
                         (event pointer-exit-event))
  (with-slots (armed) pane
              (when armed
                (when (eql armed ':button-press)
                  (highlight-button pane medium))
                (setf armed nil)
                (disarmed-callback
                 pane (gadget-client pane) (gadget-id pane)))))

;; When the user presses a pointer button, ensure that the button
;; is armed, and highlight it.
(defmethod handle-event ((pane push-button-pane)
                         (event pointer-button-press-event))
  (with-slots (armed) pane
              (unless armed
                (setf armed ':button-press)
                (armed-callback
                 pane (gadget-client pane) (gadget-id pane))
                (with-sheet-medium (medium pane)
                                   (highlight-button pane medium)))))

;; When the user releases the button and the button is still armed,
;; call the activate callback.
(defmethod handle-event ((pane push-button-pane)
                         (event pointer-button-release-event))
```

```
(with-slots (armed) pane
            (when (eql armed ':button-press)
              (activate-callback
               pane (gadget-client pane) (gadget-id pane))
              (setf armed t)
              (with-sheet-medium (medium pane)
                                 (highlight-button pane medium)))))
```

10.5.2 Basic Gadget Classes

The following are the basic gadget classes upon which all abstract gadgets are built.

gadget *Protocol Class*

Summary: The protocol class that corresponds to a gadget, a subclass of **pane**. If you want to create a new class that behaves like a gadget, it should be a subclass of **gadget**. Subclasses of **gadget** must obey the gadget protocol.

All of the subclasses of **gadget** are mutable.

gadgetp *Function*

gadgetp *object*

Summary: Returns **t** if *object* is a gadget; otherwise. it returns **nil**.

basic-gadget *Class*

Summary: The base class on which all CLIM gadget classes are built.

:id

:client

:armed-callback

:disarmed-callback *Initargs*

Summary: All subclasses of **gadget** must handle these four initargs, which are used to specify, respectively, the gadget id, client, armed callback, and disarmed callback of the gadget.

gadget-id *Generic Function*

gadget-id *gadget*

(setf gadget-id) *Generic Function*

(setf gadget-id) *id gadget*

Summary: Returns (or sets) the gadget id of the gadget *gadget*. The id is typically a simple Lisp object that uniquely identifies the gadget.

gadget-client *Generic Function*

gadget-client *gadget*

(setf gadget-client) *Generic Function*

(setf gadget-client) *client gadget*

Summary: Returns the client of the gadget *gadget*. The client is usually an application frame, but it could be another gadget (for example, a push button contained in a radio box).

gadget-armed-callback *Generic Function*

`gadget-armed-callback` *gadget*

gadget-disarmed-callback *Generic Function*

`gadget-disarmed-callback` *gadget*

Summary: Returns the functions that will be called when the armed or disarmed callback, respectively, are invoked. These functions will be invoked with a single argument, the gadget.

When these functions return **`nil`**, there is no armed (or disarmed) callback for the gadget.

armed-callback *Callback*

`armed-callback` *gadget client gadget-id*

disarmed-callback *Callback*

`disarmed-callback` *gadget client gadget-id*

Summary: These callbacks are invoked when the gadget *gadget* is, respectively, armed or disarmed. The exact definition of arming and disarming varies from gadget to gadget, but typically a gadget becomes armed when the pointer is moved into its region, and disarmed when the pointer moves out of its region.

The default methods (on **`basic-gadget`**) call the function stored in **`gadget-armed-callback`** or **`gadget-disarmed-callback`** with one argument, the gadget.

activate-gadget *Generic Function*

`activate-gadget` *gadget*

Summary: Causes the host gadget to become active, that is, available for input.

deactivate-gadget *Generic Function*

`deactivate-gadget` *gadget*

Summary: Causes the host gadget to become inactive, that is, unavailable for input. In some environments this may cause the gadget to become grayed over; in others, no visual effect may be detected.

gadget-active-p *Generic Function*

`gadget-active-p` *gadget*

Summary: Returns **`t`** if *gadget* is active, that is, has been activated with **`activate-gadget`**.

note-gadget-activated *Generic Function*

`note-gadget-activated` *client gadget*

Summary: This function is invoked after a gadget is made active.

note-gadget-deactivated *Generic Function*

`note-gadget-deactivated` *client gadget*

Summary: This function is invoked after a gadget is made inactive.

value-gadget *Class*

Summary: The class used by gadgets that have a value; a subclass of **basic-gadget**.

:value
:value-changed-callback *Initargs*

Summary: All subclasses of **value-gadget** must handle these two initargs, which specify, respectively, the initial value and the value changed callback of the gadget.

gadget-value *Generic Function*

gadget-value *value-gadget*

Summary: Returns the value of the gadget *value-gadget*. The interpretation of the value varies from gadget to gadget. For example, a scroll bar's value might be a number between 0 and 1, while a toggle button's value is either **t** or **nil**. (The documentation of each individual gadget specifies how to interpret the value.)

(setf gadget-value) *Generic Function*

(setf gadget-value) *value value-gadget* **&key** *invoke-callback*

Summary: Sets the gadget's value to the specified value. In addition, if *invoke-callback* is **t** (the default is **nil**), the value -changed callback for the gadget is invoked. The syntax for using **(setf gadget-value)** is:

```
(setf (gadget-value gadget :invoke-callback t) new-value)
```

gadget-value-changed-callback *Generic Function*

gadget-value-changed-callback *value-gadget*

Summary: Returns the function that will be called when the value changed callback is invoked. This function will be invoked with two arguments, the gadget and the new value.

When this function returns **nil**, there is no value-changed callback for the gadget.

value-changed-callback *Callback*

value-changed-callback *value-gadget client gadget-id value*

Summary: This callback is invoked whenever the value of a gadget is changed.

The default method (on **value-gadget**) calls the function stored in **gadget-value-changed-callback** with two arguments, the gadget and the new value.

CLIM implements or inherits a method for **value-changed-callback** for every gadget that is a subclass of **value-gadget**.

action-gadget *Class*

Summary: The class used by gadgets that perform some kind of action, such as a push button; a subclass of **basic-gadget**.

:activate-callback *Initarg*

Summary: All subclasses of **action-gadget** must handle this initarg, which specifies the activate callback of the gadget.

gadget-activate-callback *Generic Function*

`gadget-activate-callback` *action-gadget*

Summary: Returns the function that will be called when the gadget is activated. This function will be invoked with one argument, the gadget.

When this function returns **`nil`**, there is no value-activate callback for the gadget.

activate-callback *Callback*

`activate-callback` *action-gadget client gadget-id*

Summary: This callback is invoked when the gadget is activated.

The default method (on **`action-gadget`**) calls the function stored in **`gadget-activate-callback`** with one argument, the gadget.

CLIM implements or inherits a method for **`activate-callback`** for every gadget that is a subclass of **`action-gadget`**.

oriented-gadget-mixin *Class*

Summary: The class that is mixed into a gadget that has an orientation associated with it, for example, a slider. This class is not intended to be instantiated.

:orientation *Initarg*

Summary: All subclasses of **`oriented-gadget-mixin`** must handle this initarg, which is used to specify the orientation of the gadget. The value is either **`:horizontal`** or **`:vertical`**.

gadget-orientation *Generic Function*

`gadget-orientation` *oriented-gadget*

Summary: Returns the orientation of the gadget *oriented-gadget*. Typically, this will be a keyword such as **`:horizontal`** or **`:vertical`**.

labelled-gadget-mixin *Class*

Summary: The class that is mixed into a gadget that has a label, for example, a push button. This class is not intended to be instantiated.

:label
:align-x
:align-y *Initargs*

Summary: All subclasses of **`labelled-gadget-mixin`** must handle these initargs, which are used to specify the label and its **x** and **y** alignment. Labelled gadgets will also have a text style for the label, but this is managed by the usual text-style mechanism for panes.

gadget-label *Generic Function*

`gadget-label` *labelled-gadget*

(setf gadget-label) *Generic Function*

`(setf gadget-label)` *label labelled-gadget*

Summary: Returns (or sets) the label of the gadget *labelled-gadget*. The label must be a string. Changing the label of a gadget may result in invoking the layout protocol on the gadget and its ancestor sheets.

gadget-label-align-x *Generic Function*

`gadget-label-align-x` *labelled-gadget*

(setf gadget-label-align-x) *Generic Function*

`(setf gadget-label-align-x)` *alignment labelled-gadget*

gadget-label-align-y *Generic Function*

`gadget-label-align-y` *labelled-gadget*

(setf gadget-label-align-y) *Generic Function*

`(setf gadget-label-align-y)` *alignment labelled-gadget*

Summary: Returns (or sets) the alignment of the label of the gadget *labelled-gadget*. Changing the alignment a gadget may result in invoking the layout protocol on the gadget and its ancestor sheets.

gadget-label-text-style *Generic Function*

`gadget-label-text-style` *labelled-gadget*

(setf gadget-label-text-style) *Generic Function*

`(setf gadget-label-text-style)` *text-style labelled-gadget*

Summary: Returns (or sets) the text style of the label of the gadget *labelled-gadget*. This must be a CLIM text style object. Changing the label text style of a gadget may result in invoking the layout protocol on the gadget and its ancestor sheets.

range-gadget-mixin *Class*

Summary: The class that is mixed into a gadget that has a range, for example, a slider.

:min-value
:max-value *Initargs*

Summary: All subclasses of **`range-gadget-mixin`** must handle these two initargs, which are used to specify the minimum and maximum value of the gadget.

gadget-min-value *Generic Function*

`gadget-min-value` *range-gadget*

(setf gadget-min-value) *Generic Function*

`(setf gadget-min-value)` *min-value range-gadget*

Summary: Returns (or sets) the minimum value of the gadget *range-gadget*, a real number.

gadget-max-value *Generic Function*

`gadget-max-value` *range-gadget*

(setf gadget-max-value) *Generic Function*

`(setf gadget-max-value)` *max-value range-gadget*

Summary: Returns (or sets) the maximum value of the gadget *range-gadget*, a real number.

gadget-range *Generic Function*

`gadget-range` *range-gadget*

Summary: Returns the range of *range-gadget*, that is, the difference of the maximum value and the minimum value.

gadget-range* *Generic Function*

`gadget-range*` *range-gadget*

Summary: Returns the the minimum value and the maximum value of *range-gadget* as two values.

10.5.3 Abstract Gadget Classes

CLIM supplies a set of gadgets that have been designed to be compatible with a variety of user interface toolkits, including Xt widget-based toolkits (such as Motif), OpenLook, and the MacToolbox.

Each gadget maps to an implementation-specific object that is managed by the underlying toolkit. For example, when a CLIM program manipulates an object of class **`scroll-bar`**, the underlying implementation-specific object might be a Motif **`ScrollBar`** widget. As events are processed on the underlying object, the corresponding generic operations are applied to the Lisp gadget.

Note that not all operations will necessarily be generated by particular toolkit implementations. For example, a user interface toolkit that is designed for a 3-button mouse may generate significantly more gadget events than one designed for a 1-button mouse.

10.5.3.1 The Label Gadget

label-pane *Leaf Pane*

labelling *Macro*

`labelling (&rest` *options* **`&key`** *label label-alignment* **`&allow-other-keys) &body`** *contents*

Summary: Creates a pane that consists of the specified label, which is a string.

Valid *options* are **`:align-x`** (one of **`:left`**, **`:right`**, or **`:center`**) and **`:text-style`**.

label-alignment may be one of **`:top`** or **`:bottom`**.

contents must be a single (but possibly compound) pane.

10.5.3.2 The List-Pane and Option-Pane Gadgets

A list pane is a list of buttons. An option pane is a single button that, when pressed, pops up a menu of selections.

list-pane *Class*

Summary: The class that implements an abstract list pane. It is a subclass of **`value-gadget`**.

:mode *Initarg*

Summary: Either **:one-of** or **:some-of**. When it is **:one-of**, the list pane acts like a radio box; that is, only one item can be selected. When it is **:some-of** (the default), zero or more items can be selected at a time.

:items

:name-key

:value-key

:test *Initargs*

Summary: The **:items** initarg specifies a sequence of items to use as the items of the list pane. The name of the item is extracted by the function that is the value of the **:name-key** initarg, which defaults to **princ-to-string**. The value of the item is extracted by the function that is the value of the **:value-key** initarg, which defaults to **identity**. The **:test** initarg specifies a function of two argument that is used to compare items; it defaults to **eql**. For example:

```
(make-pane 'list-pane
           :value '("Lisp" "C++")
           :mode :some-of
           :items '("Lisp" "Fortran" "C" "C++" "Cobol" "Ada")
           :test 'string=)
```

gadget-value *Generic Function*

gadget-value (*button list-pane***)**

Summary: Returns the single selected item when the mode is **:one-of**, or a sequence of selected items when the mode is **:some-of**.

generic-list-pane *Class*

Summary: The class that implements a portable list pane; a subclass of **list-pane**.

option-pane *Class*

Summary: The class that implements an abstract option pane. It is a subclass of **value-gadget**.

:items

:name-key

:value-key

:test *Initargs*

Summary: The **:items** initarg specifies a sequence of items to use as the items of the option pane. The name of the item is extracted by the function that is the value of the **:name-key** initarg, which defaults to **princ-to-string**. The value of the item is extracted by the function that is the value of the **:value-key** initarg, which defaults to **identity**. The **:test** initarg specifies a function of two argument that is used to compare items; it defaults to **eql**.

gadget-value *Generic Function*

gadget-value (*button option-pane***)**

Summary: Returns the single selected item.

generic-option-pane *Class*

Summary: The class that implements a portable option pane; a subclass of **option-pane**.

10.5.3.3 The Menu-Button Gadget

Note: The Menu-Button gadget is available only in Liquid CL CLIM.

The **menu-button** gadget provides similar behavior to the **toggle-button** gadget, except that it is intended for items in menus. The returned value is generally the item chosen from the menu.

arm-callback will be invoked when the menu button becomes armed (such as when the pointer moves into it, or a pointer button is pressed over it). When the menu button is actually activated (by releasing the pointer button over it), **value-changed-callback** will be invoked. Finally, **disarm-callback** will be invoked after **value-changed-callback**, or when the pointer is moved outside of the menu button.

menu-button *Class*

Summary: The class that implements an abstract menu button. It is a subclass of **value-gadget** and **labelled-gadget-mixin**.

menu-button-pane *Class*

Summary: The class that implements a portable menu button; a subclass of **menu-button**.

10.5.3.4 The Push-Button Gadget

The **push-button** gadget provides press-to-activate switch behavior.

arm-callback will be invoked when the push button becomes armed (such as when the pointer moves into it, or a pointer button is pressed over it). When the button is actually activated (by releasing the pointer button over it), **activate-callback** will be invoked. Finally, **disarm-callback** will be invoked after **activate-callback**, or when the pointer is moved outside of the button.

push-button *Class*

Summary: The class that implements an abstract push button. It is a subclass of **active-gadget** and **labelled-gadget-mixin**.

:show-as-default *Initarg*

Summary: This initializes the "show as default" property for the gadget.

push-button-show-as-default *Generic Function*

push-button-show-as-default *push-button*

Summary: Returns the "show as default" property for the push button gadget. When **t**, the push button will be drawn with a heavy border, which indicates that this button is the "default operation".

push-button-pane *Class*

Summary: The class that implements a portable push button; a subclass of **push-button**.

10.5.3.5 The Radio-Box and Check-Box Gadgets

A radio box is a special kind of gadget that constrains one or more toggle buttons. At any one time, only one of the buttons managed by the radio box may be "on." A radio box is responsible for laying out its contents (the buttons that it contains). So that the value of the radio box can be properly computed, it is a client of each of its buttons. As the current selection changes, the previously selected button and the newly selected button both have their **`value-changed-callback`** handlers invoked.

Like a radio box, a check box is a gadget that constrains a number of toggle buttons, but unlike a radio box, a check box may have zero or more of its buttons selected at a time.

radio-box *Class*

Summary: The class that implements a radio box. It is a subclass of **`value-gadget`** and **`oriented-gadget-mixin`**.

:current-selection *Initarg*

Summary: This is used to specify which button, if any, should be initially selected.

radio-box-current-selection *Generic Function*

`radio-box-current-selection` *radio-box*

(setf radio-box-current-selection) *Generic Function*

`(setf radio-box-current-selection)` *button radio-box*

Summary: Returns (or sets) the current selection for the radio box. The current selection will be one of the toggle buttons in the box.

radio-box-selections *Generic Function*

`radio-box-selections` *radio-box*

Summary: Returns a sequence of all the selections in the radio box. The elements of the sequence will be toggle buttons.

gadget-value *Generic Function*

`gadget-value (`*button radio-box***`)`**

Summary: Returns the selected button (i.e., returns the same value as **`radio-box-current-selection`**).

radio-box-pane *Class*

Summary: The class that implements a portable radio box; it is a subclass of **`radio-box`**.

check-box *Class*

Summary: The class that implements a check box. **`check-box`** is a subclass of **`value-gadget`** and **`oriented-gadget-mixin`**.

:current-selection *Initarg*

Summary: This is used to specify which button, if any, should be initially selected.

check-box-current-selection *Generic Function*

`check-box-current-selection` *check-box*

(setf check-box-current-selection) *Generic Function*

(setf check-box-current-selection) *button check-box*

Summary: Returns (or sets) the current selection for the check box. The current selection will be a list of zero or more of the toggle buttons in the box.

check-box-selections *Generic Function*

check-box-selections *check-box*

Summary: Returns a sequence of all the selections in the check box. The elements of the sequence will be toggle buttons.

gadget-value *Generic Function*

gadget-value (*button check-box***)**

Summary: Returns the selected buttons as a list (i.e., returns the same value as **check-box-current-selection**).

check-box-pane *Class*

Summary: The class that implements a portable check box; it is a subclass of **check-box**.

with-radio-box *Macro*

with-radio-box (&rest *options* **&key (***type one-of***) &allow-other-keys) &body** *body*

Summary: Creates a radio box whose buttons are created by the forms in *body*. The macro **radio-box-current-selection** can be wrapped around one of forms in *body* in order to indicate that that button is the current selection.

A radio box will be created if *type* is **:one-of**, a check box if **:some-of**.

For example, the following creates a radio box with three buttons in it, the second of which is initially selected.

```
(with-radio-box ()
               (make-pane 'toggle-button :label "Mono")
               (radio-box-current-selection
                (make-pane 'toggle-button :label "Stereo"))
               (make-pane 'toggle-button :label "Quad"))
```

The following simpler form can be used when you do not need to control the appearance of each button closely.

```
(with-radio-box () "Mono" "Stereo" "Quad")
```

10.5.3.6 The Scroll-Bar Gadget

The **scroll-bar** gadget corresponds to a scroll bar.

scroll-bar *Class*

Summary: The class that implements a scroll bar. This is a subclass of **value-gadget**, **oriented-gadget-mixin**, and **range-gadget-mixin**.

:drag-callback

:scroll-to-bottom-callback

:scroll-to-top-callback

:scroll-down-line-callback
:scroll-up-line-callback
:scroll-down-page-callback
:scroll-up-page-callback *Initargs*

Summary: Specifies the various callbacks for the scroll bar.

---

scroll-bar-drag-callback *Generic Function*

`scroll-bar-drag-callback` *scroll-bar*

Summary: Returns the function that will be called when the indicator of the scroll bar is dragged. This function will be invoked with a two arguments, the scroll bar and the new value.

---

scroll-bar-scroll-to-bottom-callback *Generic Function*

`scroll-bar-scroll-to-bottom-callback` *scroll-bar*

---

scroll-bar-scroll-to-top-callback *Generic Function*

`scroll-bar-scroll-to-top-callback` *scroll-bar*

---

scroll-bar-scroll-down-line-callback *Generic Function*

`scroll-bar-scroll-down-line-callback` *scroll-bar*

---

scroll-bar-scroll-up-line-callback *Generic Function*

`scroll-bar-scroll-up-line-callback` *scroll-bar*

---

scroll-bar-scroll-down-page-callback *Generic Function*

`scroll-bar-scroll-down-page-callback` *scroll-bar*

---

scroll-bar-scroll-up-page-callback *Generic Function*

`scroll-bar-scroll-up-page-callback` *scroll-bar*

Summary: Returns the functions that will be used as callbacks when various parts of the scroll bar are clicked on. These are all functions of one argument, the scroll bar.

When any of these functions returns **`nil`**, there is no callback of that type for the gadget.

---

drag-callback *Callback*

`drag-callback` *scroll-bar client gadget-id value*

Summary: This callback is invoked when the value of the scroll bar is changed while the indicator is being dragged. The function stored in **`scroll-bar-drag-callback`** is called with two arguments, the scroll bar and the new value.

The **`value-changed-callback`** is invoked only after the indicator is released after dragging it.

---

scroll-to-top-callback *Callback*

`scroll-to-top-callback` *scroll-bar client gadget-id*

---

scroll-to-bottom-callback *Callback*

`scroll-to-bottom-callback` *scroll-bar client gadget-id*

scroll-up-line-callback *Callback*

scroll-up-line-callback *scroll-bar client gadget-id*

scroll-up-page-callback *Callback*

scroll-up-page-callback *scroll-bar client gadget-id*

scroll-down-line-callback *Callback*

scroll-down-line-callback *scroll-bar client gadget-id*

scroll-down-page-callback *Callback*

scroll-down-page-callback *scroll-bar client gadget-id*

Summary: All the callbacks above are invoked when appropriate parts of the scroll bar are clicked on. Note that each implementation may not have "hot spots" corresponding to each of these callbacks.

gadget-value *Generic Function*

gadget-value (*button scroll-bar***)**

Summary: Returns a real number within the specified range.

scroll-bar-pane *Class*

Summary: The class that implements a portable scroll bar; it is a subclass of **scroll-bar**.

10.5.3.7 The Slider Gadget

The **slider** gadget corresponds to a slider.

slider *Class*

Summary: The class that implements a slider. This is a subclass of **value-gadget**, **oriented-gadget-mixin**, **range-gadget-mixin**, and **labelled-gadget-mixin**.

:drag-callback

:show-value-p

:decimal-places *Initargs*

Summary: Specifies the drag callback for the slider, whether the slider should show its current value, and how many decimal places to the right of the decimal point should be displayed when the slider is showing its current value.

slider-drag-callback *Generic Function*

slider-drag-callback *slider*

Summary: Returns the function that will be called when the slider's indicator is dragged. This function will be invoked with two arguments, the slider and the new value.

When this function returns **nil**, there is no drag callback for the gadget.

drag-callback *Callback*

drag-callback *slider client gadget-id value*

Summary: This callback is invoked when the value of the slider is changed while the indicator is being dragged. The function stored in **`slider-drag-callback`** is called with two arguments, the slider and the new value.

The **`value-changed-callback`** is invoked only after the indicator is released after dragging it.

gadget-value *Generic Function*

`gadget-value (`*button slider***`)`**

Summary: Returns a real number that is the value of *button*.

slider-pane *Class*

Summary: The class that implements a portable slider; a subclass of **`slider`**.

:number-of-tick-marks
:number-of-quanta *Initargs*

Summary: Specifies the number of tick marks that should be drawn on the scroll bar, and the number of quanta in the scroll bar. If the scroll bar is quantized, it will consist of discrete (rather than continuous) values.

Note: :number-of-tick-marks and *:number-of-quanta* are available only in Liquid CL CLIM.

gadget-show-value-p *Generic Function*

`gadget-show-value-p` *slider*

Summary: Returns **`t`** if the slider shows its value; otherwise, it returns **`nil`**.

Note: gadget-show-value-p is available only in Liquid CL CLIM.

10.5.3.8 The Text-Field and Text-Editor Gadgets

The **`text-field`** gadget corresponds to a small field containing text. The **`text-editor`** gadget corresponds to a large field containing multiple lines of text.

text-field *Class*

Summary: The class that implements a text field. This is a subclass of **`value-gadget`** and **`action-gadget`**. The value of a text field is the text string.

:editable-p *Initarg*

Summary: Specifies whether or not the text field can be edited.

gadget-value *Generic Function*

`gadget-value (`*value-gadget text-field***`)`**

Summary: Returns the resulting string.

text-field-pane *Class*

Summary: The instantiable class that implements a portable text field; it is a subclass of **`text-field`**.

text-editor *Class*

Summary: The instantiable class that implements an abstract large text field. This is a subclass of **`text-field`**.

The value of a text editor is the text string.

:ncolumns
:nlines *Initargs*

Summary: Specifies the width and height of the text editor in columns and number of lines.

gadget-value *Generic Function*

`gadget-value (`*value-gadget text-editor***`)`**

Summary: Returns the resulting string.

text-editor-pane *Class*

Summary: The instantiable class that implements a portable text editor; it is a subclass of **`text-editor`**.

10.5.3.9 The Toggle-Button Gadget

The **`toggle-button`** gadget provides "on/off" switch behavior. This gadget typically appears as a recessed or prominent box. If the box is recessed, the gadget's value is **`t`**; if it is prominent, the value is **`nil`**.

`arm-callback` will be invoked when the toggle button becomes armed (such as when the pointer moves into it, or a pointer button is pressed over it). When the toggle button is actually activated (by releasing the pointer button over it), **`value-changed-callback`** will be invoked. Finally, **`disarm-callback`** will be invoked after **`value-changed-callback`**, or when the pointer is moved outside of the toggle button.

toggle-button *Class*

Summary: The class that implements an abstract toggle button. It is a subclass of **`value-gadget`** and **`labelled-gadget-mixin`**.

:indicator-type *Initarg*

Summary: This initializes the indicator type property for the gadget.

toggle-button-indicator-type *Generic Function*

`toggle-button-indicator-type` *toggle-button*

Summary: Returns the indicator type for the toggle button. This will be either **`:one-of`** or **`:some-of`**. The indicator type controls the appearance of the toggle button. For example, many toolkits present a one-of-many choice differently from a some-of-many choice.

gadget-value *Generic Function*

`gadget-value (`*value-gadget toggle-button***`)`**

Summary: Returns **`t`** if the button is selected; otherwise, it returns **`nil`**.

toggle-button-pane *Class*

Summary: The class that implements a portable toggle button; a subclass of **`toggle-button`**.

10.5.4 Integrating Gadgets and Output Records

In addition to gadget panes, CLIM allows gadgets to be used inside of CLIM stream panes. For instance, an **`accepting-values`** pane whose fields consist of gadgets may appear in an ordinary CLIM stream pane.

Note that many of the functions in the output record protocol must correctly manage the case where output records contain gadgets. For example, **(setf output-record-position)** may need to notify the host window system that the toolkit object representing the gadget has moved, **window-clear** needs to deactivate any gadgets, and so forth.

gadget-output-record *Class*

Summary: The instantiable class that represents an output record class that contains a gadget. This is a subclass of **output-record**.

with-output-as-gadget *Macro*

with-output-as-gadget (*stream* **&rest** *options***) &body** *body*

Summary: Invokes *body* to create a gadget, and then creates a gadget output record that contains the gadget and installs it into the output history of the output recording stream *stream*. The returned value of *body* must be the gadget.

The options in *options* are passed as initargs to the call to **invoke-with-new-output-record** that is used to create the gadget output record.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream. If *stream* is **t**, ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

For example, the following could be used to create an output record containing a radio box that contains several toggle buttons:

```
(with-output-as-gadget
 (stream)
 (let* ((radio-box
         (make-pane 'radio-box
                    :client stream :id 'radio-box)))
   (dolist (item sequence)
     (make-pane 'toggle-button
                :label (princ-to-string (item-name item))
                :value (item-value item)
                :id item :parent radio-box))
   radio-box))
```

An example of a push button that calls back into the presentation type system to execute a command might be as follows:

```
(with-output-as-gadget
 (stream)
 (make-pane 'push-button
            :label "Click here to exit"
            :activate-callback
            #'(lambda (button)
                (frame-exit (pane-frame button)))))
```

11 Commands

11.1 Introduction to CLIM Commands

In CLIM, users interact with applications through the use of ***commands***. Commands are a way of representing an operation in an application.

Commands are performed by the command loop, which accepts input of presentation type **`command`** and then executes the accepted command. **11.3 Command Objects** discusses how commands are represented.

CLIM also supports *actions*, which are performed directly by the user interface. Actions are seldom necessary, as it is usually the functionality of commands that is desired. See the macro **`define-presentation-action`** for a discussion of when presentation actions are appropriate.

CLIM supports four main styles of interaction:

- Mouse interaction via command menus.

  A command is invoked by clicking on an item in a menu.

- Mouse interaction via command translators.

  A command can be invoked by clicking on any object displayed by the interface. The particular combination of mouse-buttons and modifier keys (e.g., **`SHIFT`**, **`CONTROL`**) is called a ***gesture***. As part of the presentation system, a command translator turns a gesture on an object into a command.

- Keyboard interaction using a command-line processor.

  The user types a complete textual representation of command names and arguments. The text is parsed by the command-line processor to form a command. A special character (usually **`NEWLINE`**) indicates to the command-line processor that the text is ready to be parsed.

- Keyboard interaction using keystroke accelerators.

  A single keystroke invokes the associated command.

The choice of interaction styles is independent of the command loop or the set of commands. The relationship between a user's interactions and the commands to be executed is governed by command tables. A ***command table*** is an object that mediates between a command input context (e.g., the top level of an application frame), a set of commands, and these interaction styles.

For simple CLIM applications, **`define-application-frame`** will automatically create a command table and a top-level command input context, and define a command-defining macro for you.

Following a discussion of the simple approach, this chapter discusses command tables and the command processor in detail. This information is provided for the curious and for those who feel they require further control over their application's interactions. These are some circumstances that might suggest something beyond the simple approach:

- Your application requires more than one command table if, for example, it has multiple modes with different sets of commands available in each mode.
- If you have sets of commands that are common among several modes or even among several applications, you could use several command tables and inheritance to help organize your command sets.

- Your application may be complex enough that you may want to develop more powerful tools for examining and manipulating command tables.

If you do not require this level of detail, only read **11.2 Defining Commands the Easy Way**.

11.2 Defining Commands the Easy Way

The easiest way to define commands is to use **`define-application-frame`**, which automatically creates a command table for your application. This behavior is controlled by the **`:command-table`** option. It also defines the command-defining macro you will use to define the commands for your application. This is controlled by the **`:command-definer`** option.

This command-definer macro behaves similarly to **`define-command`**, but automatically uses your application's command table, so you need not specify one.

Here is a code fragment illustrating the use of **`define-application-frame`**, which defines an application named **`editor`**. A command table named **`editor-command-table`** is defined to mediate the user's interactions with the **`editor`** application. **`define-application-frame`** also defines a macro named **`define-editor-command`**, which you will use to define commands for the **`editor`** application and install them in the command table **`editor-command-table`**.

```
(clim:define-application-frame editor () ()
 (:command-table editor-command-table)
 (:command-definer define-editor-command) ...)
```

Note that for this particular example, the **`:command-table`** and **`:command-definer`** options are not specified, since the names that they specify are the ones that would be generated by default. Provide these options only when you want different names than the default ones, you don't want a command definer, or you want to specify which command tables the application's command table inherits from. See the macro **`define-application-frame`**, in **9.2 Defining CLIM Application Frames** for a description of these options.

11.2.1 Command Names and Command Line Names

Every command has a ***command name***, which is a symbol. The symbol names the function that implements the command. The body of the command is the function definition of that symbol.

By convention, commands are named with a **`com-`** prefix, although CLIM does not enforce this convention.

To avoid collisions among command names, each application should live in its own package; for example, there might be several commands named **`com-show-chart`** defined for each of a spreadsheet, a navigation program, and a medical application.

CLIM supports a ***command line name*** which is the "command" that the end user sees and uses, as opposed to the construct that is the command's actual name. For example, the command **`com-show-chart`** would have a command-line name of **`Show Chart`**. When defining a command using **`define-command`** (or the application's command defining macro), you can have a command line name generated automatically. As you can see from this example, the automatically generated command line name consists of the command's name with the hyphens replaced by spaces and the words capitalized. Any **`com-`** prefix is removed.

11.2.2 The Command-Defining Macro

The **`define-editor-command`** macro, automatically generated by the **`define-application-frame`** code previously, is used to define a command for the **`editor`** application. It is just like **`define-command`**, except that you don't need to specify **`editor-command-table`** as the command table in which to define the command. **`define-editor-command`** will automatically use **`editor-command-table`**.

Through the appropriate use of the options to **`define-editor-command`** (see **`define-command`** for details), you can provide the command via any number of the previously mentioned interaction styles. For example, you could install the command in the **editor** application's menu, as well as specifying a single keystroke command accelerator character for it.

The following example defines a command whose command name is **com-save-file**. The **com-save-file** command will appear in the application's command menu as **Save File**. (The command-menu name is derived from the command name in the same way as the command-line name.) The single keystroke **CONTROL-s** is also defined to invoke the command.

```
(define-editor-command
  (com-save-file :menu t
                 :keystroke (#\s :control)) () ...)
```

Here, a command line name of **Save File** is associated with the **com-save-file** command. The user can then type **Save File** to the application's interaction pane to invoke the command.

```
(define-editor-command
  (com-save-file :name "Save File") () ...)
```

Since the command processor works by establishing an input context of presentation type **command** and executing the resulting input, any displayed presentation can invoke a command, so long as there is a translator defined that translates from the presentation type of the presentation to the presentation type **command**. In this way, you can associate a command with a pointer gesture when it is applied to a displayed presentation. (**8 Presentation Translators in CLIM** for details.)

define-presentation-to-command-translator *Macro*

define-presentation-to-command-translator *name* **(***from-type command-name command-table* **&key (***gesture* **:***select***)** *tester documentation pointer-documentation* **(***menu* **t)** *priority* **(***echo* **t))** *arglist* **&body** *body*

Summary: Defines a presentation translator that translates a displayed presentation into a command.

11.3 Command Objects

A ***command*** is an object that represents a single user interaction. Each command has a command name, which is a symbol. A command can also have both positional and keyword arguments.

CLIM represents commands as ***command objects***. The internal representation of a command object is a cons of the command name and a list of the command's arguments, and is therefore analogous to a Lisp expression. Functions are provided for extracting the command name and the arguments list from a command object:

command-name *Function*

command-name *command*

Summary: Given a command object *command*, returns the command name.

command-arguments *Function*

command-arguments *command*

Summary: Given a command object *command*, returns the command's arguments.

It is possible to represent a command for which some of the arguments have not yet been specified. The value of the symbol ***unsupplied-argument*** is used in place of any argument that has not yet been specified.

partial-command-p *Function*

partial-command-p *command*

Summary: Returns **t** if the *command* is a partial command, that is, has any occurrences of

unsupplied-argument-marker in it. Otherwise, this function returns **nil**.

One can think of **define-command** as defining templates for command objects. It defines a symbol as a command name and associates with it the presentation types corresponding to each of the command's arguments.

define-command *Macro*

define-command *name-and-options arguments* **&body** *body*

The most basic command-defining form. Usually the programmer will not use **define-command** directly, but will instead use a **define-***frame***-command** form automatically generated by **define-application-frame**. **define-***frame***-command** adds the command to the application frame's command table. By default, **define-command** does not add the command to any command table.

define-command defines two functions. The first function has the same name as the command name and implements the body of the command. It takes as required and keyword arguments the arguments to the command as specified by the **define-command** form .The name of the other function defined by Lisp is unspecified. It implements the code used by the command processor for parsing and returning the command's arguments.

name-and-options is either a command name or a cons of the command name and a list of keyword-value pairs.

- **:command-table** *command-table-name*, where *command-table-name* either names a command table to which the command will be added, or is **nil** (the default), indicating that the command should not be added to any command table. If the command table does not exist, the **command-table-not-found** error will be signaled. This keyword is only accepted by **define-command**, not by **define-***frame***-command**.
- **:name** *string*, where *string* is a string that will be used as the command-line name for the command for keyboard interactions in the command table specified by the **:command-table** option. The default is **nil**, meaning that the command will not be available via command-line interactions. If *string* is **t**, then the command-line name will be generated automatically, as described in **add-command-to-command-table**.
- **:menu** *menu-spec*, where *menu-spec* describes an item in the menu of the command table specified by the **:command-table** option. The default is **nil**, meaning that the command will not be available via menu interactions. If *menu-spec* is a string, then that string will be used as the name of the command in the menu. If *menu-spec* is **t**, and if a command-line name was supplied, it will be used as the name of the command in the menu; otherwise the menu name will be generated automatically, as described in **add-command-to-command-table**. Otherwise, *menu-spec* must be a cons of the form **(***string* **.** *menu-options***)**, where *string* is the menu name and *menu-options* consists of keyword-value pairs. The valid keywords are **:after**, **:documentation**, and **:text-style**, which are as for **add-menu-item-to-command-table**.
- **:keystroke** *gesture*, where *gesture* is a keyboard gesture name that specifies a keystroke accelerator to use for this command in the command table specified by the **:command-table** option. The default is **nil**, meaning that there is no keystroke accelerator.

The **:name**, **:menu**, and **:keystroke** options are only allowed if the **:command-table** option is supplied explicitly or implicitly, as in **define-***frame***-command**.

arguments is a list consisting of argument descriptions. A single occurrence of the symbol **&key** may appear in *arguments* to separate required command arguments from keyword arguments. Each argument description consists of a parameter variable, followed by a presentation type specifier, followed by keyword-value pairs. The keywords can be:

- **:default** *value*, where *value* is the default that should be used for the argument, as for **accept**.
- **:default-type** is the same as for **accept**.
- **:display-default** is the same as for **accept**.

- **:mentioned-default** *value*, where *value* is the default that should be used for the argument when a keyword is explicitly supplied via the command-line processor, but no value is supplied for it. **:mentioned-default** is only allowed on keyword arguments.
- **:prompt** *string*, where *string* is a prompt to print out during command-line parsing, as for **accept**.
- **:documentation** *string*, where *string* is a documentation string that describes what the argument is.
- **:when** *form*. *form* is evaluated in a scope where the parameter variables for the required parameters are bound, and if the result is **nil**, the keyword argument is not available. **:when** is only allowed on keyword arguments, and *form* cannot use the values of other keyword arguments.
- **:gesture** *gesture*, where *gesture* is either a pointer gesture name or a list of a pointer gesture name followed by keyword-value pairs. When a gesture is supplied, a presentation translator will be defined that translates from this argument's presentation type to an instance of this command with the selected object as the argument; the other arguments will be filled in with their default values. The keyword-value pairs are used as options for the translator. Valid keywords are **:tester**, **:menu**, **:priority**, **:echo**, **:documentation**, and **:pointer-documentation**. The default for *gesture* is **nil**, meaning no translator will be written. **:gesture** is only allowed when the **:command-table** option was supplied to the command-defining form.

body implements the body of the command. It has lexical access to all of the commands arguments. If the body of the command needs access to the application frame itself, it should use ***application-frame***. The returned values of body are ignored. *body* may have zero or more declarations as its first forms.

define-command must arrange for the function that implements the body of the command to get the proper values for unsupplied keyword arguments.

name-and-options and *body* are not evaluated. In the argument descriptions, the parameter variable name is not evaluated. The others are evaluated at run-time when argument parsing reaches them, except that the value for **:when** is evaluated when parsing reaches the keyword arguments. **:gesture** is not evaluated.

11.4 CLIM Command Tables

CLIM command tables are represented by instances of the CLOS class **command-table**. A command table serves to mediate between a command input context, a set of commands, and the interactions of the application's user. Command tables contain the following information:

- The name of the command table, which is a symbol.
- An ordered list of command tables to inherit from.
- The set of commands that are present in this command table.
- A table that associates command-line names to command names (used to support command-line processor interactions).
- A set of presentation translators, defined via **define-presentation-translator** and **define-presentation-to-command-translator**.
- A table that associates keyboard gesture names to menu items (used to support keystroke accelerator interactions). The keystroke accelerator table does not contain any items inherited from superior command tables.
- A menu that associates menu names with command menu items (used to support interaction via command menus). The command menu items can invoke commands or submenus. The menu does not contain any command menu items inherited from superior command tables.

We say that a command is ***present*** in a command table when it has been added to that command table by being associated with some form of interaction. We say that a command is ***accessible*** in a command table when it is present in that command table or is present in any of the command tables from which that command table inherits.

command-table *Protocol Class*

Summary: The protocol class that corresponds to command tables. If you want to create a new class that behaves like a command table, it should be a subclass of **`command-table`**. Subclasses of **`command-table`** must obey the command table protocol. Members of this class are mutable.

command-table-p *Function*

`command-table-p` *object*

Summary: Returns **`t`** if *object* is a command table; otherwise, it returns **`nil`**.

standard-command-table *Class*

Summary: The instantiable class that implements command tables, a subclass of **`command-table`**. **`make-command-table`** returns objects that are members of this class.

command-table-name *Generic Function*

`command-table-name` *command-table*

Summary: Returns the name of the command table *command-table*.

command-table-inherit-from *Generic Function*

`command-table-inherit-from` *command-table*

Summary: Returns a list of the command tables from which the command table *command-table* inherits. This function returns objects that reveal CLIM's internal state; do not modify those objects.

define-command-table *Macro*

`define-command-table` *name* **`&key`** *inherit-from menu*

Summary: Defines a command table whose name is the symbol *name*. The new command table inherits from all of the command tables specified by *inherit-from*, which is a list of ***command table designators*** (that is, either a command table or a symbol that names a command table). The inheritance is done by union with shadowing. If no inheritance is specified, the command table will be made to inherit from CLIM's global command table. (This command table contains such things as the "menu" translator that is associated with the right-hand button on pointers.)

menu can be used to specify a menu for the command table. The value of *menu* is a list of clauses. Each clause is a list with the syntax **`(`***string type value* **`&key`** *keystroke documentation text-style***`)`**, where *string*, *type*, *value*, *keystroke*, *documentation*, and *text-style* are as for **`add-menu-item-to-command-table`**.

If the command table named by *name* already exists, **`define-command-table`** will modify the existing command table to have the new value for *inherit-from* and *menu*, and leaves the other attributes for the existing command table alone.

None of the arguments to **`define-command-table`** are evaluated.

make-command-table *Function*

`make-command-table` *name* **`&key`** *inherit-from menu* **`(`***errorp* **`t)`**

Summary: Creates a command table named *name*. *inherit-from* and *menu* are the same as for **`define-command-table`**. **`make-command-table`** does not implicitly include CLIM's global command table in the inheritance list for the new command table. If the command table already exists and *errorp* is **`t`**, the **`command-table-already-exists`** error will be signaled. If the command table already exists and *errorp* is **`nil`**, then the old command table will be discarded. The returned value is the command table.

find-command-table *Function*

`find-command-table` *name* **`&key (`***errorp* **`t)`**

Summary: Returns the command table named by *name*. If *name* is itself a command table, it is returned. If the command table is not found and *errorp* is **`t`**, the **`command-table-not-found`** error will be signaled.

add-command-to-command-table *Function*

`add-command-to-command-table` *command-name command-table* **`&key`** *name menu keystroke* **`(`***errorp* **`t)`**

Summary: Adds the command named by *command-name* to the command table specified by the command table designator *command-table*.

name is the command-line name for the command, and can be **`nil`**, **`t`**, or a string. When it is **`nil`**, the command will not be available via command-line interactions. When it is a string, that string is the command-line name for the command. When it is **`t`**, the command-line name is generated automatically. (The automatically generated name consists of the command's name with the hyphens replaced by spaces, and the words capitalized; any **`com-`** prefix is removed. For example, if the command name is **`com-show-file`**, the command-line name will be **`Show File`**.) For the purposes of command-line-name lookup, the character case of *name* is ignored.

menu is a menu item for the command, and can be **`nil`**, **`t`**, a string, or a cons. When it is **`nil`**, the command will not be available via menus. When it is a string, the string will be used as the menu name. When *menu* is **`t`** and *name* is a string, then *name* will be used as the menu name. When *menu* is **`t`** and *name* is not a string, an automatically generated menu name will be used. When *menu* is a cons of the form **`(`***string* **`.`** *menu-options***`)`**, *string* is the menu name and *menu-options* consists of keyword-value pairs. The valid keywords are **`:after`**, **`:documentation`**, and **`:text-style`**, which are interpreted as for **`add-menu-item-to-command-table`**.

The value for *keystroke* is either a keyboard gesture name or **`nil`**. When it is a gesture name, it is the keystroke accelerator for the command; if it is **`nil`**, the command will not be available via keystroke accelerators.

If the command is already present in the command table and *errorp* is **`t`**, the **`command-already-present`** error will be signaled. When *errorp* is **`nil`**, the old command-line name, menu, and keystroke accelerator will first be removed from the command table.

remove-command-from-command-table *Function*

`remove-command-from-command-table` *command-name command-table* **`&key (`***errorp* **`t)`**

Summary: Removes the command named by *command-name* from the command table specified by the command table designator *command-table*.

If the command is not present in the command table and *errorp* is **`t`**, the **`command-not-present`** error will be signaled.

11.5 CLIM Predefined Command Tables

CLIM provides these command tables:

global-command-table *Command Table*

Summary: The "global" command table from which all command tables inherit.

user-command-table *Command Table*

Summary: A command table reserved for user-defined commands.

accept-values-pane *Command Table*

Summary: When you use an **`accept-values`** pane in a **`define-application-frame`**, you must inherit from this command table.

It is recommended that an application's command table inherit from **`user-command-table`**. **`user-command-table`** inherits from **`global-command-table`**. If your application uses an **`:accept-values`** pane, then its command table must inherit from the **`accept-values-pane`** command table in order for it to work properly.

11.6 Conditions Relating to CLIM Command Tables

Command table operations can signal these conditions:

command-table-already-exists *Condition Class*

Summary: This condition is signaled by **`make-command-table`** when you try to create a command table that already exists.

command-table-not-found *Condition Class*

Summary: This condition is signaled by functions such as **`find-command-table`** when the named command table cannot be found.

command-already-present *Condition Class*

Summary: The error that is signaled when a function tries to add a command that is already present in a command table to that command table.

command-not-present *Condition Class*

Summary: A condition that is signaled when the command you are looking for is not present in the command table.

command-not-accessible *Condition Class*

Summary: A condition that is signaled when the command you are looking for is not accessible in the command table.

command-table-error *Condition Class*

Summary: The class that is the superclass of the previous four conditions. This class is a subclass of **`error`**.

11.7 Styles of Interaction Supported by CLIM

CLIM supports four main styles of interaction:

- Mouse interaction via command menus.
- Mouse interaction via translators.
- Keyboard interaction using a command-line processor.
- Keyboard interaction using keystroke accelerators.

See **11.2 Defining Commands the Easy Way** for a simple description of how to use **`define-command`** to associate a command with any of these interaction styles. See **11.10 Advanced Topics** for an in-depth discussion of CLIM interaction styles.

11.8 Command-Related Presentation Types

CLIM provides several presentation types pertaining to commands:

command *Presentation Type*

`command &key` *command-table*

Summary: The presentation type used to represent a command and its arguments; the command must be accessible in *command-table* and enabled in **`*application-frame*`**. *command-table* is a command table designator. If *command-table* is not supplied, it defaults to the command table for the current application frame.

The object returned by the **`accept`** presentation method for **`command`** must be a command object, that is, a cons of the command name and the list of the command's arguments.

The **`accept`** presentation method for the **`command`** type must call the command parser stored in **`*command-parser*`** to read the command. The parser will recursively call **`accept`** to read a **`command-name`** and all of the command's arguments. The parsers themselves must be implemented by accepting objects whose presentation type is **`command`**.

If the command parser returns a partial command, the **`accept`** presentation method for the **`command`** type must call the partial command parser stored in **`*partial-command-parser*`**.

The **`present`** presentation method for the **`command`** type must call the command unparser stored in **`*command-unparser*`**.

If a presentation history is maintained for the **`command`** presentation type, it should be maintained separately for each instance of an application frame.

command-name *Presentation Type*

`command-name &key` *command-table*

Summary: The presentation type used to represent the name of a command that is both accessible in the command table *command-table* and enabled in **`*application-frame*`**. *command-table* is a command table designator. If *command-table* is not supplied, it defaults to the command table for the current application frame, **`(frame-command-table *application-frame*)`**.

The textual representation of a **`command-name`** object is the command-line name of the command, while the internal representation is the command name.

command-or-form *Presentation Type*

`command-or-form &key` *command-table*

Summary: The presentation type used to represent an object that is either a Lisp form or a command and its arguments. The command must be accessible in *command-table* and enabled in **`*application-frame*`**. *command-table* is a command table designator. If *command-table* is not supplied, it defaults to the command table for the current application frame, **`(frame-command-table *application-frame*)`**.

The **`accept`** presentation method for this type reads a Lisp form, except that if the first character in the user's input is one of the characters in **`*command-dispatchers*`**, it will read a command. The two returned values from the **`accept`** presentation method will be the command or form object and a presentation type specifier that is either **`command`** or **`form`**.

A presentation history is maintained separately for the **`command-or-form`** presentation type for each instance of an application frame.

command-dispatchers *Variable*

Summary: This is a list of the characters that indicates that CLIM reads a command when it is accepting a **command-or-form**. The standard set of command argument delimiters includes the colon character, **#\:**.

11.9 The CLIM Command Processor

Once a set of commands has been defined, CLIM provides a variety of means to read a command. These are all mediated by the command processor.

The ***command loop*** of a CLIM application is performed by the application's top-level function (see **9 Defining Application Frames**). By default, this is **default-frame-top-level**. After performing some initializations, **default-frame-top-level** enters an infinite loop, reading and executing commands. It invokes the generic function **read-frame-command** to read a command that is then passed to the generic function **execute-frame-command** for execution. The specialization of these generic functions is the simplest way to modify the command loop for your application. Other techniques would involve replacing **default-frame-top-level** with your own top-level function.

read-frame-command invokes the command parser by establishing an input context of **command**. The ***input editor*** keeps track of the user's input, both from the keyboard and the pointer. Each of the command's arguments is parsed by establishing an input context of the arguments presentation type as described in the command's definition. Presentation translators provide the means by which the pointer can be used to enter command names and arguments.

read-command *Function*

read-command *command-table* **&key (***stream* ******query-io****)** *command-parser command-unparser partial-command-parser use-keystrokes*

Summary: **read-command** is the standard interface used to read a command line. *stream* is an extended input stream, and *command-table* is a command table designator.

command-parser is a function of two arguments, a command table and a stream. It reads a command from the user and returns a command object. The default value for *command-parser* is the value of ***command-parser***.

command-unparser is a function of three arguments, a command table, a stream, and a command to "unparse." It prints a textual description of the command and its supplied arguments onto the stream. The default value for *command-unparser* is the value of ***command-unparser***.

partial-command-parser is a function of four arguments, a command table, a stream, a partial command, and a start position. The partial command is a command object with the value of ***unsupplied-argument-marker*** in place of any argument that needs to be filled in. The function reads the remaining unsupplied arguments in any way it sees fit (for example, via an **accepting-values** dialog), and returns a command object. The start position is the original input-editor scan position of the stream, when the stream is an interactive stream. The default value for *partial-command-parser* is the value of ***partial-command-parser***.

command-parser, *command-unparser*, and *partial-command-parser* have dynamic extent.

When *use-keystrokes* is **t**, the command reader will also process keystroke accelerators.

Input editing, while conceptually an independent facility, fits into the command processor via its use of **accept**. That is, **read-command** calls **accept** to read command objects, and **accept** itself makes use of the input editing facilities.

read-frame-command *Generic Function*

read-frame-command *frame* **&key** *stream*

Summary: **read-frame-command** reads a command from the user on the stream *stream*, and returns the command object. *frame* is an application frame.

The default method for **read-frame-command** calls **read-command** on *frame*'s current command table.

execute-frame-command *Generic Function*

execute-frame-command *frame command*

Summary: **execute-frame-command** executes the command *command* on behalf of the application frame *frame*.

with-command-table-keystrokes *Macro*

with-command-table-keystrokes (*keystroke-var command-table***) &body** *body*

Summary: Binds *keystroke-var* to a sequence that contains all of the keystroke accelerators in *command-table*'s menu, and then executes *body* in that context. *command-table* is a command table designator. *body* may have zero or more declarations as its first forms.

read-command-using-keystrokes *Function*

read-command-using-keystrokes *command-table keystrokes* **&key (***stream* ******query-io****)** *command-parser command-unparser partial-command-parser*

Summary: Reads a command from the user via command lines, the pointer, or a single keystroke, and returns either a command object or a keyboard gesture object. (The latter only occurs when the user types a keystroke that is in *keystrokes* but does not have a command associated with it in *command-table*.)

keystrokes is a sequence of keyboard gesture names that are the keystroke accelerators.

command-table, *stream*, *command-parser*, *command-unparser*, and *partial-command-parser* are as for **read-command**.

An application can control which commands are enabled and which are disabled on an individual basis by using **enable-command** and **disable-command**. The user is not allowed to enter a disabled command via any interaction style.

enable-command *Function*

enable-command *command-name frame*

Summary: Enables the use of the command named by *command-name* while in the application *frame*.

disable-command *Function*

disable-command *command-name frame*

Summary: Disables the use of the command named by *command-name* while in the application *frame*.

The special variable ***command-dispatchers*** controls the behavior of the **command-or-form** presentation type.

command-dispatchers *Variable*

Summary: This is a list of the characters that indicates that CLIM reads a command when it is accepting a **command-or-form**. The standard set of command argument delimiters includes the colon character, **#\:**.

11.10 Advanced Topics

The material in this section is advanced; most CLIM programmers can skip to the next chapter.

11.10.1 CLIM Command Tables

For more information on CLIM command tables, see **11.4 CLIM Command Tables**.

do-command-table-inheritance *Macro*

`do-command-table-inheritance (`*command-table-var command-table***`) &body`** *body*

> *Summary:* Successively executes *body* with *command-table-var* bound first to the command table specified by the command table designator *command-table*, and then (recursively) to all of the command tables from which *command-table* inherits.
>
> The *command-table-var* argument is not evaluated. *body* may have zero or more declarations as its first forms.

map-over-command-table-commands *Function*

`map-over-command-table-commands` *function command-table* **`&key (`***inherited* **`t)`**

> *Summary:* Applies *function* to all of the commands accessible in the command table specified by the command table designator *command-table*. *function* must be a function that takes a single argument, the command name; it has dynamic extent.
>
> If *inherited* is **`nil`**, this applies *function* only to those commands present in *command-table*, that is, it does not map over any inherited command tables. If *inherited* is **`t`**, then the inherited command tables are traversed in the same order as for **`do-command-table-inheritance`**.

map-over-command-table-names *Function*

`map-over-command-table-names` *function command-table* **`&key (`***inherited* **`t)`**

> *Summary:* Applies *function* to all of the command-line name accessible in the command table specified by the command table designator *command-table*. *function* must be a function of two arguments, the command-line name and the command name; it has dynamic extent.
>
> If *inherited* is **`nil`**, this applies *function* only to those command-line names present in *command-table*, that is, it does not map over any inherited command tables. If *inherited* is **`t`**, then the inherited command tables are traversed in the same order as for **`do-command-table-inheritance`**.

command-present-in-command-table-p *Function*

`command-present-in-command-table-p` *command-name command-table*

> *Summary:* Returns **`t`** if the command named by *command-name* is present in the command table specified by the command table designator *command-table*; otherwise, it returns **`nil`**.

command-accessible-in-command-table-p *Function*

`command-accessible-in-command-table-p` *command-name command-table*

> *Summary:* If the command named by *command-name* is not accessible in the command table specified by the command table designator *command-table*, then this function returns **`nil`**. Otherwise, it returns the command table in which the command was found.

find-command-from-command-line-name *Function*

`find-command-from-command-line-name` *name command-table* **`&key (`***errorp* **`t)`**

> *Summary:* Given a command-line name *name* and a command table, returns two values, the command name and the command table in which the command was found. If the command is not accessible in *command-table* and *errorp* is **`t`**, the **`command-not-accessible`** error will be signaled. *command-table* is a command table designator.

find-command-from-command-line-name ignores character case.

command-line-name-for-command *Function*

command-line-name-for-command *command-name command-table* **&key (***errorp* **t)**

Summary: Returns the command-line name for *command-name* as it is installed in *command-table*. *command-table* is a command table designator.

If the command is not accessible in *command-table* or has no command-line name, then there are three possible results. If *errorp* is **nil**, then the returned value will be **nil**. If *errorp* is **:create**, then a command-line name will be generated, as described in **add-command-to-command-table**. Otherwise, if *errorp* is **t**, then the **command-not-accessible** error will be signaled. The returned command-line name should not be modified.

command-table-complete-input *Function*

command-table-complete-input *command-table string action* **&key** *frame*

Summary: A function that can be used as in conjunction with **complete-input** in order to complete over all of the command lines names accessible in the command table *command-table*. *string* is the input string to complete over, and *action* is as for **complete-from-possibilities**.

frame is either an application frame, or **nil**. If *frame* is supplied, no disabled commands should be offered as valid completions.

11.10.2 CLIM Command Menu Interaction Style

Each command table may describe a menu consisting of an ordered sequence of command menu items. The menu specifies a mapping from a menu name (the name displayed in the menu) to either a command object or a submenu. The menu of an application's top-level command table may be presented in a window-system specific way, for example, as a menu bar or in a **:menu** application frame pane.

Command menu items are stored as a list of the form **(***type value* **.** *options***)**, where *type* and *value* are as for **add-menu-item-to-command-table**, and *options* is a list of keyword-value pairs. The allowable keywords are **:documentation**, which is used to supply optional pointer documentation for the command menu item, and **:text-style**, which is used to indicate what text style should be used for this command menu item when it is displayed in a command menu.

The following functions can be used to display a command menu in one of the panes of an application frame or to choose a command from a menu. **add-menu-item-to-command-table**, **remove-menu-item-from-command-table**, and **find-menu-item** ignore the character case of the command menu item's name when searching through the command table's menu.

display-command-table-menu *Generic Function*

display-command-table-menu *command-table stream* **&key** *max-width max-height n-rows n-columns x-spacing y-spacing initial-spacing* **(***cell-align-x* **:***left***)** **(***cell-align-y* **:***top***)** **(***move-cursor* **t)**

Summary: Displays *command-table*'s menu on *stream*. It may use **formatting-item-list** or display the command table's menu in a platform-dependent manner, such as using the menu bar on a Macintosh. *command-table* is a command table designator.

max-width, *max-height*, *n-rows*, *n-columns*, *x-spacing*, *y-spacing*, *initial-spacing*, *cell-align-x*, *cell-align-y*, and *move-cursor* are as for **formatting-item-list**.

display-command-menu *Generic Function*

display-command-menu *frame stream* **&key** *command-table initial-spacing max-width max-height n-rows n-columns* **(***cell-*

align-x **:***left***)** **(***cell-align-y* **:***top***)**

Summary: Displays the menu described by the command table associated with the application frame *frame* on *stream*. This is generally used as the display function for extended stream panes of type **:command-menu**.

menu-choose-command-from-command-table *Function*

menu-choose-command-from-command-table *command-table* **&key** *associated-window default-style label cache unique-id id-test cache-value cache-test*

Summary: Invokes a window-system-specific routine that displays a menu of commands from *command-table*'s menu, and allows the user to choose one of the commands. *command-table* is a command table designator. The returned value is a command object. This may invoke itself recursively when there are submenus.

associated-window, default-style, label, cache, unique-id, id-test, cache-value, and *cache-test* are as for **menu-choose**.

A number of lower level functions for manipulating command menus are also provided:

add-menu-item-to-command-table *Function*

add-menu-item-to-command-table *command-table string type value* **&key** *documentation* **(***after* **:***end***)** *keystroke text-style* **(***errorp* **t)**

Summary: Adds a command menu item to *command-table*'s menu. *string* is the name of the command menu item; its character case is ignored. *type* is either **:command**, **:function**, **:menu**, or **:divider**. *command-table* is a command table designator.

When *type* is **:command**, *value* must be a command (a cons of a command name followed by a list of the command's arguments), or a command name. (When *value* is a command name, it behaves as though a command with no arguments was supplied.) In the case where all of the command's required arguments are supplied, clicking on an item in the menu invokes the command immediately. Otherwise, the user will be prompted for the remaining required arguments.

When *type* is **:function**, *value* must be a function having indefinite extent that, when called, returns a command. It is called with two arguments, the gesture the user used to select the item (either a keyboard or button press event) and a "numeric argument".

When *type* is **:menu**, this item indicates that a submenu will be invoked, and so *value* must be another command table or the name of another command table.

When *type* is **:divider**, some sort of a dividing line is displayed in the menu at that point. If *string* is supplied, it will be drawn as the divider instead of a line. If the look and feel provided by the underlying window system has no corresponding concept, **:divider** items may be ignored. *value* is ignored.

documentation is a documentation string, which can be used as mouse documentation for the command menu item.

text-style is either a text style spec or **nil**. It is used to indicate that the command menu item should be drawn with the supplied text style in command menus.

after must be either **:start** (meaning to add the new item to the beginning of the menu), **:end** or **nil** (meaning to add the new item to the end of the menu), or a string naming an existing entry (meaning to add the new item after that entry). If *after* is **:sort**, then the item is inserted in such as way as to maintain the menu in alphabetical order.

If *keystroke* is supplied, the item will be added to the command table's keystroke accelerator table. The value of *keystroke* must be a keyboard gesture name. This is exactly equivalent to calling **add-keystroke-to-command-table** with the arguments *command-table, keystroke, type* and *value*. When *keystroke* is supplied and *type* is **:command** or **:function**, typing a key on the keyboard that matches to the keystroke accelerator gesture will invoke the command specified by *value*. When *type* is **:menu**, the command will continue to be read from the submenu indicated by *value* in a window-system-specific manner.

If the item named by *string* is already present in the command table's menu and *errorp* is **t**, then the

command-already-present error will be signaled. When the item is already present in the command table's menu and *errorp* is **nil**, the old item will first be removed from the menu. Note that the character case of *string* is ignored when searching the command table's menu.

remove-menu-item-from-command-table *Function*

remove-menu-item-from-command-table *command-table string* **&key (***errorp* **t)**

Summary: Removes the item named by *string* from *command-table*'s menu. *command-table* is a command table designator.

If the item is not present in the command table's menu and *errorp* is **t**, then the **command-not-present** error will be signaled. Note that the character case of *string* is ignored when searching the command table's menu.

map-over-command-table-menu-items *Function*

map-over-command-table-menu-items *function command-table*

Summary: Applies *function* to all of the items in *command-table*'s menu. *function* must be a function of three arguments, the menu name, the keystroke accelerator gesture (which will be **nil** if there is none), and the command menu item; it has dynamic extent. The command menu items are mapped over in the order specified by **add-menu-item-to-command-table**. *command-table* is a command table designator.

find-menu-item *Function*

find-menu-item *menu-name command-table* **&key (***errorp* **t)**

Summary: Given a menu name and a command table, returns two values, the command menu item and the command table in which it was found. (Since menus are not inherited, the second returned value will always be *command-table*.) *command-table* is a command table designator. This function returns objects that reveal CLIM's internal state; do not modify those objects.

If there is no command menu item corresponding to *menu-name* present in *command-table* and *errorp* is **t**, then the **command-not-accessible** error will be signaled. Note that the character case of *string* is ignored when searching the command table's menu.

command-menu-item-type *Function*

command-menu-item-type *menu-item*

Summary: Returns the type of the command menu item *menu-item*, for example, **:menu** or **:command**. If *menu-item* is not a command menu item, the result is unspecified.

command-menu-item-value *Function*

command-menu-item-value *menu-item*

Summary: Returns the value of the command menu item *menu-item*. For example, if the type of *menu-item* is **:command**, this will return a command or a command name. If *menu-item* is not a command menu item, the result is unspecified.

command-menu-item-options *Function*

command-menu-item-options *menu-item*

Summary: Returns a list of the options for the command menu item *menu-item*. If *menu-item* is not a command menu item, the result is unspecified.

11.10.3 Mouse Interaction Via Presentation Translators

A command table maintains a database of presentation translators. A ***presentation translator*** translates from its *from-presentation-type* to its *to-presentation-type* when its associated gesture (e.g., clicking a mouse button) is input. A presentation translator is triggered when its *to-presentation-type* matches the input context and its *from-presentation-type* matches the presentation type of the displayed presentation (the appearance of one of your application's objects on the display) on which the gesture is performed.

`define-presentation-to-command-translator` can be used to associate a presentation and a gesture with a command to be performed on the object which the presentation represents.

Translators can also be used to translate from an object of one type to an object of another type based on context. For example, consider a computer-aided design system for electrical circuits. You might have a translator that translates from a resistor object to the numeric value of its resistance. When asked to enter a resistance (as an argument to a command or for some other query), the user could click on the presentation of a resistor.

Here are some utilities for maintaining presentation translators in command tables. See **6.1 Conceptual Overview of CLIM Presentation Types** for a discussion of the facilities supporting the mouse translator interaction style.

add-presentation-translator-to-command-table *Function*

`add-presentation-translator-to-command-table` *command-table translator-name* **`&key (`***errorp* **`t)`**

Summary: Adds the translator named by *translator-name* to *command-table*. The translator must have been previously defined with **`define-presentation-translator`** or **`define-presentation-to-command-translator`**. *command-table* is a command table designator.

If *translator-name* is already present in *command-table* and *errorp* is **`t`**, then the **`command-already-present`** error will be signaled. When the translator is already present and *errorp* is **`nil`**, the old translator will first be removed.

remove-presentation-translator-from-command-table *Function*

`remove-presentation-translator-from-command-table` *command-table translator-name* **`&key (`***errorp* **`t)`**

Summary: Removes the translator named by *translator-name* from *command-table*. *command-table* is a command table designator.

If the translator is not present in the command table and *errorp* is **`t`**, then the **`command-not-present`** error will be signaled.

map-over-command-table-translators *Function*

`map-over-command-table-translators` *function command-table* **`&key (`***inherited* **`t)`**

Summary: Applies *function* to all of the translators accessible in *command-table*. *function* must be a function of one argument, the translator; it has dynamic extent. *command-table* is a command table designator.

If *inherited* is **`nil`**, this applies *function* only to those translators present in *command-table*, that is, it does not map over any inherited command tables. If *inherited* is **`t`**, then the inherited command tables are traversed in the same order as for **`do-command-table-inheritance`**.

find-presentation-translator *Function*

`find-presentation-translator` *translator-name command-table* **`&key (`***errorp* **`t)`**

Summary: Given a translator name and a command table, returns two values, the presentation translator and the command table in which it was found. If the translator is not present in *command-table* and *errorp* is **`t`**, then the **`command-not-accessible`** error will be signaled. *command-table* is a command table designator.

11.10.4 CLIM Command Line Interaction Style

One interaction style supported by CLIM is the ***command line style*** of interaction provided on most conventional operating systems. A command prompt is displayed in the application's **`:interactor`** pane. The user enters a command by typing its command line name followed by its arguments. What the user types (or enters via the pointer) is echoed to the interactor window. When the user has finished typing the command, it is executed.

In CLIM, this interaction style is augmented by the ***input editing*** facility, which allows the user to correct typing mistakes, and by the prompting and help facilities, which provide a description of the command and the expected arguments (see **16 Input Editing and Completion Facilities**). Command entry is also facilitated by the presentation substrate, which allows the input of objects matching the input context, both for command names and command arguments.

See **11.4 CLIM Command Tables** and **11.10.1 CLIM Command Tables** for complete descriptions of these functions.

find-command-from-command-line-name *Function*

`find-command-from-command-line-name` *name command-table* **`&key (`***errorp* **`t)`**

Summary: Given a command-line name *name* and a *command-table*, this function returns two values, the command name and the command table in which the command was found.

command-line-name-for-command *Function*

`command-line-name-for-command` *command-name command-table* **`&key (`***errorp* **`t)`**

Summary: Returns the command-line name for *command-name* as it is installed in *command-table*.

map-over-command-table-names *Function*

`map-over-command-table-names` *function command-table* **`&key (`***inherited* **`t)`**

Summary: Applies *function* to all the command-line names accessible in *command-table*.

11.10.5 CLIM Keystroke Interaction Style

Each command table may have a mapping from keystroke accelerator gesture names to command menu items. When a user presses a key that corresponds to the gesture for keystroke accelerator, the corresponding command menu item will be invoked. Command menu items are shared among the command table's menu and the accelerator table. This lets the menu display the keystroke associated with a particular item, if there is one.

Note that, despite the fact the keystroke accelerators are specified using keyboard gesture names rather than characters, the conventions for typed characters vary widely from one platform to another. Therefore the programmer must be careful in choosing keystroke accelerators. Some sort of per-platform conditionalization is to be expected.

Keystroke accelerators will typically be associated with commands through the use of the **`:keystroke`** option to **`define-command`** (or the application's command defining macro).

add-keystroke-to-command-table *Function*

`add-keystroke-to-command-table` *command-table gesture type value* **`&key`** *documentation* **`(`***errorp* **`t)`**

Summary: Adds a command menu item to *command-table*'s keystroke accelerator table. *gesture* is a keyboard gesture name to be used as the accelerator. *type* and *value* are as for **`add-menu-item-to-command-table`**, except that *type* must be either **`:command`**, **`:function`** or **`:menu`**. *command-table* is a command table designator.

documentation is a documentation string, which can be used as documentation for the keystroke accelerator.

If the command menu item associated with *gesture* is already present in the command table's accelerator table and *errorp* is **`t`**, then the **`command-already-present`** error will be signaled. When the item is already present in the command table's accelerator table and *errorp* is **`nil`**, the old item will first be removed.

remove-keystroke-from-command-table *Function*

`remove-keystroke-from-command-table` *command-table gesture* **`&key (`***errorp* **`t)`**

Summary: Removes the command menu item named by keyboard gesture name *gesture* from *command-table*'s accelerator table. *command-table* is a command table designator.

The **`command-not-present`** error will be signaled if the command menu item associated with *gesture* is not in the command table's menu and *errorp* is **`t`**.

map-over-command-table-keystrokes *Function*

`map-over-command-table-keystrokes` *function command-table*

Summary: Applies *function* to all the keystroke accelerators in *command-table*'s accelerator table. *function* must be a function of three arguments, the menu name (which will be **`nil`** if there is none), the keystroke accelerator, and the command menu item; it has dynamic extent. *command-table* is a command table designator.

`map-over-command-table-keystrokes` is not recursive. If you want it to descend into submenus, check that the type of the command menu item is **`eql`** to **`:menu`** before using **`map-over-command-table-keystrokes`** recursively.

find-keystroke-item *Function*

`find-keystroke-item` *gesture command-table* **`&key (`***errorp* **`t)`**

Summary: Given a keyboard gesture *gesture* and a command table, returns two values, the command menu item associated with the gesture and the command table in which it was found. (Since keystroke accelerators are not inherited, the second returned value will always be *command-table*.)

This function returns objects that reveal CLIM's internal state; do not modify those objects.

Note that *gesture* may be either a keyboard gesture name or a gesture object. When it is a gesture name, **`eql`** will be used to compare the supplied gesture to the gesture names stored in the command table's menu. When it is a gesture object, **`event-matches-gesture-name-p`** will be used to do the comparison.

If the keystroke accelerator is not present in *command-table* and *errorp* is **`t`**, then the **`command-not-present`** error will be signaled. *command-table* is a command table designator.

lookup-keystroke-item *Function*

`lookup-keystroke-item` *gesture command-table*

Summary: Given a keyboard gesture *gesture* and a command table, returns two values, the command menu item associated with the gesture and the command table in which it was found. *gesture* may be either a keyboard gesture name or a gesture object, and is handled in the same way as in **`find-keystroke-item`**. This function returns objects that reveal CLIM's internal state; do not modify those objects.

Unlike **`find-keystroke-item`**, this follows the submenu chains that can be created with **`add-menu-item-to-command-table`**. If the keystroke accelerator cannot be found in the command table or any of the command tables from which it inherits, **`lookup-keystroke-item`** will return **`nil`**. *command-table* is a command table designator.

lookup-keystroke-command-item *Function*

`lookup-keystroke-command-item` *gesture command-table* **`&key`** *numeric-arg*

Summary: Given a keyboard gesture *gesture* and a command table, returns the command associated with the keystroke, or *gesture* if no command is found. Note that *gesture* may be either a keyboard gesture name or a gesture object, and is handled in the same way as in **find-keystroke-item**. This function returns objects that reveal CLIM's internal state; do not modify those objects.

This is like **find-keystroke-item**, except that only keystrokes that map to an enabled application command will be matched. *command-table* is a command table designator.

numeric-arg (which defaults to 1) is substituted into the resulting command for any occurrence of ***numeric-argument-marker*** in the command. This is intended to allow programmers to define keystroke accelerators that take simple numeric arguments, which will be passed on by the input editor.

substitute-numeric-argument-marker *Function*

substitute-numeric-argument-marker *command numeric-arg*

Summary: Given a command object *command*, this substitutes the value of *numeric-arg* for all occurrences of the value of ***numeric-argument-marker*** in the command, and returns a command object with those substitutions.

For a description of the CLIM command processor, see **11.9 The CLIM Command Processor**.

11.10.6 The CLIM Command Processor

command-line-command-parser *Function*

command-line-command-parser *command-table stream*

Summary: The default command-line parser. It reads a command name and the command's arguments as a command line from *stream* (with completion as much as is possible), and returns a command object. *command-table* is a command table designator that specifies the command table to use; the commands are read via the textual command-line name.

command-line-command-unparser *Function*

command-line-command-unparser *command-table stream command*

Summary: The default command-line unparser. It prints the command *command* as a command name and its arguments as a command line on *stream*. *command-table* is a command table designator that specifies the command table to use; the commands are displayed using the textual command-line name.

command-line-read-remaining-arguments-for-partial-command *Function*

command-line-read-remaining-arguments-for-partial-command *command-table stream partial-command start-position*

Summary: The default partial command-line parser. If the remaining arguments are at the end of the command line, it reads them as a command line; otherwise, it constructs a dialog using **accepting-values** and reads the remaining arguments from the dialog. *command-table* is a command table designator.

menu-command-parser *Function*

menu-command-parser *command-table stream*

Summary: The default menu-driven command parser. It uses only pointer clicks to construct a command. It relies on presentations of all arguments being visible. *command-table* and *stream* are as for **command-line-parser**.

There is no menu-driven command unparser, since it makes no sense to unparse a completely menu-driven command.

menu-read-remaining-arguments-for-partial-command *Function*

menu-read-remaining-arguments-for-partial-command *command-table stream partial-command start-position*

Summary: The default menu-driven partial command parser. It uses only pointer clicks to fill in the command. Again, it relies on presentations of all arguments being visible. *command-table* is a command table designator.

command-parser *Variable*

Summary: Contains the currently active command parsing function. The default value is the function **`command-line-command-parser`**, which is the default command-line parser.

command-unparser *Variable*

Summary: Contains the currently active command unparsing function. The default value is the function **`command-line-command-unparser`**, which is the default command-line unparser.

partial-command-parser *Variable*

Summary: Contains the currently active partial command parsing function. The default value is the function **`command-line-read-remaining-arguments-for-partial-command`**.

unsupplied-argument-marker *Variable*

Summary: The value of **`*unsupplied-argument-marker*`** is an object that can be uniquely identified as standing for an unsupplied argument in a command object.

numeric-argument-marker *Variable*

Summary: The value of **`*numeric-argument-marker*`** is an object that can be uniquely identified as standing for a numeric argument in a command object.

command-name-delimiters *Variable*

Summary: This is a list of the characters that separate the command name from the command arguments in a command line. The standard set of command name delimiters includes **`#\Space`**.

command-argument-delimiters *Variable*

Summary: This is a list of the characters that separate the command arguments from each other in a command line. The standard set of command argument delimiters includes **`#\Space`**.

12 Menus and Dialogs

12.1 Conceptual Overview of Menus and Dialogs

CLIM provides three powerful menu routines for allowing user to interact with an application through various kinds of menus and dialogs:

- **menu-choose** is a straightforward menu generator that provides a quick way to construct menus. You can call it with a list of menu items. (For a complete definition of menu items, see the function **menu-choose**.)
- **menu-choose-from-drawer** is a lower-level routine that allows the user much more control in specifying the appearance and layout of a menu. You can call it with a window and a drawing function. Use this function for more advanced, customized menus.
- **accepting-values** enables you to build a dialog. Unlike menus, you can specify several items that can be individually selected or modified within the dialog before dismissing it.To abort the dialog, press **control-z**. To exit the dialog, unless you are editing the field, press **control-]**. These key bindings can be changed by using **add-keystroke-to-command-table** and **remove-keystroke-from-command-table**.

12.2 CLIM Menu Operators

menu-choose *Generic Function*

menu-choose *items* **&key** *associated-window printer presentation-type default-item text-style label cache unique-id id-test cache-value cache-test max-width max-height n-rows n-columns x-spacing y-spacing row-wise cell-align-x cell-align-y pointer-documentation scroll-bars*

Summary: Displays a menu whose choices are given by the elements of the sequence *items*. It returns three values: the value of the chosen item, the item itself, and the pointer button event corresponding to the gesture that the user used to select it. If the user aborts out of the menu, a single value is returned, **nil**.

menu-choose calls **frame-manager-menu-choose** on the frame manager being used by *associated-window* (or the frame manager of the current application frame). All the arguments to **menu-choose** will be passed on to **frame-manager-menu-choose**.

items is a sequence of menu items. Each menu item has a visual representation derived from a display object, an internal representation that is a value object, and a set of menu item options. The form of a menu item is one of the following:

- An atom—the item is both the display object and the value object.
- A cons—the car is the display object and the cdr is the value object. The value object must be an atom. If you need to return a list as the value, use the **:value** option in the list menu item format.
- A list—the car is the display object and the cdr is a list of alternating option keywords and values. The value object is specified with the keyword **:value** and defaults to the display object if **:value** is not present.

The menu item options are:

- **:value**—This specifies the value object.

- **:text-style**—This specifies the text style used to **princ** the display object when neither *presentation-type* nor *printer* is supplied.
- **:items**—This specifies a sequence of menu items for a submenu used if this item is selected.
- **:documentation**—This associates some documentation with the menu item. When *pointer-documentation* is not **nil**, this will be used as pointer documentation for the item.
- **:active**—When **t** (the default), this item is active. When **nil**, the item is inactive, and cannot be selected. CLIM will generally provide some visual indication that an item is inactive, such as by "graying over" the item.
- **:type**—This specifies the type of the item. **:item** (the default) indicates that the item is a normal menu item. **:label** indicates that the item is simply an inactive label; labels will not be "grayed over." **:divider** indicates that the item serves as a separator between groups of other items; separator items will usually be drawn as a horizontal line.

The visual representation of an item depends on the *printer* and *presentation-type* keyword arguments. If *presentation-type* is supplied, the visual representation is produced by **present** of the menu item with that presentation type. Otherwise, if *printer* is supplied, the visual representation is produced by the *printer* function, which receives two arguments, the *item* and a *stream* to do output on. The *printer* function should output some text or graphics at the stream's cursor position, but need not call **present**. If neither *presentation-type* nor *printer* is supplied, the visual representation is produced by **princ** of the display object. Note that if *presentation-type* or *printer* is supplied, the visual representation is produced from the entire menu item, not just from the display object.

associated-window is the CLIM window with which the menu is associated. This defaults to the top-level window of the current application frame.

default-item is the menu item that is indicated as the default either by some form of highlighting or by warping the mouse to appear over it.

default-style is a text style that defines how the menu items are presented.

label is a string to which the menu title will be set.

printer is a function of two arguments used to print the menu items in the menu. The two arguments are the menu item and the stream to output it on. It has dynamic extent.

presentation-type specifies the presentation type of the menu items.

cache is a boolean that indicates whether CLIM should cache this menu for later use. (Caching menus might speed up later uses of the same menu.) If *cache* is **t**, then *unique-id* and *id-test* serve to identify this menu uniquely. When cache is **t**, *unique-id* defaults to *items*, but programmers will generally wish to specify a more efficient tag. *id-test* is a function of two arguments used to compare unique-ids, which defaults to **equal**. *cache-value* is the value that is used to indicate that a cached menu is still valid. It defaults to *items*, but programmers may wish to supply a more efficient cache value than that. *cache-test* is a function of two arguments that is used to compare cache values, which defaults to **equal**. Both *cache-value* and *unique-id* have dynamic extent.

max-width and *max-height* specify the maximum width and height of the menu, in device units. They can be overridden by *n-rows* and *n-columns*.

n-rows and *n-columns* specify the number of rows and columns in the menu.

x-spacing specifies the amount of space to be inserted between columns of the table; the default is the width of a space character. It is specified the same way as the **:x-spacing** option to **formatting-table**.

y-spacing specifies the amount of blank space inserted between rows of the table; the default is the vertical spacing for the stream. The possible values for this option are the same as for the **:y-spacing** option to **formatting-table**.

If *row-wise* is **t** (the default) and the item list requires multiple columns, each successive element in the item list is laid out from left to right. If *row-wise* is **`nil`** and the item list requires multiple columns, each successive element in the item list is laid out below its predecessor, as in a telephone book.

cell-align-x specifies the horizontal placement of the cell's contents. Like the **`:align-x`** option to **`formatting-cell`**, it is one of **`:left`** (the default), **`:right`**, or **`:center`**. **17.1.2 CLIM Operators for Formatting Tables**.

cell-align-y specifies the vertical placement of the contents of the cell. It can be one of **`:top`**, **`:bottom`**, or **`:center`**. The default is **`:top`**. The semantics are the same as for the **`:align-y`** option to **`formatting-cell`**.

pointer-documentation is either **`nil`** (the default), meaning that no pointer documentation should be computed, or a stream on which pointer documentation should be displayed.

frame-manager-menu-choose *Generic Function*

`frame-manager-menu-choose` *frame-manager items* **`&key`** *associated-window printer presentation-type default-item text-style label cache unique-id id-test cache-value cache-test max-width max-height n-rows n-columns x-spacing y-spacing row-wise cell-align-x cell-align-y pointer-documentation scroll-bars toolkit-p*

Summary: Displays a menu whose choices are given by the elements of the sequence *items*. It returns three values: the value of the chosen item, the item itself, and the pointer button event corresponding to the gesture that the user used to select it. If the user aborts out of the menu, a single value is returned, **`nil`**.

For the values of the arguments, see **`menu-choose`**.

frame-manager-menu-view *Generic Function*

`frame-manager-menu-view` *frame-manager*

Summary: Returns the view used by default for **`menu-choose`** when mediated by *frame-manager*.

(setf frame-manager-menu-view) *Generic Function*

`(setf frame-manager-menu-view)` *frame-manager view*

Summary: Sets the view used by default for **`menu-choose`** when mediated by *frame-manager*. Useful values for the view are **`+gadget-menu-view+`** and **`+textual-menu-view+`**.

menu-choose-from-drawer *Generic Function*

`menu-choose-from-drawer` *menu type drawer* **`&key`** *x-position y-position cache unique-id id-test cache-value cache-test default-presentation pointer-documentation leave-menu-visible*

Summary: This is a lower-level routine for displaying menus. It allows the programmer much more flexibility in the menu layout. Unlike **`menu-choose`**, which automatically creates and lays out the menu, **`menu-choose-from-drawer`** takes a programmer-provided window and drawing function. The drawing function is responsible for drawing the contents of the menu; generally it will be a lexical closure over the menu items.

`menu-choose-from-drawer` draws the menu items into that window using the drawing function. The drawing function gets called with two arguments, *stream* and *type*. It can use *type* for its own purposes, for example, as the type argument in a call to **`present`**.

`menu-choose-from-drawer` returns two values: the object the user clicked on, and the pointer button event. If the user aborts out of the menu, **`nil`** is returned.

menu is a CLIM window to use for the menu. This argument may be specialized to provide a different look-and-feel for different host window systems.

type is a presentation type specifier for each of the mouse-sensitive items in the menu. This is the input context that will be established once the menu is displayed. For programmers who don't need to define their own types, a useful presentation type is **`menu-item`**.

drawer is a function that takes two arguments, *stream* and *type*, and draws the contents of the menu. It has dynamic extent.

x-position and *y-position* are the requested **`x`** and **`y`** positions of the menu. They may be **`nil`**, meaning that the position is unspecified.

If *leave-menu-visible* is **`t`**, the window will not disappear once the selection has been made. The default is **`nil`**, meaning that the window will disappear once the selection has been made.

default-presentation is used to identify the presentation that the mouse is pointing to when the menu comes up.

cache, *unique-id*, *id-test*, *cache-value*, and *cache-test* are as for **`menu-choose`**.

draw-standard-menu *Function*

`draw-standard-menu` *stream presentation-type items default-item* **`&key`** *item-printer max-width max-height n-rows n-columns x-spacing y-spacing cell-align-x cell-align-y*

Summary: **`draw-standard-menu`** is the function used by CLIM to draw the contents of a menu, unless the current frame manager determines that host window toolkit should be used to draw the menu instead. *stream* is the stream onto which to draw the menu, *presentation-type* is the presentation type to use for the menu items (usually **`menu-item`**), and *item-printer* is a function used to draw each item. *item-printer* defaults to **`print-menu-item`**.

items, *default-item*, *max-width*, *max-height*, *n-rows*, *n-columns*, *x-spacing*, *y-spacing*, *cell-align-x*, and *cell-align-y* are as for **`menu-choose`**.

print-menu-item *Function*

`print-menu-item` *menu-item* **`&optional`** *stream*

Summary: Given a menu item *menu-item*, displays it on the stream *stream*. This is the function that **`menu-choose`** uses to display menu items if no printer is supplied.

menu-item-value *Function*

`menu-item-value` *menu-item*

Summary: Returns the value of *menu-item*, where the format of a menu item is described under **`menu-choose`**.

menu-item-display *Function*

`menu-item-display` *menu-item*

Summary: Returns the display object of the menu item *menu-item*, where the format of a menu item is described under **`menu-choose`**.

menu-item-options *Function*

`menu-item-options` *menu-item*

Summary: Returns the options of the menu item *menu-item*, where the format of a menu item is described under **`menu-choose`**.

with-menu *Macro*

`with-menu (`*menu* **`&optional`** *associated-window* **`&key (`***deexpose* **`t)) &body`** *body*

Summary: Binds *menu* to a "temporary" window, exposes the window on the same screen as the *associated-window* and runs the body. After the body has been run, the window disappears only if the boolean *deexpose* is **`t`** (the default).

The values returned by **`with-menu`** are the values returned by *body*. *body* may have zero or more declarations as its first forms.

menu must be a variable name. *associated-window* is as for **menu-choose**.

None of the arguments is evaluated.

12.3 CLIM Dialog Operators

accepting-values *Macro*

accepting-values (&optional *stream* **&key** *own-window exit-boxes initially-select-query-identifier resynchronize-every-pass label scroll-bars x-position y-position frame-class***) &body** *body*

Summary: Builds a dialog for user interaction based on calls to **accept** within *body*. The user can select the values and change them, or use defaults if they are supplied. The dialog will also contain some sort of "end" and "abort" choices. If "end" is selected, then **accepting-values** returns whatever values the body returns. If "abort" is selected, **accepting-values** will invoke the **abort** restart.

stream is an interactive stream that **accepting-values** will use to build up the dialog. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***query-io*** is used.

body is the body of the dialog, which contains calls to **accept** that will be intercepted by **accepting-values** and used to build up the dialog. *body* may have zero or more declarations as its first forms.

An **accepting-values** dialog is a looping structure. First, *body* is evaluated in order to collect the output. During the evaluation, all calls to **accept** call the **accept-present-default** presentation methods instead of calling the **accept** presentation methods. The output is displayed with incremental redisplay. **accepting-values** awaits a user gesture, such as clicking on one of the fields of the dialog. When that happens, **accepting-values** reads a new value for that field using **accept** and replaces the old value with the new value. The loop is started again, until the user either exits or aborts from the dialog.

Because of this looping structure, **accepting-values** uses the ***query identifier*** to uniquely identify each call to **accept** in the body of the dialog. The query identifier is computed on each loop through the dialog, and should therefore be free of side-effects. Query identifiers are compared using **equal**. Inside of **accepting-values**, the **:query-identifier** argument should be supplied to each call to **accept**. If it is not explicitly supplied, the prompt for that call to **accept** is used as the query identifier. Thus, if **:query-identifier** is not supplied, programmers must ensure that all of the prompts are different. If there is more than one call to **accept** with the same query identifier, the behavior of **accepting-values** is unspecified.

While inside **accepting-values**, calls to **accept** return a third value, the boolean **changed-p** that indicates whether the object is the result of new input by the user, or is just the previously supplied default. The third value will be **t** in the former case, **nil** in the latter.

When *own-window* is non-nil, the dialog will appear in its own "popped-up" window. In this case the initial value of *stream* is a window with which the dialog is associated. (This is similar to the *associated-window* argument to **menu-choose**.) Within the *body*, the value of *stream* will be the "popped-up" window. *own-window* is either **t** or a list of alternating keyword options and values. The accepted options are **:right-margin** and **:bottom-margin**; their values control the amount of extra space to the right of and below the dialog (useful if the user's responses to the dialog take up more space than the initially displayed defaults). The allowed values for **:right-margin** are the same as for the **:x-spacing** option to **formatting-table**; the allowed values for **:bottom-margin** are the same as for the **:y-spacing** option.

exit-boxes specifies what the exit boxes should look like. The default behavior is though the following were supplied:

```
'((:exit "Control-] uses these values")
  (:abort "Control-z aborts"))
```

initially-select-query-identifier specifies that a particular field in the dialog should be pre-selected when the user interaction begins. The field to be selected is tagged by the **:query-identifier** option to **accept**; use this tag as the value for the **:initially-select-query-identifier** keyword, as in this example:

```
(defun avv ()
  (let (a b c)
    (accepting-values
     (*query-io* :initially-select-query-identifier 'the-tag)
     (setq a (accept 'pathname :prompt "A pathname"))
     (terpri *query-io*)
     (setq b (accept 'integer :prompt "A number"
                     :query-identifier 'the-tag))
     (terpri *query-io*)
     (setq c (accept 'string :prompt "A string")))
    (values a b c)))
```

When the initial display is output, the input editor cursor appears after the prompt of the tagged field, just as if the user had selected that field by clicking on it. The default value, if any, for the selected field is not displayed.

resynchronize-every-pass is a boolean option specifying whether earlier queries depend on later values; the default is **nil**. When it is **t**, the contents of the dialog are redisplayed an additional time after each user interaction. This has the effect of ensuring that, when the value of some field of a dialog depends on the value of another field, all of the displayed fields will be up to date.

You can use this option to alter the dialog dynamically. The following example initially displays an integer field that disappears if a value other than 1 is entered; a two-field display appears in its place.

```
(defun alter-multiple-accept ()
  (let ((flag 2))
    (accepting-values
     (*query-io* :resynchronize-every-pass t)
     (setq flag (accept 'integer :default flag :prompt "Number"))
     (when (= flag 1)
           (terpri *query-io*)
           (accept 'string :prompt "String"
                   (terpri *query-io*)
                   (accept 'pathname :prompt "Pathname"))))))
```

label is as for **menu-choose**. *scroll-bars* controls what and whether scroll-bars appear on the dialog. The value is one of: **:vertical**, **:horizontal**, **:both**, and **nil** (the default). *x-position* and *y-position* are as for **menu-choose-from-drawer**.

accept-values *Application Frame*

Summary: **accepting-values** is a CLIM application frame that uses **accept-values** as the name of the frame class.

accept-values-pane-displayer *Function*

accept-values-pane-displayer *frame pane* **&key** *displayer resynchronize-every-pass*

Summary: When you use an **:accept-values** pane, the display function must use **accept-values-pane-displayer**. *displayer* is a function that is the body of an **accepting-values** dialog. It takes two arguments, the frame and a stream. The display function does not need to call **accepting-values** itself, since that is done by **accept-values-pane-displayer**. *resynchronize-every-pass* is as for **accepting-values**.

display-exit-boxes *Generic Function*

display-exit-boxes *frame stream view*

Summary: Displays the exits boxes for the **accepting-values** frame *frame* on the stream *stream*, in the view *view*.

The exit boxes specification is not passed in directly, but is a slot in the frame. The default method (on **accept-values**) simply writes a line of text associating the Exit and Abort strings with presentations that either exit or abort from the dialog.

The *frame*, *stream*, and *view* arguments may be specialized to provide a different look-and-feel for different host window systems.

accept-values-resynchronize *Generic Function*

accept-values-resynchronize *stream*

Summary: Causes **accepting-values** to resynchronizes the dialog once on the accepting values stream *stream* before it restarts the dialog loop.

accept-values-command-button *Macro*

accept-values-command-button (&optional *stream* **&key** *documentation query-identifier cache-value cache-test resynchronize***)** *prompt* **&body** *body*

Summary: The prompt *prompt* creates the button area by writing to the appropriate **accepting-values** stream *stream*. *prompt* should not produce a string itself. When a pointer button is clicked in this area at run time, *body* will be evaluated.

accept-values-command-button expands into a call to **invoke-accept-values-command-button**, supplying a function that executes *body* as the *continuation* argument to **invoke-accept-values-command-button**.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***query-io*** is used. *body* may have zero or more declarations as its first forms.

invoke-accept-values-command-button *Generic Function*

invoke-accept-values-command-button *stream continuation view prompt* **&key** *documentation query-identifier cache-value cache-test resynchronize*

Summary: Displays the prompt *prompt* on the stream *stream* and creates the button areas. When a pointer button is clicked in this area at run time, the continuation will be called. *continuation* is a function that takes no arguments. *view* is a view.

prompt may be either a string (which will be displayed via **write-string**), or a form that will be evaluated to draw the button.

documentation is an object that will be used to produce pointer documentation for the button. It defaults to *prompt*. If it is a string, the string itself will be used as the pointer documentation. Otherwise it must be a function of one argument, the stream to which the documentation should be written.

When *resynchronize* is **t**, the dialog will be redisplayed an additional time whenever the command button is clicked on. See the *resynchronize-every-pass* argument to **accepting-values**.

cache-value and *cache-test* are as for **updating-output**. That is, *cache-value* should evaluate to the same value if and only if the output produced by *prompt* does not ever change. *cache-test* is a function of two arguments that is used to compare cache values. *cache-value* defaults to **t** and *cache-test* defaults to **eql**.

This function may only be used inside the dynamic context of an **accepting-values**.

frame-manager-dialog-view *Generic Function*

frame-manager-dialog-view *frame-manager*

Summary: Returns the view used by default for **accepting-values** when mediated by *frame-manager*.

(setf frame-manager-dialog-view) *Generic Function*

`(setf frame-manager-dialog-view)` *frame-manager view*

Summary: Sets the view used by default for **`accepting-values`** when mediated by *frame-manager*. Useful values for *view* are **`+gadget-dialog-view+`** and **`+textual-dialog-view+`**.

12.4 Examples of Menus and Dialogs in CLIM

12.4.1 Using accepting-values

This example sets up a dialog in the CLIM window **`stream`** that displays the current month, date, hour, and minute (as obtained by a call to **`get-universal-time`**) and allows the user to modify those values. The user can select values to change by using the mouse to select values, typing in new values, and pressing **`RETURN`**. When done, the user selects **`<END>`** to accept the new values, or **`<ABORT>`** to terminate without changes.

```
(defun reset-clock (stream)
  (multiple-value-bind (second minute hour day month)
      (decode-universal-time
       (get-universal-time))
  (declare (ignore second))
  (format stream "Enter the time~%")
    (restart-case
     (progn
       (clim:accepting-values (stream)
        (setq month
              (clim:accept 'integer :stream stream
                           :default month :prompt "Month"))
        (terpri stream)
        (setq day
              (clim:accept 'integer :stream stream
                           :default day :prompt "Day"))
        (terpri stream)
        (setq hour
              (clim:accept 'integer :stream stream
                           :default hour :prompt "Hour"))
        (terpri stream)
        (setq minute
              (clim:accept 'integer :stream stream
                           :default minute :prompt "Minute")))
       ;; This could be code to reset the time, but instead
       ;; we're just printing it out
       (format t "~%New values: Month: ~D, Day: ~D, Time: ~D:~2,'0D."
               month day hour minute))
    (abort () (format t "~&Time not set")))))
```

Note that in CLIM, calls to **`accept`** do not automatically insert newlines. If you want to put each query on its own line of the dialog, use **`terpri`** between the calls to **`accept`**.

12.4.2 Using accept-values-command-button

Here is the reset-clock example with the addition of a command button that will set the number of seconds to zero.

```
(defun reset-clock (stream)
  (multiple-value-bind (second minute hour day month)
      (decode-universal-time (get-universal-time))
    (declare (ignore second))
    (format stream "Enter the time~%")
```

```
    (restart-case

(progn
  (clim:accepting-values
   (stream)
   (setq month
         (clim:accept 'integer :stream stream
                      :default month :prompt "Month"))
   (terpri stream)
   (setq day
         (clim:accept 'integer :stream stream
                      :default day :prompt "Day"))
   (terpri stream)
   (setq hour
         (clim:accept 'integer :stream stream
                      :default hour :prompt "Hour"))
   (terpri stream)
   (setq minute
         (clim:accept 'integer :stream stream
                      :default minute :prompt "Minute")))
   (terpri stream)

;; Print the current time to the terminal.
(accept-values-command-button
 (stream) "Print-Clock"
 (format t
         "~%Current values: Month: ~D, Day: ~D, Time: ~D:~2,'0D."
         month day hour minute))))
(abort () (format t "~&Time not set")))))
```

12.4.3 Using :resynchronize-every-pass in accepting-values

It often happens that the programmer wants to present a dialog where the individual fields of the dialog depend on one another. For example, consider a spreadsheet with seven columns representing the days of a week. Each column is headed with that day's date. If the user inputs the date of any single day, the other dates can be computed from that single piece of input.

If you build CLIM dialogs using **`accepting-values`**, you can achieve this effect by using the **`:resynchronize-every-pass`** argument to **`accepting-values`** in conjunction with the **`:default`** argument to **`accept`**. There are three points to remember:

- The entire body of the **`accepting-values`** runs each time the user modifies any field. The body can be made to run an extra time by specifying **`:resynchronize-every-pass t`**. Code in the body may be used to enforce constraints among values.
- If the **`:default`** argument to **`accept`** is used, then every time that call to **`accept`** is run, it will pick up the new value of the default.
- Inside **`accepting-values`**, **`accept`** returns a third value, a boolean that indicates whether the returned value is the result of new input by the user or is just the previously supplied default.

In this example we show a dialog that accepts two real numbers, delimiting an interval on the real line. The two values are labelled **`Min`** and **`Max`**, but we wish to allow the user to supply a **`Min`** that is greater than the **`Max`**, and automatically exchange the values rather than signalling an error.

```
(defun accepting-interval (&key (min -1.0) (max 1.0)
                                (stream *query-io*))
  (clim:accepting-values (stream :resynchronize-every-pass t)
                         (fresh-line stream)
                         (setq min
                               (clim:accept
```

```
                                   'clim:real :default min
                                   :prompt "Min" :stream stream))
                            (fresh-line stream)
                            (setq max
                                  (clim:accept
                                   'clim:real :default max
                                   :prompt "Max" :stream stream))
                            (when (< max min)
                              (rotatef min max)))
      (values min max))
```

(You may want to try this example after dropping the **`:resynchronize-every-pass`** and see the behavior. Without **`:resynchronize-every-pass`**, the constraint is still enforced, but the display lags behind the values and does not reflect the updated values immediately.)

12.4.4 Using the third value from accept in accepting-values

As a second example, consider a dialog that accepts four real numbers that delimit a rectangular region in the plane, but we wish to enforce a constraint that the region be a square. We allow the user to input any of **`Xmin`**, **`Xmax`**, **`Ymin`**, or **`Ymax`**, but enforce the constraint that:

```
Xmax - Xmin = Ymax - Ymin
```

We want to avoid changing the value that a user inputs, so we decide (in cases where the constraint has to be enforced) to change the X value if the user inputs a Y value, and to change the Y value if the user inputs an X value. When changing values, we preserve the center of the interval. We use the third returned value from **`accept`** to control the constraint enforcement.

```
(defun accepting-square
  (&key (xmin -1.0) (xmax 1.0)
        (ymin -1.0) (ymax 1.0)
        (stream *query-io*))

(let (xmin-changed xmax-changed ymin-changed ymax-changed ptype)
  (clim:accepting-values
   (stream :resynchronize-every-pass t)
   (fresh-line stream)
   (multiple-value-setq
       (xmin ptype xmin-changed)
       (clim:accept 'clim:real :default xmin
        :prompt "Xmin" :stream stream))
   (fresh-line stream)
   (multiple-value-setq
       (xmax ptype xmax-changed)
       (clim:accept 'clim:real :default xmax
        :prompt "Xmax" :stream stream))
   (fresh-line stream)
   (multiple-value-setq
       (ymin ptype ymin-changed)
       (clim:accept 'clim:real :default ymin
        :prompt "Ymin" :stream stream))
   (fresh-line stream)
   (multiple-value-setq
       (ymax ptype ymax-changed)
       (clim:accept 'clim:real :default ymax
        :prompt "Ymax"  :stream stream))
   (cond ((or xmin-changed xmax-changed)
          (let ((y-center (/ (+ ymax ymin) 2.0))
                (x-half-width (/ (- xmax xmin) 2.0)))
            (setq ymin (- y-center x-half-width)
```

```
                  ymax (+ y-center x-half-width)))
          (setq xmin-changed nil
                xmax-changed nil))
         ((or ymin-changed ymax-changed)
          (let ((x-center (/ (+ xmax xmin) 2.0))
                (y-half-width (/ (- ymax ymin) 2.0)))
            (setq xmin (- x-center y-half-width)
                  xmax (+ x-center y-half-width)))
          (setq ymin-changed nil
                ymax-changed nil)))))
(values xmin xmax ymin ymax))
```

12.4.5 Using menu-choose

The simplest use of **menu-choose** is when each item is not a list. In that case, the entire item will be printed and is also the value to be returned.

```
(clim:menu-choose '("One" "Two" "Seventeen"))
```

If you want to return a value that is different from what was printed, the simplest method is as follows. Each item is a list; the first element is what will be printed, the remainder of the list is treated as a ***plist***—the **:value** property will be returned. (Note **nil** is returned if you click on **Seventeen** since it has no **:value**.)

```
(clim:menu-choose
 '(("One" :value 1 :documentation "the loneliest number")
   ("Two" :value 2 :documentation "for tea")
   ("Seventeen"
    :documentation "teen magazine")))
```

The list of items you pass to **menu-choose** can serve other purposes in your application, so you might not want to put the printed appearance in the first element. You can supply a **:printer** function that will be called on the item to produce its printed appearance.

```
(clim:menu-choose '(1 2 17)
                  :printer #'(lambda (item stream)
                               (format stream "~R" item)))
```

The items in the menu need not be printed textually:

```
(clim:menu-choose
  '(circle square triangle)
  :printer
  #'(lambda (item stream)
      (case item
        (circle (clim:draw-circle* stream 0 0 10))
        (square (clim:draw-polygon* stream '(-8 -8 -8 8 8 8 8 -8)))
        (triangle (clim:draw-polygon* stream '(10 8 0 -10 -10 8))))))
```

The **:item-list** option of the list form of menu item can be used to describe a set of hierarchical menus.

```
(clim:menu-choose
  '(("Class: Osteichthyes" :documentation "Bony fishes"
     :style (nil :italic nil))
    ("Class: Chondrichthyes"
     :documentation "Cartilaginous fishes"
     :style (nil :italic nil)
      :item-list (("Order: Squaliformes" :documentation "Sharks")
               ("Order: Rajiformes" :documentation "Rays")))
```

```
        ("Class: Mammalia" :documentation "Mammals" :style (nil :italic nil)
         :item-list
         (("Order Rodentia" :item-list ("Family Sciuridae"
                                        "Family Muridae"
                                        "Family Cricetidae"
                                        ("..." :value nil)))
          ("Order Carnivora" :item-list ("Family: Felidae"
                                         "Family: Canidae"
                                         "Family: Ursidae"
                                         ("..." :value nil)))
          ("..." :value nil)))
     ("..." :value nil)) )
```

12.4.6 Using menu-choose-from-drawer

This example displays in the window **`*page-stream*`** the choices **`One`** through **`Ten`** in boldface type. When the user selects one, the string is returned along with the gesture that selected it.

```
(clim:menu-choose-from-drawer
 *page-stream* 'string
 #'(lambda (stream type)
     (clim:with-text-face (:bold stream)
                          (dotimes (count 10)
                            (clim:present (string-capitalize
                                           (format nil "~R" (1+ count)))
                                          type :stream stream)
                            (terpri stream))))))
```

This example shows how you can use **`menu-choose-from-drawer`** with **`with-menu`** to create a temporary menu:

```
(defun choose-compass-direction (parent-window)
  (labels
      ((draw-compass-point
        (stream ptype symbol x y)
        (clim:with-output-as-presentation
         (:stream stream :object symbol :type ptype)
         (clim:draw-string* stream
                            (symbol-name symbol) x y
                            :align-x :center
                            :align-y :center
                            :text-style
                            '(:sans-serif :roman :large))))
       (draw-compass
        (stream ptype)
        (clim:draw-line* stream 0 25 0 -25 :line-thickness 2)
        (clim:draw-line* stream 25 0 -25 0 :line-thickness 2)
        (loop for point in '((n 0 -30) (s 0 30) (e 30 0)(w -30 0))
              do (apply #'draw-compass-point
                        stream ptype point))))
    (clim:with-menu (menu parent-window)
                    (clim:menu-choose-from-drawer menu 'clim:menu-item
                                                  #'draw-compass))))
```

13 Extended Stream Output Facilities

13.1 Basic Output Streams

CLIM performs all of its input and output operations on objects called ***streams***. Stream functionality is partitioned into two layers: the basic stream protocol and the extended stream protocol. The stream-oriented output layer is implemented on top of the sheet output architecture. The basic CLIM output stream protocol is based on the character output stream protocol proposal submitted to the ANSI Common Lisp committee by David Gray. This proposal was not approved by the committee, but CLIM provides an implementation of the basic output stream facilities. This protocol is documented in **Appendix D: Common Lisp Streams**.

standard-output-stream *Class*

Summary: This class provides an implementation of the CLIM basic output stream protocol, based on the CLIM output kernel. Members of this class are mutable.

stream-write-char *Generic Function*

`stream-write-char` *stream character*

Summary: Writes the character *character* to the output stream *stream*, and returns *character* as its value.

stream-line-column *Generic Function*

`stream-line-column` *stream*

Summary: This function returns the column number where the next character will be written on the output stream *stream*. The first column on a line is numbered 0.

stream-start-line-p *Generic Function*

`stream-start-line-p` *stream*

Summary: Returns **`t`** if the output stream *stream* is positioned at the beginning of a line (that is, column 0); otherwise, it returns **`nil`**.

stream-write-string *Generic Function*

`stream-write-string` *stream string* **`&optional (`***start* **`0)`** *end*

Summary: Writes the string *string* to the output stream *stream*. If *start* and *end* are supplied, they are integers that specify what part of *string* to output. *string* is returned as the value.

stream-terpri *Generic Function*

`stream-terpri` *stream*

Summary: Writes an end-of-line character on the output stream *stream*, and returns **`nil`**.

stream-fresh-line *Generic Function*

`stream-fresh-line` *stream*

Summary: Writes an end-of-line character on the output stream *stream* only if the stream is not at the beginning of the line.

stream-finish-output *Generic Function*

`stream-finish-output` *stream*

Summary: Ensures that all the output sent to the output stream *stream* has reached its destination, and only then does it return **`nil`**.

stream-force-output *Generic Function*

`stream-force-output` *stream*

Summary: Like **`stream-finish-output`**, except that it may immediately return **`nil`** without waiting for the output to complete.

stream-clear-output *Generic Function*

`stream-clear-output` *stream*

Summary: Aborts any outstanding output operation in progress on the output stream *stream*, and returns **`nil`**.

stream-advance-to-column *Generic Function*

`stream-advance-to-column` *stream column*

Summary: Writes enough blank space on the output stream *stream* so that the next character will be written at the position specified by *column*, which is an integer.

13.2 Extended Output Streams

In addition to the basic output stream protocol, CLIM defines an extended output stream protocol. This protocol extends the stream model to maintain the state of a text cursor, margins, text styles, inter-line spacing, and so forth.

The extended output stream protocol is discussed in the following two sections, **13.3 The Text Cursor** and **13.4 Text**.

extended-output-stream *Protocol Class*

Summary: The protocol class for CLIM extended output streams. This is a subclass of **`output-stream`**. If you want to create a new class that behaves like an extended output stream, it should be a subclass of **`extended-output-stream`**. Subclasses of **`extended-output-stream`** must obey the extended output stream protocol.

extended-output-stream-p *Function*

`extended-output-stream-p` *object*

Summary: Returns **`t`** if *object* is a CLIM extended output stream; otherwise, it returns **`nil`**.

:foreground

:background

:default-text-style

:vertical-spacing

:text-margin

:end-of-line-action

:end-of-page-action

:default-view *Initargs*

Summary: All subclasses of **`extended-output-stream`** must handle these initargs, which are used to specify, respectively, the medium foreground and background inks, default text style, vertical spacing, default text margin, end of line and end of page actions, and the default view for the stream.

standard-extended-output-stream *Class*

Summary: This class provides an implementation of the CLIM extended output stream protocol, based on the CLIM output kernel.

Members of this class are mutable.

13.3 The Text Cursor

In the days when display devices displayed only two-dimensional arrays of fixed-width characters, the text cursor was a simple thing. A discrete position was selected in integer character units, and a character could go there and nowhere else. Even for variable-width fonts, it was enough to address a character by the pixel position of one of its corners. However, variable-height fonts with variable baselines on pixel-addressable displays upset this simple model. The "logical" vertical reference point is the baseline, as it is in typesetting. In typesetting, however, an entire line of text is created with baselines aligned and padded to the maximum ascent and descent, and then the entire line is put below the previous line.

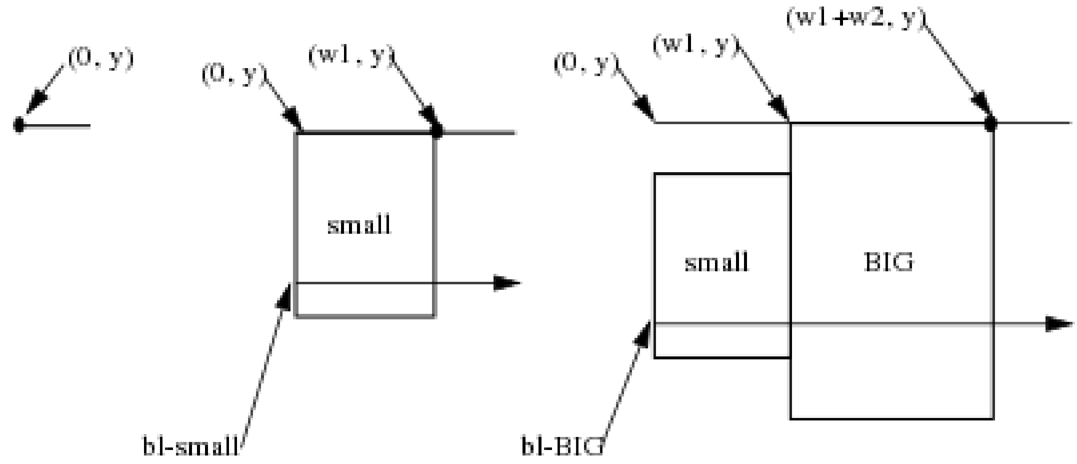
It is clearly desirable to have the characters on a line aligned with their baselines, but when the line on the display is formed piece by piece, it is impossible to pick in advance the proper baseline. The solution CLIM adopts is to choose a **provisional** baseline.

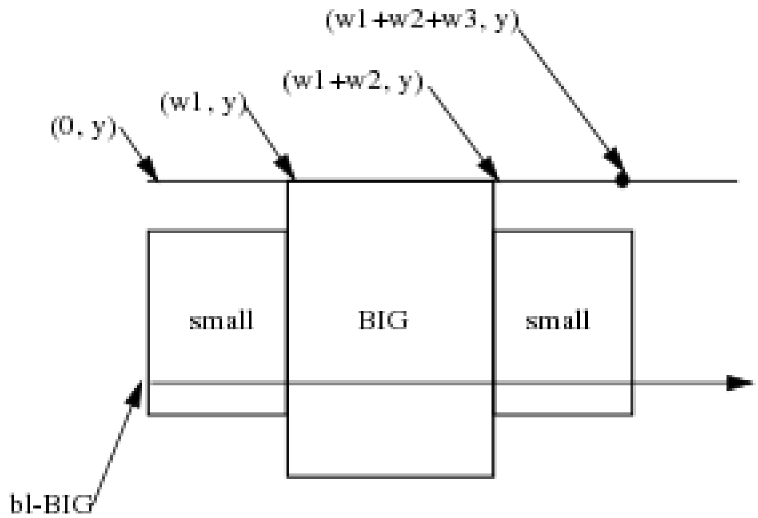
We assume that text has at least six properties. With a reference point of (0, 0) at the upper left of the text, it has a bounding box consisting of ascent, descent, left kerning, right extension, and a displacement to the next reference point in both **x** and **y**. CLIM determines the position of the reference point and draws the text relative to that, and then the cursor position is adjusted by the displacement. In this way, text has width and height, but the **x** and **y** displacements need not equal the width and height.

CLIM adopts the following approach to the actual rendering of a glyph. Textual output using the stream functions (**not** the graphics functions) maintains text on a "line." Note that a line is not an output record, but is rather a collection of "text so far," a top (positioned at the bottom of the previous line plus the stream's vertical spacing), a baseline, a bottom, and a "cursor position." The cursor position is defined to be at the top of the line, not at the baseline. The reason for this is that the baseline can move, but the top is relative to the previous line, which has been completed and therefore does not move. If text is drawn on the current line whose ascent is greater than the current ascent of the line, then the line is moved down to make room. This can be done easily using the output records for the existing text on the line. When there is enough room, the reference point for the text is the **x** position of the cursor at the baseline, and the cursor position is adjusted by the displacement.

Figure 21 shows this in action before and after each of three characters are drawn. In all three cases, the small circle is the "cursor position." At first, there is nothing on the line.

Determining the Position of the Text Cursor





The first character establishes the initial baseline and is then drawn. The upper left corner of the character is where the cursor was (as in the traditional model), but this will not remain the case. Drawing the second character, which is larger than the first, requires moving the first character down in order to get the baselines to align; during this time, the top of the line remains the same. Again, the upper left of the second character is where the cursor was, but that is no longer the case for the first character (which has moved down). The third character is smaller than the second, so no moving of characters needs to be done. However, the character is drawn to align the baselines, which in this case means the upper left is **not** where the cursor was. Nor is the cursor at the upper right of the character as it was for the previous two characters. It is, however, at the upper right of the collective line.

13.3.1 The Text Cursor Protocol

Many streams that maintain a text cursor also display some visible indication of it. The object that represents this display is (somewhat confusingly) also called a cursor.

cursor *Protocol Class*

Summary: The protocol class that corresponds to cursors. If you want to create a new class that behaves like cursor, it should be a subclass of **cursor**. Subclasses of **cursor** must obey the cursor protocol. Members of this class are mutable.

cursorp *Function*

cursorp *object*

Summary: Returns **t** if *object* is a cursor; otherwise, it returns **nil**.

:sheet *Initarg*

Summary: The **:sheet** initarg is used to specify the sheet with which the cursor is associated.

standard-text-cursor *Class*

Summary: The instantiable class that implements a text cursor. Typically, ports will further specialize this class.

cursor-sheet *Generic Function*

cursor-sheet *cursor*

Summary: Returns the sheet with which the cursor *cursor* is associated.

cursor-position *Generic Function*

cursor-position *cursor*

Summary: Returns the **x** and **y** position of the cursor *cursor* as two values.

(setf* cursor-position) *Generic Function*

(setf* cursor-position) *x y cursor*

Summary: Sets the **x** and **y** position of the cursor *cursor* to the specified position. For the details of **setf***, see **C.4 Multiple-Value Setf**.

cursor-visibility *Generic Function*

cursor-visibility *cursor*

(setf cursor-visibility) *Generic Function*

(setf cursor-visibility) *visibility cursor*

Summary: Returns (or sets) the visibility of the cursor *cursor*. The visibility is one of **:on** (the cursor will be visible at its current position), **:off** (the cursor is active, but not visible at its current position), or **nil** (the cursor is to be deactivated).

display-cursor *Generic Function*

display-cursor *cursor state*

Summary: This draws or erases the cursor *cursor*. If *state* is **:draw**, the cursor will be drawn. If the *state* is **:erase**, the cursor will be erased.

13.3.2 The Stream Text Cursor Protocol

The following generic functions comprise the stream text cursor protocol. Any extended output stream class must implement methods for these generic functions.

stream-text-cursor *Generic Function*

`stream-text-cursor` *stream*

(setf stream-text-cursor) *Generic Function*

`(setf stream-text-cursor)` *cursor stream*

Summary: Returns (or sets) the text cursor object for the stream *stream*.

stream-cursor-position *Generic Function*

`stream-cursor-position` *stream*

Summary: Returns the current text cursor position for the extended output stream *stream* as two integer values, the **x** and **y** positions.

(setf* stream-cursor-position) *Generic Function*

`(setf* stream-cursor-position)` *x y stream*

Summary: Sets the text cursor position of the extended output stream *stream* to *x* and *y*. *x* and *y* are in device units, and must be integers. For the details of **`setf*`**, see **C.4 Multiple-Value Setf**.

stream-increment-cursor-position *Generic Function*

`stream-increment-cursor-position` *stream dx dy*

Summary: Moves the text cursor position of the extended output stream *stream* relatively, adding *dx* to the **x** coordinate and *dy* to the **y** coordinate. Either of *dx* or *dy* may be **`nil`**, meaning the the **x** or **y** cursor position will be unaffected. Otherwise, *dx* and *dy* must be integers.

13.4 Text

This section addresses text as it relates to output streams.

13.4.1 The Text Protocol

The following generic functions comprise the text protocol. Any extended output stream class must implement methods for these generic functions.

stream-character-width *Generic Function*

`stream-character-width` *stream character* **`&key`** *text-style*

Summary: Returns a rational number corresponding to the amount of horizontal motion of the cursor position that would occur if the character *character* were output to the extended output stream *stream* in the text style *text-style* (which defaults to the current text style for the stream). This ignores the stream's text margin.

stream-string-width *Generic Function*

`stream-string-width` *stream string* **`&key`** *start end text-style*

Summary: Computes how the cursor position would move horizontally if the string *string* were output to the extended output stream *stream* in the text style *text-style* (which defaults to the current text style for the stream) starting at the left margin. This ignores the stream's text margin.

The first returned value is the **x** coordinate that the cursor position would move to. The second returned value is the maximum **x** coordinate the cursor would visit during the output. (This is the same as the first value unless the string contains a **#\Newline** character.)

start and *end* are integers that default to 0 and the string length, respectively.

stream-text-margin *Generic Function*

stream-text-margin *stream*

(setf stream-text-margin) *Generic Function*

(setf stream-text-margin) *margin stream*

Summary: Returns the **x** coordinate at which text wraps around on the extended output stream *stream* (see **stream-end-of-line-action**). The default setting is the width of the viewport, which is the right-hand edge of the viewport when it is horizontally scrolled to the "initial position".

You can use **setf** with **stream-text-margin** to establish a new text margin. If *margin* is **nil**, then the width of the viewport will be used. If the width of the viewport is later changed, the text margin will change, too.

stream-line-height *Generic Function*

stream-line-height *stream* **&key** *text-style*

Summary: Returns what the line height of a line on the extended output stream *stream* containing text in the text style *text-style* would be, as a rational number. *text-style* defaults to the current text style for the stream.

stream-vertical-spacing *Generic Function*

stream-vertical-spacing *stream*

Summary: Returns the current inter-line spacing (as a rational number) for the extended output stream *stream*.

stream-baseline *Generic Function*

stream-baseline *stream*

Summary: Returns the current text baseline (as a rational number) for the extended output stream *stream*.

13.4.2 Mixing Text and Graphics

The following macro provides a convenient way to mix text and graphics on the same output stream.

with-room-for-graphics *Macro*

with-room-for-graphics (&optional *stream* **&key (***move-cursor* **t)** *height record-type***) &body** *body*

Summary: Binds the dynamic environment to establish a local Cartesian coordinate system for doing graphics output onto the extended output stream designated by *stream*. The origin (0, 0) of the local coordinate system is placed at the current cursor position, and is in the lower left corner of the area created. If the boolean *move-cursor* is **t** (the default), then after the graphic output is completed, the cursor is positioned past (immediately below) this origin. The bottom of the vertical block allocated is at this location, that is just below point (0, 0), not necessarily at the bottom of the output done.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

If *height* is supplied, it must be a rational number that specifies the amount of vertical space to allocate for the output, in device units. If it is not supplied, the height is computed from the output.

record-type specifies the class of output record to create to hold the graphical output. The default is **standard-sequence-output-record**.

13.4.3 Wrapping Text Lines

stream-end-of-line-action *Generic Function*

stream-end-of-line-action *stream*

(setf stream-end-of-line-action) *Generic Function*

(setf stream-end-of-line-action) *action stream*

Summary: The end-of-line action controls what happens if the text cursor position moves horizontally out of the viewport or if text output reaches the text margin. (By default the text margin is the width of the viewport, so these often coincide.)

stream-end-of-line-action returns the end-of-line action for the extended output stream *stream*. It can be changed by using **setf** on **stream-end-of-line-action**.

The end-of-line action is one of:

- **:wrap**—when doing text output, wrap the text around (that is, break the text line and start another line). When setting the cursor position, scroll the window horizontally to keep the cursor position inside the viewport. This is the default.
- **:scroll**—scroll the window horizontally to keep the cursor position inside the viewport, then keep doing the output.
- **:allow**—ignore the text margin and do the output on the drawing plane beyond the visible part of the viewport.

with-end-of-line-action *Macro*

with-end-of-line-action (*stream action***) &body** *body*

Summary: Temporarily changes *stream*'s end-of-line action for the duration of execution of body. *action* must be one of the actions described in **stream-end-of-line-action**.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t**, ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

stream-end-of-page-action *Generic Function*

stream-end-of-page-action *stream*

(setf stream-end-of-page-action) *Generic Function*

(setf stream-end-of-page-action) *action stream*

Summary: The end-of-page action controls what happens if the text cursor position moves vertically out of the viewport.

stream-end-of-page-action returns the end-of-page action for the extended output stream *stream*. Change it by using **setf** on **stream-end-of-page-action**.

The end-of-page action is one of:

- **:wrap**—when doing text output, wrap the text around (that is, go back to the top of the viewport).
- **:scroll**—scroll the window vertically to keep the cursor position inside the viewport, then keep doing output. This is the default.

- **`:allow`**—ignore the viewport and do the output on the drawing plane beyond the visible part of the viewport.

with-end-of-page-action *Macro*

`with-end-of-page-action (`*stream action***`) &body`** *body*

> *Summary:* Temporarily changes *stream*'s end-of-page action for the duration of execution of body. *action* must be one of the actions described in **`stream-end-of-page-action`**.
>
> The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

13.5 Attracting the User's Attention

beep *Generic Function*

`beep &optional` *sheet*

> *Summary:* Attracts the user's attention, usually with an audible sound.

13.6 Buffering Output

Some mediums that support the output protocol may buffer output. When buffering is enabled on a medium, the time at which output is actually done on the medium is unpredictable. **`force-output`** or **`finish-output`** can be used to ensure that all pending output gets completed. If the medium is a bidirectional stream, a **`force-output`** is performed whenever any sort of input is requested on the stream.

`with-buffered-output` provides a way to control when buffering is enabled on a medium. By default, CLIM's interactive streams are buffered if the underlying window system supports buffering.

medium-buffering-output-p *Generic Function*

`medium-buffering-output-p` *medium*

> *Summary:* Returns **`t`** if the medium *medium* is currently buffering output; otherwise, it returns **`nil`**.

(setf medium-buffering-output-p) *Generic Function*

`(setf medium-buffering-output-p)` *buffer-p medium*

> *Summary:* Sets **`medium-buffering-output-p`** of the medium *medium* to *buffer-p*.

with-output-buffered *Macro*

`with-output-buffered (`*medium* **`&optional (`***buffer-p* **`t)) &body`** *body*

> *Summary:* If *buffer-p* is **`t`** (the default), this causes the medium designated by *medium* to start buffering output, and evaluates *body* in that context. If *buffer-p* is **`nil`**, **`force-output`** will be called before *body* is evaluated. When *body* is exited (or aborted from), **`force-output`** will be called if output buffering will be disabled after **`with-output-buffered`** is exited.
>
> The *medium* argument is not evaluated, and must be a symbol that is bound to a medium. If *medium* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

13.7 CLIM Window Stream Pane Functions

The following functions can be called on any pane that is a subclass of **`clim-stream-pane`**. (Such a pane is often simply referred to as a ***window***.) These are provided as a convenience for programmers and for compatibility with CLIM 1.1.

window-clear *Generic Function*

`window-clear` *window*

Summary: Clears the entire drawing plane by filling it with the background design of the CLIM stream pane *window*. If *window* has an output history, it is cleared as well. The text cursor position of *window*, if there is one, is reset to the upper left corner.

window-refresh *Generic Function*

`window-refresh` *window*

Summary: Clears the visible part of the drawing plane of the CLIM stream pane *window*, and then if the window stream is an output recording stream, the output records in the visible part of the window are replayed.

window-viewport *Generic Function*

`window-viewport` *window*

Summary: Returns the viewport region of the CLIM stream pane *window*. The returned region will usually be a **`standard-bounding-rectangle`**.

window-erase-viewport *Generic Function*

`window-erase-viewport` *window*

Summary: Clears the visible part of the drawing plane of the CLIM stream pane *window* by filling it with the background design.

window-viewport-position *Generic Function*

`window-viewport-position` *window*

Summary: Returns two values, the **x** and **y** position of the upper left corner of the CLIM stream pane *window*'s viewport.

(setf window-viewport-position) *Generic Function*

`(setf window-viewport-position)` *x y window*

Summary: Sets the position of the upper left corner of the CLIM stream pane *window*'s viewport to *x* and *y*.

14 Output Recording and Redisplay

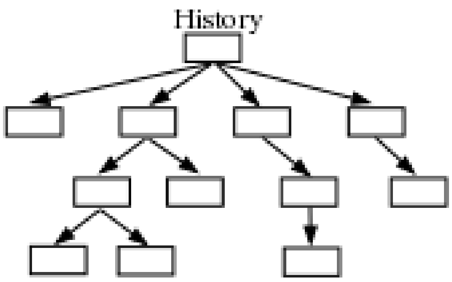
14.1 Conceptual Overview of Output Recording

Output recording is an important part of CLIM. It provides the basis for scrolling windows, for formatted output of tables and graphs, for the ability of presentations to retain their semantics, and for incremental redisplay.

The output recording mechanism is enabled by default. Unless you turn it off, all output that occurs on a window is captured and saved by the output recording mechanism. The output is captured in output records. An ***output record*** is an object that contains either other output records or an output record element.

Since output records can contain other output records, we can view the organization of output records as a tree structure. The top-level output record, which contains all the output done on that window, is called the ***history*** of the window.

The Tree Structure of an Output Record



Each rectangle in **The Tree Structure of an Output Record** is an output record. The top-level record is an output record called a history. Each output record is a leaf of the tree and is called a displayed output record element. The intermediate output records are both output records and output record elements of their immediate superior.

CLIM automatically segments the output into output records. The result of each atomic drawing operation is put into a new output record. Each presentation is put into a new output record. Strings are treated differently; CLIM concatenates strings into one output record until a newline is encountered, which begins a new output record.

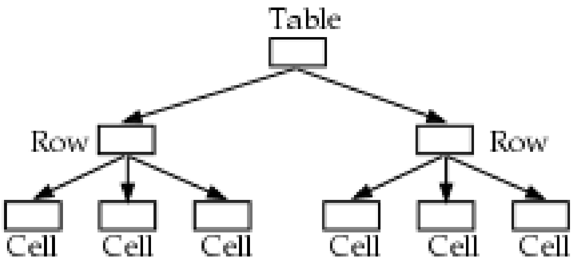
One use of an output record is to *replay* it; that is, to produce the output again. Scrolling is implemented by replaying the appropriate output records. When using the techniques of incremental redisplay, your code determines which portions of the display have changed, whereupon the appropriate output records are updated to the new state and the output records are replayed.

CLIM's table and graph formatters use output records. For example, your code uses **`formatting-table`** to format output into rows and cells; this output is sent to a particular stream. Invisibly to you, CLIM temporarily binds this stream to an intermediate stream and runs a constraint engine over the code to determine the layout of the table. The result is a set of output records which contain the table, its rows, and its cells. Finally, CLIM replays these output records to your original stream.

Presentations are a special case of output records that remember the object and the type of object associated with the output.

The concept of the tree structure organization of output records is further illustrated by the organization of the output records of a formatted table. The table itself is stored in an output record; each row has its own output record and each cell has its own output record.

The Output Records of a Formatted Table



14.2 CLIM Operators for Output Recording

The purpose of output recording is to capture the output done by an application onto a stream. The objects used to capture output are called output records and output record elements. The following classes and predicates correspond to the objects used in output recording.

output-record *Protocol Class*

Summary: The protocol class used to indicate that an object is an output record. A subclass of **`bounding-rectangle`**, output records obey the bounding rectangle protocol. If you want to create a new class that behaves like an output record, it should be a subclass of **`output-record`**. Subclasses of **`output-record`** must obey the output-record protocol.

All output records are mutable.

output-record-p *Function*

`output-record-p` *object*

Summary: Returns **`t`** if *object* is an output record; otherwise, it returns **`nil`**.

displayed-output-record *Protocol Class*

Summary: The protocol class that is used to indicate that an object is a displayed output record, that is, an object that represents a visible piece of output on some output stream. This is a subclass of **`bounding-rectangle`**. If you want to create a new class that behaves like a displayed output record, it should be a subclass of **`displayed-output-record`**. Subclasses of **`displayed-output-record`** must obey the displayed output record protocol.

All displayed output records are mutable.

displayed-output-record-p *Function*

`displayed-output-record-p` *object*

Summary: Returns **`t`** if *object* is a displayed output record; otherwise, it returns **`nil`**.

:x-position

:y-position

:parent *Initargs*

Summary: All subclasses of either **`output-record`** or **`displayed-output-record`** must handle these three initargs, which are used to specify, respectively, the **`x`** and **`y`** position of the output record, and the parent of the output record.

:size *Initarg*

Summary: All subclasses of **`output-record`** must handle the **`:size`** initarg, which specifies how much room should be left for child output records (if, for example, the children are stored in a vector). **`:size`** may be ignored, provided that the resulting output record is able to store the specified number of child output records.

14.2.1 The Basic Output Record Protocol

All subclasses of **`output-record`** and **`displayed-output-record`** must inherit or implement methods for the following generic functions. For details of **`setf*`**, see **C.4 Multiple-Value Setf**.

output-record-position *Generic Function*

`output-record-position` *record*

Summary: Returns the **x** and **y** position of the output record *record* as two rational numbers. The position of an output record is the position of the upper-left corner of its bounding rectangle. The position is relative to the stream, where (0, 0) is (initially) the upper-left corner of the stream.

(setf* output-record-position) *Generic Function*

`(setf* output-record-position)` *x y record*

Summary: Changes the **x** and **y** position of the output record *record* to be *x* and *y* (which are rational numbers), and updates the bounding rectangle to reflect the new position (and saved cursor positions, if the output record stores it). If *record* has any children, all of the children (and their descendants as well) will be moved by the same amount as *record* was moved. The bounding rectangles of all of *record*'s ancestors will also be updated to be large enough to contain *record*. This does not replay the output record, but the next time the output record is replayed it will appear at the new position.

output-record-start-cursor-position *Generic Function*

`output-record-start-cursor-position` *record*

Summary: Returns the **x** and **y** starting cursor position of the output record *record* as two integer values. The positions are relative to the stream, where (0, 0) is (initially) the upper-left corner of the stream.

Text output records and updating output records maintain the cursor position. Graphical output records and other output records that do not require or affect the cursor position will return **`nil`** as both of the values.

(setf* output-record-start-cursor-position) *Generic Function*

`(setf* output-record-start-cursor-position)` *x y record*

Summary: Changes the **x** and **y** starting cursor position of the output record *record* to be *x* and *y* (which are integers). This does not affect the bounding rectangle of *record*, nor does it replay the output record. For those output records that do not require or affect the cursor position, the method for this function does nothing.

output-record-end-cursor-position *Generic Function*

`output-record-end-cursor-position` *record*

Summary: Returns the **x** and **y** ending cursor position of the output record *record* as two integer values. The positions are relative to the stream, where (0, 0) is initially the upper-left corner. Graphical output records do not track the cursor position, so only text output record and some others will return meaningful values for this.

Text output records and updating output records maintain the cursor position. Graphical output records and other output records that do not require or affect the cursor position will return **`nil`** as both of the values.

(setf* output-record-end-cursor-position) *Generic Function*

(setf* output-record-end-cursor-position) *x y record*

Summary: Changes the **x** and **y** ending cursor position of the output record *record* to be *x* and *y* (which are integers). This does not affect the bounding rectangle of *record*, nor does it replay the output record. For those output records that do not require or affect the cursor position, the method for this function does nothing.

output-record-parent *Generic Function*

output-record-parent *record*

Summary: Returns the output record that is the parent of the output record *record*, or **nil** if the record has no parent.

replay *Function*

replay *record stream* **&optional** *region*

Summary: This function binds **stream-recording-p** of *stream* to **nil**, and then calls **replay-output-record** on the arguments *record*, *stream*, and *region*. If **stream-drawing-p** of *stream* is **nil**, **replay** does nothing. **replay** is typically called during scrolling, by repaint handlers, and so on.

region defaults to **nil**.

replay-output-record *Generic Function*

replay-output-record *record stream* **&optional** *region x-offset y-offset*

Summary: Displays the output captured by the output record *record* on the output recording stream *stream*, exactly as it was originally captured (subject to subsequent modifications). The current user transformation, line style, text style, ink, and clipping region of *stream* are all ignored during the replay operation. Instead, these are gotten from the output record.

If *record* is not a displayed output record, then replaying it involves replaying all of its children. If *record* is a displayed output record, then replaying it involves redoing the graphics operation captured in the record.

region is a region that limits what records are displayed. Only those records that overlap *region* are replayed. The default for *region* is **+everywhere+**.

stream must be the same stream on which the output records were originally recorded.

erase-output-record *Generic Function*

erase-output-record *record stream*

Summary: Erases the output record *record* from the output recording stream *stream*, removes *record* from *stream*'s output history, and ensures that all other output records that were covered by *record* are visible. In effect, this draws background ink over the record, and then redraws all the records that overlap *record*.

output-record-refined-sensitivity-test *Generic Function*

output-record-refined-sensitivity-test *record x y*

Summary: This is used to definitively answer hit detection queries, that is, determining that the point (**x**, **y**) is contained within the output record *record*. Once the position (**x**, **y**) has been determined to lie within **output-record-hit-detection-rectangle***, **output-record-refined-sensitivity-test** is invoked. Output record subclasses can provide a method that defines a hit more precisely; for example, output records for elliptical rings will implement a method that detects whether the pointing device is on the elliptical ring.

highlight-output-record *Generic Function*

`highlight-output-record` *record stream state*

Summary: This method is called in order to draw a highlighting box around the output record *record* on the output recording stream *stream*. *state* will be either **`:highlight`** (meaning to draw the highlighting) or **`:unhighlight`** (meaning to erase the highlighting). The default method (on CLIM's standard output record class) simply draws a rectangle that corresponds to the bounding rectangle of *record*.

14.2.2 The Output Record "Database" Protocol

All classes that are subclasses of **`output-record`** must implement methods for the following generic functions.

output-record-children *Generic Function*

`output-record-children` *record*

Summary: Returns a fresh list of all the children of the output record *record*.

add-output-record *Generic Function*

`add-output-record` *child record*

Summary: Adds the new output record *child* to the output record *record*. The bounding rectangle for *record* and all its ancestors is updated accordingly.

The methods for the **`add-output-record`** will typically specialize only the *record* argument.

delete-output-record *Generic Function*

`delete-output-record` *child record* **`&optional (`***errorp* **`t)`**

Summary: Removes the output record *child* from the output record *record*. The bounding rectangle for *record* (and all its ancestors) is updated to account for the child having been removed.

If *errorp* is **`t`** (the default) and *child* is not contained within *record*, then an error is signaled.

The methods for the **`delete-output-record`** will typically specialize only the *record* argument.

clear-output-record *Generic Function*

`clear-output-record` *record*

Summary: Removes all of the children from the output record *record*, and resets the bounding rectangle of *record* to its initial state.

output-record-count *Generic Function*

`output-record-count` *record*

Summary: Returns the number of children contained within the output record *record*.

map-over-output-records-containing-position *Generic Function*

`map-over-output-records-containing-position` *function record x y* **`&optional`** *x-offset y-offset*

Summary: Maps over all of the children of the output record *record* that contain the point at (**x**, **y**), calling *function* on each one. *function* is a function of one argument, the record containing the point; it has dynamic extent.

If there are multiple records that contain the point and that overlap each other,

map-over-output-records-containing-position hits the most recently inserted record first and the least recently inserted record last.

map-over-output-records-overlapping-region *Generic Function*

map-over-output-records-overlapping-region *function record region* **&optional** *x-offset y-offset*

Summary: Maps over all of the children of the output record *record* that overlap the region *region*, calling *function* on each one. *function* is a function of one argument, the record overlapping the region; it has dynamic extent.

If there are multiple records that overlap the region and that overlap each other, **map-over-output-records-overlapping-region** hits the least recently inserted record first and the most recently inserted record last.

14.2.3 Types of Output Records

This section discusses several types of output records, including two standard classes of output records and the displayed output record protocol.

14.2.3.1 Standard Output Record Classes

standard-sequence-output-record *Class*

Summary: The standard class provided by CLIM to store a relatively short sequence of output records; a subclass of **output-record**. The retrieval complexity of this class is 0(n). Most of the formatted output facilities (such as **formatting-table**) create output records that are a subclass of **standard-sequence-output-record**.

standard-tree-output-record *Class*

Summary: The standard class provided by CLIM to store longer sequences of output records. Typically, the child records of a tree output record will be sorted in some way, such as an ordering on the **x** and **y** coordinates of the children. The retrieval complexity of this class is 0(log n).

14.2.3.2 Graphics Displayed Output Records

Graphics displayed output records are used to record the output produced by the graphics functions, such as **draw-line***. Each graphics displayed output record describes the output produced by a call to one of the graphics functions.

CLIM graphics displayed output records capture the following information, so that the original output can be redrawn exactly at replay time:

- The description of the graphical object itself, for example, the end points of a line or the center point and radius of a circle.
- The programmer-supplied ink at the time the drawing function was called (indirect inks are not resolved, so you can later change the default foreground and background ink of the medium and have that change affect the already-created output records during replay).
- For paths, the programmer-supplied line-style at the time the drawing function was called.
- The programmer-supplied clipping region at the time the drawing function was called.
- The user transformation.

graphics-displayed-output-record *Protocol Class*

Summary: The protocol class that corresponds to output records for the graphics functions, such as **`draw-line*`**. This is a subclass of **`displayed-output-record`**. If you want to create a new class that behaves like a graphics displayed output record, it should be a subclass of **graphics-displayed-output-record**. Subclasses of **`graphics-displayed-output-record`** must obey the graphics displayed output record protocol.

graphics-displayed-output-record-p *Function*

`graphics-displayed-output-record-p` *object*

Summary: Returns **`t`** if *object* is a graphics displayed output record; otherwise, it returns **`nil`**.

14.2.3.3 Text Displayed Output Records

Text displayed output records are used to record the textual output produced by such functions as **`stream-write-char`** and **`stream-write-string`**. Each text displayed output record corresponds to no more than one line of textual output (that is, line breaks caused by **`terpri`** and **`fresh-line`** create a new text output record, as do certain other stream operations).

Text displayed output records store the following information:

- The displayed text strings.
- The starting and ending cursor positions.
- The text style in which the text string was written.
- The programmer-supplied ink at the time the drawing function was called (indirect inks are not resolved, so that you can later change the default foreground and background ink of the medium and have that change affect the already-created output records during replay).
- The programmer-supplied clipping region at the time the drawing function was called.

text-displayed-output-record *Protocol Class*

Summary: The protocol class that corresponds to text displayed output records. This is a subclass of **`displayed-output-record`**. If you want to create a new class that behaves like a text displayed output record, it should be a subclass of **`text-displayed-output-record`**. Subclasses of **`text-displayed-output-record`** must obey the text displayed output record protocol.

text-displayed-output-record-p *Function*

`text-displayed-output-record-p` *object*

Summary: Returns **`t`** if *object* is a text displayed output record; otherwise, it returns **`nil`**.

The following three generic functions comprise the text displayed output record protocol.

add-character-output-to-text-record *Generic Function*

`add-character-output-to-text-record` *text-record character text-style width height baseline*

Summary: Adds the character *character* to the text displayed output record *text-record* in the text style *text-style*. *width* and *height* are the width and height of the character in device units, and are used to compute the bounding rectangle for the text record. *baseline* is the new baseline for characters in the output record.

add-string-output-to-text-record *Generic Function*

`add-string-output-to-text-record` *text-record string start end text-style width height baseline*

Summary: Adds the string *string* to the text displayed output record *text-record* in the text style *text-style*. *start* and *end* are integers that specify the substring within *string* to add to the text output record. *width* and *height* are the width and height of the character in device units, and are used to compute the bounding rectangle for the text record. *baseline* is the new baseline for characters in the output record.

text-displayed-output-record-string *Generic Function*

`text-displayed-output-record-string` *text-record*

Summary: Returns the string contained by the text displayed output record *text-record*. This function returns objects that reveal CLIM's internal state; do not modify those objects.

14.2.3.4 Top-Level Output Records

Top-level output records are similar to ordinary output records, except that they maintain additional state, such as the information required to display scroll bars.

stream-output-history-mixin *Class*

Summary: This class is mixed into some other output record class to produce a new class that is suitable for use as a a top -level output history.

When the bounding rectangle of a member of this class is updated, any window decorations (such as scroll bars) associated with the stream with which the output record *history* is associated are updated, too.

standard-tree-output-history *Class*

Summary: The standard class provided by CLIM to use as the top-level output history. This will typically be a subclass of both **`standard-tree-output-record`** and **`stream-output-history-mixin`**.

14.2.4 Output Recording Streams

CLIM defines an extension to the stream protocol that supports output recording. The stream has an associated output history record and provides controls to enable and disable output recording.

output-recording-stream *Protocol Class*

Summary: The protocol class that indicates that a stream is an output recording stream. If you want to create a new class that behaves like an output recording stream, it should be a subclass of **`output-recording-stream`**. Subclasses of **output-recording-stream** must obey the output recording stream protocol.

output-recording-stream-p *Function*

`output-recording-stream-p` *object*

Summary: Returns **`t`** if *object* is an output recording stream; otherwise, it returns **`nil`**.

standard-output-recording-stream *Class*

Summary: The class used by CLIM to implement output record streams. This is a subclass of **`output-recording-stream`**. Members of this class are mutable.

14.2.4.1 The Output Recording Stream Protocol

The following generic functions comprise the output recording stream protocol. All subclasses of **output-recording-stream** implement methods for these generic functions.

stream-recording-p *Generic Function*

stream-recording-p *stream*

Summary: Returns **t** when the output recording stream *stream* is recording all output performed to it; otherwise, it returns **nil**.

(setf stream-recording-p) *Generic Function*

(setf stream-recording-p) *recording-p stream*

Summary: Changes the state of **stream-recording-p** to be *recording-p*, which must be either **t** or **nil**.

stream-drawing-p *Generic Function*

stream-drawing-p *stream*

Summary: Returns **t** when the output recording stream *stream* will actually draw on the viewport when output is being performed to it; otherwise, it returns **nil**.

(setf stream-drawing-p) *Generic Function*

(setf stream-drawing-p) *drawing-p stream*

Summary: Changes the state of **stream-recording-p** to be *drawing-p*, which must be either **t** or **nil**.

stream-output-history *Generic Function*

stream-output-history *stream*

Summary: Returns the history (or top-level output record) for the output recording stream *stream*.

stream-current-output-record *Generic Function*

stream-current-output-record *stream*

Summary: The current "open" output record for the output recording stream *stream*, to which **stream-add-output-record** will add a new child record. Initially, this is the same as **stream-output-history**. As nested output records are created, this acts as a "stack".

(setf stream-current-output-record) *Generic Function*

(setf stream-current-output-record) *record stream*

Summary: Sets the current "open" output record for the output recording stream *stream* to the output record *record*.

stream-add-output-record *Generic Function*

stream-add-output-record *stream record*

Summary: Adds the output record *record* to the current output record on the output recording stream *stream*. (The current output record is the output record returned by **stream-current-output-record**.)

stream-replay *Generic Function*

stream-replay *stream* **&optional** *region*

Summary: Directs the output recording stream *stream* to invoke **replay** on its output history. Only those records that overlap the region *region* (which defaults to the viewport of the stream) are replayed.

14.2.4.2 Graphics Output Recording

We use **draw-line*** as an example here, but calling any of the drawing functions specified in **2.3 CLIM Drawing Functions** and **2.4 Graphics Protocols** results in the following series of function calls on an output recording stream:

- A program calls **draw-line*** on arguments *sheet*, *x1*, *y1*, *x2*, *y2*, and perhaps some drawing options.
- **draw-line*** merges the supplied drawing options into the sheet's medium, and then calls **medium-draw-line*** on the sheet.
- The **:around** method for **medium-draw-line*** on the output recording stream is called. This creates an output record with all of the information necessary to replay the output record, if **stream-recording-p** is **t**. If **stream-drawing-p** is **t**, this then does a **call-next-method**.
- The primary method for **medium-draw-line*** performs the necessary user transformations by applying the medium transformation to *x1*, *y1*, *x2*, *y2*, and the clipping region. Then it draws on the underlying window.

replay-output-record for a graphics displayed output record simply calls the medium drawing function (such as **medium-draw-line***) directly on the sheet (**not** on the medium) with **stream-recording-p** set to **nil** and **stream-drawing-p** set to **t**.

14.2.4.3 Text Output Recording

This is the place where **write-string** and similar functions are captured in order to create an output record. The generic functions include protocol like **stream-write-string** that are specialized by output recording streams to do the output recording.

stream-text-output-record *Generic Function*

stream-text-output-record *stream text-style*

Summary: Returns a text output record for the output recording stream *stream* suitable for holding characters in the text style *text-style*. If there is a currently "open" text output record that can hold characters in the specified text style, it is returned. Otherwise a new text output record is created that can hold characters in that text style, and its starting cursor position is set to the cursor position of *stream*.

stream-close-text-output-record *Generic Function*

stream-close-text-output-record *stream*

Summary: Closes the output recording stream *stream*'s currently "open" text output record by recording the stream's current cursor position as the ending cursor position of the record and adding the text output record to *stream*'s current output record by calling **stream-add-output-record**.

If there is no "open" text output record, **stream-close-text-output-record** does nothing.

Calling **stream-finish-output**, **stream-force-output**, calling **redisplay**, setting the text cursor position (via **stream-set-cursor-position**, **terpri**, or **fresh-line**), creating a new output record (for example, via **with-new-output-record**), or changing the state of **stream-recording-p** closes the current text output record.

stream-add-character-output *Generic Function*

stream-add-character-output *stream character text-style width height baseline*

Summary: Adds the character *character* to the output recording stream *stream*'s text output record in the text style *text-*

style. *width* and *height* are the width and height of the character in device units. *baseline* is the new baseline for the stream. **`stream-add-character-output`** calls **`add-character-output-to-text-record`**.

`stream-write-char` on an output recording stream will call **`stream-add-character-output`** when **`stream-recording-p`** is **`t`**.

stream-add-string-output *Generic Function*

`stream-add-string-output` *stream string start end text-style width height baseline*

Summary: Adds the string *string* to the output recording stream *stream*'s text output record in the text style *text-style*. *start* and *end* are integers that specify the substring within *string* to add to the text output record. *width* and *height* are the width and height of the string in device units. *baseline* is the new baseline for the stream. **`stream-add-string-output`** calls **`add-string-output-to-text-record`**.

`stream-write-string` on an output recording stream will call **`stream-add-string-output`** when **`stream-recording-p`** is **`t`**.

14.2.4.4 Output Recording Utilities

CLIM provides several helper macros to control the output recording facility.

with-output-recording-options *Macro*

`with-output-recording-options (`*stream* **`&key`** *record draw***`) &body`** *body*

Summary: Enables or disables output recording and/or drawing on the output recording stream designated by *stream*, within the extent of *body*.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream. If *stream* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

`with-output-recording-options` expands into a call to **`invoke-with-output-recording-options`**, supplying a function that executes *body* as the *continuation* argument to **`invoke-with-output-recording-options`**.

invoke-with-output-recording-options *Generic Function*

`invoke-with-output-recording-options` *stream continuation record draw*

Summary: Enables or disables output recording and/or drawing on the output recording stream *stream*, and calls the function *continuation* with the new output recording options in effect. *continuation* is a function of one argument, the stream; it has dynamic extent.

If *draw* is **`nil`**, output to the stream is not drawn on the viewport, but recording proceeds according to *record*; if *draw* is **`t`**, the output is drawn. If *record* is **`nil`**, output recording is disabled, but output otherwise proceeds according to *draw*; if *draw* is **`t`**, output recording is enabled.

All output recording streams must implement a method for **`invoke-with-output-recording-options`**.

with-new-output-record *Macro*

`with-new-output-record (`*stream* **`&optional`** *record-type record* **`&rest`** *init-args***`) &body`** *body*

Summary: Creates a new output record of type *record-type* (which defaults to **`standard-sequence-output-record`**), captures the output of *body* into the new output record, and inserts the new record into the current "open" output record associated with the output recording stream *stream*. While *body* is being evaluated, the current output record for *stream* will be bound to the new output record.

If *record* is supplied, it is the name of a variable that will be lexically bound to the new output record inside of body. *init-args* are CLOS initialization arguments that are passed to **make-instance** when the new output record is created.

with-new-output-record returns the output record it creates.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream. If *stream* is **t**, ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

with-new-output-record expands into a call to **invoke-with-new-output-record**, supplying a function that executes *body* as the *continuation* argument to **invoke-with-new-output-record**.

with-output-to-output-record *Macro*

with-output-to-output-record (*stream* **&optional** *record-type record* **&rest** *init-args***) &body** *body*

Summary: Like **with-new-output-record**, except that the new output record is not inserted into the output record hierarchy, and the text cursor position of *stream* is initially bound to (0, 0).

record-type is the type of output record to create, which defaults to **standard-sequence-output-record**. *init-args* are CLOS initialization arguments that are passed to **make-instance** when the new output record is created. *record*, if supplied, is a variable that will be bound to the new output record while *body* is evaluated.

with-output-to-output-record returns the output record it creates.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream. If *stream* is **t**, ***standard-output*** is used. Unlike facilities such as **with-output-to-string**, *stream* must be an actual stream, but no output will be done to it. *body* may have zero or more declarations as its first forms.

with-output-to-output-record expands into a call to **invoke-with-output-to-output-record**, supplying a function that executes *body* as the *continuation* argument to **invoke-with-output-to-output-record**.

invoke-with-new-output-record *Generic Function*

invoke-with-new-output-record *stream continuation record-type* **&rest** *init-args* **&key**

Summary: Creates a new output record of type *record-type*. The function *continuation* is then called, and any output it does to the output recording stream *stream* is captured in the new output record. The new record is then inserted into the current "open" output record associated with *stream* (or the top-level output record if there is no currently "open" one). While *continuation* is being executed, the current output record for *stream* will be bound to the new output record.

continuation is a function of two arguments, the stream and the output record; it has dynamic extent. *init-args* are CLOS initialization arguments that are passed to **make-instance** when the new output record is created.

invoke-with-new-output-record returns the output record it creates.

All output recording streams must implement a method for **invoke-with-new-output-record**.

invoke-with-output-to-output-record *Generic Function*

invoke-with-output-to-output-record *stream continuation record-type* **&rest** *init-args* **&key**

Summary: Like **invoke-with-new-output-record** except that the new output record is not inserted into the output record hierarchy, and the text cursor position of *stream* is initially bound to (0, 0). That is, when **invoke-with-output-to-output-record** is used, no drawing on the stream occurs and nothing is put into the stream's normal output history. The function *continuation* is called, and any output it does to *stream* is captured in the output record.

continuation is a function of two arguments, the stream and the output record; it has dynamic extent. *record-type* is the type of output record to create. *init-args* are CLOS initialization arguments that are passed to **make-instance** when the new output record is created.

invoke-with-output-to-output-record returns the output record it creates.

All output recording streams must implement a method for **invoke-with-output-to-output-record**.

make-design-from-output-record *Generic Function*

make-design-from-output-record *record*

Summary: Makes a design that replays the output record *record* when drawn via **draw-design**. If *record* is changed after the design is made, the consequences are unspecified. Applying a transformation to the design and calling **draw-design** on the new design is equivalent to establishing the same transformation before creating the output record.

The current version of CLIM supports this only for those output records that correspond to the geometric object classes (for example, the output records created by **draw-line*** and **draw-ellipse***).

14.3 Conceptual Overview of Incremental Redisplay

Some kinds of applications can benefit greatly from the ability to redisplay information on a window only when that information has changed. This feature, called ***incremental redisplay***, can significantly improve the speed at which your application updates information on the screen. Incremental redisplay is very useful for programs that display a window of changing information where some portions of the window are static and some are continually changing.

Incremental redisplay is a facility to allow you to change the output in an output history (and hence on the screen or other output device). It allows you to redisplay pieces of the existing output differently, under your control. "Incremental" here means that CLIM redisplays only the part of the output history visible in the viewport that has changed and thus needs to be redisplayed.

There are two different ways to do incremental redisplay:

- Call **redisplay** on an output record.

  This essentially tells the system to start that output record over from scratch. It compares the results with the existing output and tries to do minimal redisplay. The **updating-output** form allows you to assist the system by informing it that entire branches of the output history are known not to have changed. **updating-output** also allows you to communicate the fact that a piece of the output record hierarchy has moved.

- Update the output history manually, and then notify the output record that its child has changed.

  This causes CLIM to propagate the changes up the output record tree and allows parent output records to readjust themselves to account for the changes.

Each way is appropriate under different circumstances. **redisplay** is often easier to code and is more useful in cases where there might be large changes between two passes, or where you have little idea as to what the changes might be. Notifying the output record of changes can be more efficient for small changes at the bottom of the output-record hierarchy, or in cases where you are well informed as to the specific changes necessary and can describe these changes to the system.

14.4 CLIM Operators for Incremental Redisplay

The following functions are used to create an output record that should be incrementally redisplayed, and then to redisplay that record.

updating-output *Macro*

updating-output (*stream* **&rest** *args* **&key** *unique-id* **(***id-test* **\#'***eql***)** *cache-value* **(***cache-test* **\#'***eql***)** *copy-cache-value fixed-position all-new parent-cache record-type***) &body** *body*

Summary: Introduces a caching point for incremental redisplay.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream. If *stream* is **t**, ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

record-type specifies the class of output record to create. The default is **standard-updating-output-record**. This argument should only be supplied by a programmer if there is a new class of output record that supports the updating output record protocol.

updating-output expands into a call to **invoke-updating-output**, supplying a function that executes *body* as the *continuation* argument to **invoke-updating-output**.

invoke-updating-output *Generic Function*

invoke-updating-output *stream continuation record-type unique-id id-test cache-value cache-test copy-cache-value* **&key** *all-new parent-cache*

Summary: Introduces a caching point for incremental redisplay. Calls the function *continuation*, which generates the output records to be redisplayed. *continuation* is a function of one argument, the stream; it has dynamic extent.

If this is used outside the dynamic scope of an incremental redisplay, it has no particular effect. However, when incremental redisplay is occurring, the supplied *cache-value* is compared with the value stored in the cache identified by *unique-id*. If the values differ or the code in *body* has not been run before, the code in *body* runs, and *cache-value* is saved for next time. If the cache values are the same, the code in *body* is not run, because the current output is still valid.

unique-id uniquely identifies the output done by *body*. If *unique-id* is not supplied, CLIM will generate one that is guaranteed to be unique. *unique-id* may be any object as long as it is unique with respect to the *id-test* predicate among all such unique ids in the current incremental redisplay. *id-test* is a function of two arguments that is used for comparing unique ids; it has indefinite extent.

cache-value is a value that remains constant if and only if the output produced by body does not need to be recomputed. If the cache value is not supplied, CLIM will not use a cache for this piece of output. *cache-test* is a function of two arguments that is used for comparing cache values; it has indefinite extent. If *copy-cache-value* is **t**, then the supplied cache value will be copied using **copy-seq** before it is stored in the output record. The default for *copy-cache-value* is **nil**.

If *fixed-position* is **t**, then the location of this output is fixed relative to its parent output record. When CLIM redisplays an output record that has a fixed position, then if the contents have not changed, the position of the output record will not change. If the contents have changed, CLIM assumes that the code will take care to preserve its position. The default for *fixed-position* is **nil**.

If *all-new* is **t**, that indicates that all of the output done by *body* is new, and will never match output previously recorded. In this case, CLIM will discard the old output and do the redisplay from scratch. The default for *all-new* is **nil**.

The output record tree created by **updating-output** defines a caching structure where mappings from a *unique-id* to an output record are maintained. If the programmer specifies an output record via the *parent-cache* argument, then CLIM will try to find a corresponding output record with the matching *unique-id* in the cache belonging to *parent-cache*. If neither *parent-cache* is not provided, then CLIM looks for the *unique-id* in the output record created by immediate dynamically enclosing call to **updating-output**. If that fails, CLIM use the *unique-id* to find an output record that is a child of the output history of *stream*. Once CLIM has found an output record that matches the *unique-id*, it uses the cache value and cache test to determine whether the output record has changed. If the output record has not changed, it may have moved, in which case CLIM will simply move the display of the output record on the display device.

redisplay *Function*

redisplay *record stream* **&key (***check-overlapping* **t)**

Summary: This function calls **redisplay-output-record** on the arguments *record* and *stream*. When **check-overlapping** is **t**, redisplay checks overlapped output records more carefully in order to display them correctly. The default is **nil**.

redisplay-output-record *Generic Function*

`redisplay-output-record` *record stream* **`&optional (`***check-overlapping* **`t)`** *x y parent-x parent-y*

Summary: **`(redisplay-output-record`** *record stream***`)`** causes the output of *record* to be recomputed. CLIM redisplays the changes "incrementally"; that is, it only displays those parts that have been changed. *record* must already be part of the output history of the output recording stream *stream*, although it can be anywhere inside the hierarchy.

When **`check-overlapping`** is **`t`**, redisplay checks overlapped output records more carefully in order to display them correctly. The default is **`nil`**. This means that CLIM can assume that no sibling output records overlap each other at any level. Supplying a false value for this argument can improve performance of redisplay.

The other optional arguments can be used to specify where on the *stream* the output record should be redisplayed. *x* and *y* represent where the cursor should be, relative to **`(output-record-parent`** *record***`)`**, before *record* is redisplayed. *parent-x* and *parent-y* can be supplied to say: do the output as if the parent started at positions *parent-x* and *parent-y* (which are in absolute coordinates). The default values for *x* and *y* are **`(output-record-start-position`** *record***`)`**. The default values for *parent-x* and *parent-y* are:

```
(convert-from-relative-to-absolute-coordinates stream
 (output-record-parent record))
```

record will usually be an output record created by **`updating-output`**. If it is not, then **`redisplay-output-record`** will be equivalent to **`replay-output-record`**.

14.5 Using updating-output

One technique of incremental redisplay is to use **`updating-output`** to inform CLIM what output has changed, and to use **`redisplay`** to recompute and redisplay that output.

The outermost call to **`updating-output`** identifies a program fragment that produces incrementally redisplayable output. A nested call to **`updating-output`** (that is, a call to **`updating-output`** that occurs during the execution of the body of the outermost **`updating-output`** and that specifies the same stream) identifies an individually redisplayable piece of output, the program fragment that produces that output, and the circumstances under which that output needs to be redrawn.

The outermost call to **`updating-output`** executes its body, producing the initial version of the output, and returns an **`updating-output-record`** that captures the body in a closure. Each nested call to **`updating-output`** caches its **`:unique-id`** and **`:cache-value`** arguments and the portion of the output produced by its body.

`redisplay` takes an **`updating-output-record`** and executes the captured body of **`updating-output`** over again. When a nested call to **`updating-output`** is executed during redisplay, **`updating-output`** decides whether the cached output can be reused or the output needs to be redrawn. This is controlled by the **`:cache-value`** argument to **`updating-output`**. If its value matches its previous value, the body would produce output identical to the previous output, which would thus be unnecessary. In this case, the cached output is reused and **`updating-output`** does not execute its body. If the **`:cache-value`** does not match, the output needs to be redrawn, so **`updating-output`** executes its body and the new output drawn on the stream replaces the previous output. The **`:cache-value`** argument is only meaningful for nested calls to **`updating-output`**.

If the **`:incremental-redisplay`** pane option is used, CLIM supplies the outermost call to **`updating-output`**, saves the **`updating-output-record`**, and calls **`redisplay`**. The function specified by the **`:display-function`** pane option performs only the nested calls to **`updating-output`**.

If you use incremental redisplay without using the **`:incremental-redisplay`** pane option, you must perform the outermost call to **`updating-output`**, save the **`updating-output-record`**, and call **`redisplay`** yourself.

In order to compare the cache to the output record, two pieces of information are necessary:

1. An association between the output being done by the program and a particular cache. This is supplied in the **`:unique-id`** option to **updating-output**.

2. A means of determining whether this particular cache is valid. This is the **`:cache-value`** option to **updating-output**.

Normally you would supply both options. The **`:unique-id`** would be some data structure associated with the corresponding part of output. The cache value would be something in that data structure that changes whenever the output changes.

It is valid to give the **`:unique-id`** and not the **`:cache-value`**. This is done to identify a superior in the hierarchy. By this means, the inferiors essentially get a more complex **`:unique-id`** when they are matched for output. (It is rather like using a telephone area code.) The cache without a cache value is never valid. Its inferiors always have to be checked.

It is also valid to give the **`:cache-value`** and not the **`:unique-id`**. In this case, unique ids are just assigned sequentially. So, if output associated with the same thing is done in the same order each time, it isn't necessary to invent new unique ids for each piece. This is especially true in the case of inferiors of a cache with a unique id and no cache value of its own. In this case, the superior marks the particular data structure, whose components can change individually, and the inferiors are always in the same order and properly identified by their superior and the order in which they are output.

A **`:unique-id`** need not be unique across the entire redisplay, only among the inferiors of a given output cache, that is, among all possible (current and additional) uses you make of **updating-output** that are dynamically (not lexically) within another.

To make your incremental redisplay maximally efficient, you should attempt to give as many caches with **`:cache-value`** as possible. For instance, if you have a deeply nested tree, it is better to be able to know when whole branches have not changed than to have to recurse to every single leaf and check it. So, if you are maintaining a modification tick in the leaves, it is better to maintain one in their superiors as well and to propagate the modification up when things change. While the simpler approach works, it requires CLIM to do more work than is necessary.

14.6 Example of Incremental Redisplay in CLIM

The following function illustrates the standard use of incremental redisplay:

```
(defun test (stream)
  (let* ((list (list 1 2 3 4 5))
         (record
          (clim:updating-output
           (stream)
           (do* ((elements list (cdr elements))
                 (count 0 (1+ count))
                 (element (first elements) (first elements)))
               ((null elements))
             (clim:updating-output (stream :unique-id count
                                           :cache-value element)
                                   (format stream "Element ~D~%" element))))))
    (force-output stream)
    (sleep 10)
    (setf (nth 2 list) 17)
    (clim:redisplay record stream)))
```

When **`test`** is run on a window, the initial display looks like:

```
Element 1
Element 2
Element 3
Element 4
Element 5
```

After the sleep has terminated, the display looks like:

```
Element 1
Element 2
Element 17
Element 4
Element 5
```

Incremental redisplay takes care of ensuring that only the third line gets erased and redisplayed. In the case where items have moved around, Incremental Redisplay ensures that the minimum amount of work is done in updating the display, thereby minimizing "flashiness" while providing a powerful user interface. For example, try substituting the following for the form after the sleep:

```
(setf list (sort list #'(lambda (&rest args) (zerop (random 2)))))
```

15 Extended Stream Input Facilities

15.1 Basic Input Streams

CLIM provides a stream-oriented input layer that is implemented on top of the sheet input architecture. The basic CLIM input stream protocol is based on the character input stream protocol proposal submitted to the ANSI Common Lisp committee by David Gray. This proposal was not approved by the committee, but CLIM provides an implementation of the basic input stream facilities.

standard-input-stream *Class*

Summary: This class provides an implementation of the CLIM's basic input stream protocol based on CLIM's input kernel. It defines a **`handle-event`** method for keystroke events and queues the resulting characters in a per-stream input buffer. Members of this class are mutable.

stream-read-char *Generic Function*

`stream-read-char` *stream*

Summary: Returns the next character available in the input stream *stream*, or **`:eof`** if the stream is at end-of-file. If no character is available, this function will wait until one becomes available.

stream-unread-char *Generic Function*

`stream-unread-char` *stream character*

Summary: Places the character *character* back into the input stream *stream*'s input buffer. The next call to **`read-char`** on *stream* will return the unread character. The character supplied must be the most recent character read from the stream.

stream-read-char-no-hang *Generic Function*

`stream-read-char-no-hang` *stream*

Summary: Like **`stream-read-char`**, except that if no character is available, the function returns **`nil`**.

stream-peek-char *Generic Function*

`stream-peek-char` *stream*

Summary: Returns the next character available in the input stream *stream*. The character is not removed from the input buffer, so the same character will be returned by a subsequent call to **`stream-read-char`**.

stream-listen *Generic Function*

`stream-listen` *stream*

Summary: Returns **`t`** if there is input available on the input stream *stream*, **`nil`** if not.

stream-read-line *Generic Function*

`stream-read-line` *stream*

Summary: Reads and returns a string containing a line of text from the input stream *stream*, delimited by the **`#\Newline`** character.

stream-clear-input *Generic Function*

`stream-clear-input` *stream*

Summary: Clears any buffered input associated with the input stream *stream* and returns **`nil`**.

15.2 Extended Input Streams

In addition to the basic input stream protocol, CLIM defines an extended input stream protocol. This protocol extends the stream model to allow manipulation of non-character user gestures, such as pointer button presses. The extended input protocol provides the programmer with more control over input processing, including the options of specifying input wait timeouts and auxiliary input test functions.

extended-input-stream *Protocol Class*

Summary: The protocol class for CLIM extended input streams. This is a subclass of **`input-stream`**. If you want to create a new class that behaves like an extended input stream, it should be a subclass of **`extended-input-stream`**. Subclasses of **`extended-input-stream`** must obey the extended input stream protocol.

extended-input-stream-p *Function*

`extended-input-stream-p` *object*

Summary: Returns **`t`** if *object* is a CLIM extended input stream; otherwise, it returns **`nil`**.

:input-buffer

:pointer

:text-cursor *Initargs*

Summary: All subclasses of **`extended-input-stream`** must handle these initargs, which are used to specify, respectively, the input buffer, pointer, and text cursor for the extended input stream.

standard-extended-input-stream *Class*

Summary: This class provides an implementation of the CLIM extended input stream protocol based on CLIM's input kernel. The extended input stream maintains the state of the display's pointing devices (such as a mouse) in pointer objects associated with the stream. It defines a **`handle-event`** methods for keystroke and pointer motion and button press events and updates the pointer object state and queues the resulting events in a per-stream input buffer.

Members of this class are mutable.

15.2.1 The Extended Input Stream Protocol

The following generic functions comprise the extended input stream protocol. All extended input streams must implement methods for these generic functions.

stream-input-buffer *Generic Function*

`stream-input-buffer` *stream*

(setf stream-input-buffer) *Generic Function*

`(setf stream-input-buffer)` *buffer stream*

Summary: These functions provide access to the stream's input buffer. Normally programs do not need to manipulate the input buffer directly. It is sometimes useful to cause several streams to share the same input buffer so that input that comes in on one of them is available to an input call on any of the streams. The input buffer must be a vector with a fill pointer capable of holding general input gesture objects (such as characters and event objects).

stream-pointers *Generic Function*

`stream-pointers` *stream*

Summary: Returns the list of pointer objects corresponding to the pointing devices of the port associated with *stream*. This function returns objects that reveal CLIM's internal state; do not modify those objects.

stream-primary-pointer *Generic Function*

`stream-primary-pointer` *stream*

(setf stream-primary-pointer) *Generic Function*

`(setf stream-primary-pointer)` *pointer stream*

Summary: Returns (or sets) the pointer object corresponding to the primary pointing device of the console.

Note: CLIM currently supports only a single pointer for any port. Therefore, the length of the list returned by **`stream-pointers`** will always be one, and **`stream-primary-pointer`** will always return an object that is the only element of that list.

stream-pointer-position *Generic Function*

`stream-pointer-position` *stream* **`&key`** *pointer*

Summary: Returns the current position of the pointing device *pointer* for the extended input stream *stream* as two values, the **`x`** and **`y`** positions in the stream's drawing surface coordinate system. If *pointer* is not supplied, it defaults to the **`stream-primary-pointer`** of the stream.

(setf* stream-pointer-position) *Generic Function*

`(setf* stream-pointer-position)` *x y stream* **`&key`** *pointer*

Summary: Sets the position of the pointing device for the extended input stream *stream* to *x* and *y*, which are integers. *pointer* is as for **`stream-pointer-position`**. For the details of **`setf*`**, see **C.4 Multiple-Value Setf**.

stream-set-input-focus *Generic Function*

`stream-set-input-focus` *stream*

Summary: Sets the "input focus" to the extended input stream *stream* and returns the old input focus as its value.

stream-restore-input-focus *Generic Function*

`stream-restore-input-focus` *stream old-focus*

Summary: Restores the "input focus" of the extended input stream *stream* to *old-focus*.

with-input-focus *Macro*

`with-input-focus (`*stream***`) &body`** *body*

Summary: Temporarily gives the keyboard input focus to the extended input stream *stream*. By default, an application frame gives the input focus to the window associated with **`frame-query-io`**.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **`t`**,

`*standard-input*` is used. *body* may have zero or more declarations as its first forms.

input-wait-test

input-wait-handler

pointer-button-press-handler — *Variables*

Summary: These three variables are used to hold the default values for the current input wait test, wait handler, and pointer button press handler. These variables are globally bound to **`nil`**.

read-gesture — *Function*

`read-gesture &key (`*stream* **`*`***standard-input***`*)`** *timeout peek-p* **`(`***input-wait-test* **`*`***input-wait-test***`*) (`***input-wait-handler* **`*`***input-wait-handler***`*) (`***pointer-button-press-handler* **`*`***pointer-button-press-handler***`*)`**

Summary: Calls **`stream-read-gesture`** on the extended input stream *stream* and all of the other keyword arguments. Returns the next gesture available in the extended input stream *stream*; the gesture will be a character, an event (such as a pointer button event), or **`(values nil :timeout)`** if no input is available. The input is not echoed.

These arguments are the same as for **`stream-read-gesture`**.

stream-read-gesture — *Generic Function*

`stream-read-gesture` *stream* **`&key`** *timeout peek-p* **`(`***input-wait-test* **`*`***input-wait-test***`*) (`***input-wait-handler* **`*`***input-wait-handler***`*) (`***pointer-button-press-handler* **`*`***pointer-button-press-handler***`*)`**

Summary: Returns the next gesture available in the extended input stream *stream*; the gesture will be either a character or an event (such as a pointer button event). The input is not echoed.

If the user types an abort gesture (that is, a gesture that matches any of the gesture names in **`*abort-gestures*`**), then the **`abort-gesture`** condition will be signaled.

If the user types an accelerator gesture (that is, a gesture that matches any of the gesture names in **`*accelerator-gestures*`**), then the **`accelerator-gesture`** condition will be signaled.

`stream-read-gesture` works by invoking **`stream-input-wait`** on *stream*, *input-wait-test*, and *timeout*, and then processing the input, if there is any.

timeout is either **`nil`** or an integer that specifies the number of seconds that **`stream-read-gesture`** will wait for input to become available. If no input is available, **`stream-read-gesture`** will return two values, **`nil`** and **`:timeout`**.

If *peek-p* is **`t`**, the returned gesture will be left in the stream's input buffer.

input-wait-test is a function of one argument, the stream. The function should return **`t`** when there is input to process, otherwise it should return **`nil`**. This argument will be passed on to **`stream-input-wait`**. **`stream-read-gesture`** will bind **`*input-wait-test*`** to *input-wait-test*.

input-wait-handler is a function of one argument, the stream. It is called when **`stream-input-wait`** returns **`nil`** (that is, no input is available). This option can be used in conjunction with *input-wait-test* to handle conditions other than keyboard gestures, or to provide some sort of interactive behavior (such as highlighting applicable presentations). **`stream-read-gesture`** will bind **`*input-wait-handler*`** to *input-wait-handler*.

pointer-button-press-handler is a function of two arguments, the stream and a pointer button press event. It is called when the user clicks a pointer button. **`stream-read-gesture`** will bind **`*pointer-button-press-handler*`** to *pointer-button-press-handler*.

input-wait-test, *input-wait-handler*, and *pointer-button-press-handler* have dynamic extent.

stream-input-wait *Generic Function*

`stream-input-wait` *stream* **`&key`** *timeout input-wait-test*

Summary: Waits for input to become available on the extended input stream *stream*. *timeout* and *input-wait-test* are as for **`stream-read-gesture`**.

unread-gesture *Function*

`unread-gesture` *gesture* **`&key (`***stream* **`*`***standard-input***`*)`**

Summary: Calls **`stream-unread-gesture`** on *gesture* and *stream*. These arguments are the same as for **`stream-unread-gesture`**.

stream-unread-gesture *Generic Function*

`stream-unread-gesture` *stream gesture*

Summary: Places *gesture* back into the extended input stream *stream*'s input buffer. The next call to **`stream-read-gesture`** request will return the unread gesture. *gesture* must be the most recent gesture read from the stream via **`read-gesture`**.

15.2.2 Extended Input Stream Conditions

abort-gestures *Variable*

Summary: A list of all of the gesture names that correspond to abort gestures. The global set of standard abort gestures is unspecified; it includes the **`:abort`** gesture name. The actual keystroke sequence is **`Control-z`**.

abort-gesture *Condition Class*

Summary: This condition is signaled by **`read-gesture`** whenever an abort gesture (one of the gestures in **`*abort-gestures*`**) is read from the user.

abort-gesture-event *Generic Function*

`abort-gesture-event` *condition*

Summary: Returns the event that cause the abort gesture condition to be signaled. **`condition`** is an object of type **`abort-gesture`**.

accelerator-gestures *Variable*

Summary: A list of all of the gesture names that correspond to keystroke accelerators. The global value for this is **`nil`**.

accelerator-gesture *Condition Class*

Summary: This condition is signaled by **`read-gesture`** whenever an keystroke accelerator gesture (one of the gestures in **`*accelerator-gestures*`**) is read from the user.

accelerator-gesture-event *Generic Function*

`accelerator-gesture-event` *condition*

Summary: Returns the event that causes the accelerator gesture condition to be signaled. **`condition`** is an object of type **`accelerator-gesture`**.

accelerator-gesture-numeric-argument *Generic Function*

`accelerator-gesture-numeric-argument` *condition*

Summary: Returns the accumulated numeric argument (maintained by the input editor) at the time the accelerator gesture condition was signaled. **`condition`** is an object of type **`accelerator-gesture`**.

15.3 Gestures and Gesture Names

A ***gesture*** is some sort of input action by the user, such as typing a character or clicking a pointer button. A ***keyboard gesture*** refers to those gestures that are input by typing something on the keyboard. A ***pointer gesture*** refers to those gestures that are input by doing something with the pointer, such as clicking a button.

A ***gesture name*** is a symbol that gives a name to a set of similar gestures. Gesture names are used in order to provide a level of abstraction above raw device events; greater portability can be achieved by avoiding referring directly to platform-dependent constructs, such as character objects that refer to a particular key on the keyboard. For example, the **`:complete`** gesture is used to name the gesture that causes the **`complete-input`** complete the current input string; on Genera, this may correspond to the **`COMPLETE`** key on the keyboard (which generates a **`#\Complete`** character), but on a Unix workstation, it may correspond to **`TAB`** or some other key. Another example is **`:select`**, which is commonly used to indicate a left button click on the pointer.

Note that gesture names participate in a one-to-many mapping, that is, a single gesture name can name a group of physical gestures. For example, an **`:edit`** might include both a pointer button click and a key press.

CLIM uses ***event*** objects to represent user gestures. Some of the more common events are those of the class **`pointer-button-event`**. Event objects store the sheet associated with the event, a timestamp, and the modifier key state (a quantity that indicates which modifier keys were held down on the keyboard at the time the event occurred). Pointer button event objects also store the pointer object, the button that was clicked on the pointer, the window the pointer was over, and the **`x`** and **`y`** position within that window. Keyboard gestures store the key name.

In some contexts, the object used to represent a user gesture is referred to as an ***gesture object***. An gesture object might be exactly the same as an event object, or might contain less information. For example, for a keyboard gesture that corresponds to a standard printing character, it may be enough to represent the gesture object as a character.

define-gesture-name *Macro*

`define-gesture-name` *name type gesture-spec* **`&key (`***unique* **`t)`**

Summary: Defines a new gesture named by the symbol *name*. It expands into a call to **`add-gesture-name`**.

type is the type of gesture being created, and is either **`:keyboard`** or **`:pointer-button`**. *gesture-spec* specifies the physical gesture that corresponds to the named gesture; its syntax depends on the value of *type*.

- When *type* is **`:keyboard`**, *gesture-spec* is a list of the form (*key-name . modifier-key-names*). *key-name* is the name of a non-modifier key on the keyboard. *modifier-key-names* is a (possibly empty) list of modifier key names (**`:shift`**, **`:control`**, **`:meta`**, **`:super`**, and **`:hyper`**).

  For the standard Common Lisp characters (the 95 ASCII printing characters including **`#\Space`**), *key-name* is the character object itself. For the other "semi-standard" characters, *key-name* is a keyword symbol naming the character (**`:newline`**, **`:linefeed`**, **`:return`**, **`:tab`**, **`:backspace`**, **`:page`**, and **`:rubout`**).

  The names of the modifier keys have been chosen to be uniform across all platforms, even though not all platforms will have keys on the keyboard with these names. The per-port part of CLIM simply chooses a sensible mapping from the modifier key names to the names of the keys on the keyboard. For example, CLIM on the Macintosh maps **`:meta`** to the **`COMMAND SHIFT`** key, and **`:super`** to the **`OPTION SHIFT`** key.

- When *type* is **`:pointer-button`**, *gesture-spec* is a list of the form (*button-name* . *modifier-key-names*). *button* is the name of a pointer button (**`:left`**, **`:middle`**, **`:right`**, or **`:wheel`**), and *modifier-key-names* is as for when *type* is **`:keyboard`**.

If *unique* is **`t`** (the default), all old gestures named by *name* are removed.

None of the arguments to **`define-gesture-name`** are evaluated.

add-gesture-name *Function*

`add-gesture-name` *name type gesture-spec* **`&key`** *unique*

Summary: Adds a gesture named by the symbol *name* to the set of gesture names. *type* and *gesture-spec* are as for **`define-gesture-name`**.

If *unique* is **`t`**, all old gestures named by *name* are removed. *unique* defaults to **`nil`**.

As an example, the **`:edit`** gesture name could be defined as follows using **`define-gesture-name`**:

```
(define-gesture-name :edit :pointer-button (:left :meta))
(define-gesture-name :edit :keyboard (#\E :control))
```

delete-gesture-name *Function*

`delete-gesture-name` *name*

Summary: Removes the gesture named by the symbol *name*.

CLIM provides a standard set of gesture names that correspond to a common set of gestures. Here are the required, standard keyboard gesture names:

- **`:abort`**—corresponds to gestures that cause the currently running application to be aborted back to top-level. In LispWorks CLIM, this may match the event corresponding to typing **`CONTROL-Z`**.
- **`:clear-input`**—corresponds to gestures that cause the current input buffer to be cleared. In LispWorks CLIM, this may match the event corresponding to typing **`CONTROL-BACKSPACE`**.
- **`:complete`**—corresponds to the gestures that tell the completion facility to complete the current input. On most systems, this will typically match the **`#\Tab`** or **`#\Escape`** character.
- **`:help`**—corresponds to the gestures that tell **`accept`** and the completion facility to display a help message. On most systems, this will typically match the event corresponding to typing **`CONTROL-/`**.
- **`:possibilities`**—corresponds to the gestures that tell the completion facility to display the current set of possible completions. On most systems, this will typically match the event corresponding to typing **`CONTROL-?`**.

Here are the required, standard pointer gesture names:

- **`:select`**—corresponds to the gesture that is used to "select" the object being pointed to with the pointer. Typically, this will correspond to the left button on the pointer.
- **`:describe`**—corresponds to the gesture that is used to "describe" or display some sort of documentation on the object being pointed to with the pointer. Typically, this will correspond to the middle button on the pointer.
- **`:menu`**—corresponds to the gesture that is used to display a menu of all possible operations on the object being pointed to with the pointer. Typically, this will correspond to the right button on the pointer.
- **`:edit`**—corresponds to the gesture that is used to "edit" the object being pointed to with the pointer. Typically, this will correspond to the left button on the pointer with some modifier key held down (such as the **`META`** key).

- **:delete**—corresponds to the gesture that is used to "delete" the object being pointed to with the pointer. Typically, this will correspond to the middle button on the pointer with some modifier key held down (such as the **SHIFT** key).

15.4 The Pointer Protocol

pointer *Protocol Class*

Summary: The protocol class that corresponds to a pointing device. If you want to create a new class that behaves like pointer, it should be a subclass of **pointer**. Subclasses of **pointer** must obey the pointer protocol. Members of this class are mutable.

pointerp *Function*

pointerp *object*

Summary: Returns **t** if *object* is a pointer; otherwise, it returns **nil**.

:port *Initarg*

Summary: Specifies the port with which the pointer is associated.

standard-pointer *Class*

Summary: The instantiable class that implements a pointer.

pointer-port *Generic Function*

pointer-port *pointer*

Summary: Returns the port with which the pointer *pointer* is associated.

pointer-sheet *Generic Function*

pointer-sheet *pointer*

(setf pointer-sheet) *Generic Function*

(setf pointer-sheet) *sheet pointer*

Summary: Returns (or sets) the sheet over which the pointer *pointer* is located.

pointer-button-state *Generic Function*

pointer-button-state *pointer*

Summary: Returns the state of the buttons of the pointer *pointer*. This is represented as the **logior** of the values obtained from **pointer-event-button**.

pointer-position *Generic Function*

pointer-position *pointer*

Summary: Returns the **x** and **y** position of the pointer *pointer* as two values.

(setf* pointer-position) *Generic Function*

(setf* pointer-position) *x y pointer*

Summary: Sets the **x** and **y** position of the pointer *pointer* to the specified position. For the details of **setf***, see **C.4 Multiple-Value Setf**.

pointer-cursor *Generic Function*

pointer-cursor *pointer*

(setf pointer-cursor) *Generic Function*

(setf pointer-cursor) *cursor pointer*

Summary: A pointer object usually has a visible cursor associated with it. These functions return (or set) the cursor associated with the pointer *pointer*.

15.5 Pointer Tracking

tracking-pointer *Macro*

tracking-pointer (&optional *stream* **&key** *pointer multiple-window transformp context-type highlight***) &body** *body*

Summary: The **tracking-pointer** macro provides a general means for running code while following the position of a pointing device and monitoring for other input events. The programmer supplies code (the clauses in *body*) to be run upon the occurrence of any of the following types of events:

- Motion of the pointer.
- Motion of the pointer over a presentation.
- Clicking or releasing a pointer button.
- Clicking or releasing a pointer button while the pointer is over a presentation.
- Keyboard event (typing a character).

The *stream* argument is not evaluated, and must be a symbol that is bound to an input sheet or stream. If *stream* is **t**, ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

The *pointer* argument specifies a pointer to track. It defaults to the primary pointer for the sheet, (**port-pointer** *stream*).

When *multiple-window* is **t**, the pointer will be tracked across multiple windows; when **nil**, it will be tracked only in the window corresponding to *stream*.

When the boolean *transformp* is **t**, then the coordinates supplied to the **:pointer-motion** clause will be in the "user" coordinate system rather than in stream coordinates; that is, the medium's transformation will be applied to the coordinates.

context-type is used to specify the presentation type of presentations that will be "visible" to the tracking code for purposes of highlighting and for the **:presentation**, **:presentation-button-press**, and **:presentation-button-release** clauses. Supplying *context-type* is only useful when *sheet* is an output recording stream. *context-type* defaults to **t**, meaning that all presentations are visible.

When *highlight* is **t**, **tracking-pointer** will highlight applicable presentations as the pointer is positioned over them. *highlight* defaults to **t** when any of the **:presentation**, **:presentation-button-press**, or **:presentation-button-release** clauses is supplied; otherwise, it defaults to **nil**.

The body of **tracking-pointer** consists of a list of clauses. Each clause is of the form (*clause-keyword arglist . clause-body*) and defines a local function to be run upon occurrence of each type of event. The possible values for *clause-keyword* and the associated *arglist* are:

- **`:pointer-motion`** (**`&key`** *window x y*) Defines a clause to run whenever the pointer moves. In the clause, *window* is bound to the window in which the motion occurred, and *x* and *y* to the coordinates of the pointer. (See the keyword argument **`:transformp`** for a description of the coordinate system in which *x* and *y* are expressed.)

- **`:presentation`** (**`&key`** *presentation window x y*) Defines a clause to run whenever the pointer moves over a presentation of the desired type. (See the keyword argument **`:context-type`** for a description of how to specify the desired type.) In the clause, *presentation* is bound to the presentation, *window* to the window in which the motion occurred, and *x* and *y* to the coordinates of the pointer. (See the keyword argument **`:transformp`** for a description of the coordinate system in which *x* and *y* are expressed.)

When both **`:presentation`** and **`:pointer-motion`** clauses are provided, the two are mutually exclusive. The **`:presentation`** clause will run only if the pointer is over an applicable presentation; otherwise the **`:pointer-motion`** clause will run.

- **`:pointer-button-press`** (**`&key`** *event x y*) Defines a clause to run whenever a pointer button is pressed. In the clause, *event* is bound to the pointer button press event. (The window and the coordinates of the pointer are part of *event*.)

  x and *y* are the transformed **x** and **y** positions of the pointer. These will be different from **`pointer-event-x`** and **`pointer-event-y`** if the user transformation is not the identity transformation.

- **`:presentation-button-press`** (**`&key`** *presentation event x y*) Defines a clause to run whenever the pointer button is pressed while the pointer is over a presentation of the desired type. (See the keyword argument **`:context-type`** for a description of how to specify the desired type.) In the clause, *presentation* is bound to the presentation, and *event* to the pointer button press event. (The window and the stream coordinates of the pointer are part of *event*.) *x* and *y* are as for the **`:pointer-button-press`** clause.

When both **`:presentation-button-press`** and **`:pointer-button-press`** clauses are provided, the two clauses are mutually exclusive. The **`:presentation-button-press`** clause will run only if the pointer is over an applicable presentation; otherwise, the **`:pointer-button-press`** clause will run.

- **`:pointer-button-release`** (**`&key`** *event x y*) Defines a clause to run whenever a pointer button is released. In the clause, *event* is bound to the pointer button release event. (The window and the coordinates of the pointer are part of *event*.)

  x and *y* are the transformed **x** and **y** positions of the pointer. These will be different from **`pointer-event-x`** and **`pointer-event-y`** if the user transformation is not the identity transformation.

- **`:presentation-button-release`** (**`&key`** *presentation event x y*) Defines a clause to run whenever a pointer button is released while the pointer is over a presentation of the desired type. (See the keyword argument **`:context-type`** for a description of how to specify the desired type.) In the clause, *presentation* is bound to the presentation, and *event* to the pointer button release event. (The window and the stream coordinates of the pointer are part of *event*.) *x* and *y* are as for the **`:pointer-button-release`** clause.

When both **`:presentation-button-release`** and **`:pointer-button-release`** clauses are provided, the two clauses are mutually exclusive. The **`:presentation-button-release`** clause will run only if the pointer is over an applicable presentation; otherwise, the **`:pointer-button-release`** clause will run.

- **`:keyboard`** (**`&key`** *gesture*) Defines a clause to run whenever a character is typed on the keyboard. In the clause, *gesture* is bound to the keyboard gesture corresponding to the character typed.

Here is an example of **`tracking-pointer`**:

```
(in-package 'clim-user)

(define-application-frame test ()
  ()
  (:panes
   (main :application)))
```

```
(define-test-command (rubberband :menu t) ()
  (let ((x1 0);; x1, y1 represents the fix point
        (y1 0)
        (x2 0);; x2,y2 represents the point that is changing
        (y2 0)
        (mouse-button-press nil);; set to T when mouse button has
        ;; press to select pivot
        (stream (get-frame-pane *application-frame* 'main)))

(tracking-pointer
 (stream)
 (:pointer-button-press
  (event x y )
  (setf x1 x
        y1 y
        x2 x
        y2 y)
  (draw-rectangle* stream x1 y1 x2 y2
                   :ink +flipping-ink+ :filled nil)
  (setf mouse-button-press t))
 (:pointer-motion
  (window x y)
  (when mouse-button-press
    ;;erase
    (draw-rectangle* stream x1 y1 x2 y2
                     :ink +flipping-ink+ :filled nil)
    ;; draw
    (draw-rectangle* stream x1 y1 x y
                     :ink +flipping-ink+ :filled nil)
    (setf x2 x y2 y)))
 (:pointer-button-release (event x y )
                          (when mouse-button-press
                            (return (list x1 y1 x2 y2)))))))

(define-test-command (com-exit :menu "EXEUNT" :keystroke #-) ()
  (frame-exit *application-frame*))
```

drag-output-record *Generic Function*

drag-output-record *stream output-record* **&key** *repaint multiple-window erase feedback finish-on-release*

Summary: Enters an interaction mode in which the user moves the pointer and *output-record* "follows" the pointer by being dragged on the output recording stream *stream*. By default, the dragging is accomplished by erasing the output record from its previous position and redrawing at the new position. *output-record* remains in the output history of *stream* at its final position.

The returned values are the final **x** and **y** positions of the pointer, and the delta-x and delta-y position of the mouse with respect to the origin of the object at the time it was originally selected by the pointer.

The boolean *repaint* controls the appearance of the windows as the pointer is dragged. If *repaint* is **t** (the default), displayed contents of windows are not disturbed as the output record is dragged over them (that is, those regions of the screen are repainted). If it is **nil**, then no repainting is done as the output record is dragged.

erase identifies a function that will be called to erase the output record as it is dragged. It must be a function of two arguments, the output record to erase and the stream; it has dynamic extent. The default is **erase-output-record**.

feedback allows the programmer to identify a "feedback" function of seven arguments: the output record, the stream, the initial **x** and **y** position of the pointer, the current **x** and **y** position of the pointer, and a drawing argument (either **:erase** or **:draw**). It has dynamic extent. The default is **nil**, meaning that the feedback behavior will be for the output record to track the pointer. (The *feedback* argument is used when the programmer desires more complex feedback behavior, such as drawing a "rubber band" line as the user moves the mouse.) Note that if *feedback* is supplied, *erase* is ignored.

If the boolean *finish-on-release* is **nil** (the default), **drag-output-record** is exited when the user presses a pointer button. When it is **t**, **drag-output-record** is exited when the user releases the pointer button currently being held down.

dragging-output *Macro*

dragging-output (&optional *stream* **&key** *repaint multiple-window finish-on-release***) &body** *body*

Summary: This macro is used by functions that want to move output records in an interactive fashion in a CLIM window. The body of the macro invocation contains code to draw a CLIM graphic. The resulting graphic tracks mouse motion in the window until the mouse button is pressed (or released, depending on the options).

body is evaluated inside of **with-output-to-output-record** to produce an output record for the stream *stream*, and then invokes **drag-output-record** on the record in order to drag the output. The output record is not inserted into *stream*'s output history.

The returned values are the final **x** and **y** positions of the pointer, and the delta-x and delta-y position of the mouse with respect to the origin of the object at the time it was originally selected by the pointer.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream stream. If *stream* is **t** (the default), ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

repaint and *finish-on-release* are as for **drag-output-record**.

pointer-place-rubber-band-line* *Function*

pointer-place-rubber-band-line* &key *start-x start-y stream pointer multiple-window finish-on-release*

Summary: This function is used to place a rubber-band line. The input is the end points of a rubber-band line on the stream **stream** (which defaults to ***standard-input***) via the pointer **pointer**.

If **start-x** and **start-y** are provided, the start point of the line is at (**start-x,start-y**). Otherwise, the start point of the line is selected by pressing a button on the pointer.

The *pointer* argument specifies a pointer from which to take input. It defaults to (**port-pointer** *stream*).

When the boolean **multiple-window** argument is **t**, input can be taken from a window other than the default window. However, input cannot be taken from more than one window at the same time. For instance, you cannot press the pointer button in one window to begin the line and release it in another window to indicate the end point of the line; the press and release must happen in the same window.

When the boolean *finish-on-release* is **t**, **pointer-place-rubber-band-line*** is exited when the user releases the pointer button currently being held down. When it is **nil**, **pointer-place-rubber-band-line*** is exited when the user presses a pointer button.

pointer-place-rubber-band-line* returns five values: the start X and Y of the line, the end X and Y of the line, and the window on which the line was drawn. The final value is useful only when **multiple-window** is **t**.

pointer-input-rectangle* *Function*

pointer-input-rectangle* &key *left top right bottom stream pointer multiple-window finish-on-release*

Summary: This function is used to input a rectangle via the pointer **pointer**. The input is the corners of a rectangle on the stream **stream**, which defaults to ***standard-input***.

If **left** and **top** are provided, the upper left corner of the rectangle will be placed at (**left,top**). If **right** and **bottom** are provided, the lower right corner of the rectangle will be placed at (**right,bottom**). Otherwise, the upper left corner of the rectangle is selected by pressing a button on the pointer.

pointer, *multiple-window*, and *finish-on-release* are as for **pointer-place-rubber-band-line***.

pointer-input-rectangle* returns five values: the left, top, right, and bottom corners of the rectangle, and the window on which the rectangle was drawn. The final value is useful only when **multiple-window** is true.

pointer-input-rectangle *Function*

pointer-input-rectangle &rest *options* **&key** *rectangle stream pointer multiple-window finish-on-release* **&allow-other-keys**

pointer-input-rectangle is exactly like **pointer-input-rectangle*** except that it takes as input and returns a rectangle object.

16 Input Editing and Completion Facilities

16.1 Input Editing

An input editing stream "encapsulates" an interactive stream. That is, most operations are handled by the encapsulated interactive stream, but some operations are handled directly by the input editing stream itself. (See **Appendix D: Common Lisp Streams** for a discussion of encapsulating streams.)

An input editing stream has the following components:

- The encapsulated interactive stream.
- A buffer with a fill pointer, which we shall refer to as *fp*. The buffer contains all of the user's input, and *fp* is the length of that input.
- An insertion pointer, which we shall refer to as *ip*. The insertion pointer is the point in the buffer at which the "editing cursor" is.
- A scan pointer, which we shall refer to as *sp*. The scan pointer is the point in the buffer from which CLIM will get the next input gesture object (in the sense of **`read-gesture`**).
- A "rescan queued" flag, indicating that the programmer (or CLIM) requested that a "rescan" operation should take place before the next gesture is read from the user.
- A "rescan in progress" flag, indicating that CLIM is rescanning the user's input, rather than reading freshly supplied gestures from the user.

The input editor reads either "real" gestures from the user (such as characters from the keyboard or pointer button events) or input editing commands, which can modify the state of the input buffer. When they do so, the input buffer must be "rescanned"; that is, the scan pointer *sp* must be reset to its original state, and the contents of the input editor buffer must be reparsed before any other gestures from the user are read. While this rescanning operation is taking place, the "rescan in progress" flag is set to **`t`**. The relationship *sp* ≤ *ip* ≤ *fp* always holds.

The overall control structure of the input editor is:

```
(catch 'rescan                                ;thrown to when a rescan is invoked
  (reset-scan-pointer stream)               ;sets STREAM-RESCANNING-P to T
  (loop
   (funcall continuation stream)))
```

where *stream* is the input editing stream and *continuation* is the code supplied by the programmer, which typically contains calls to such functions as **`accept`** and **`read-token`** (which will eventually call **`stream-read-gesture`**). When a rescan operation is invoked, it throws to the **`rescan`** tag in the previous example. The loop is terminated when an activation gesture is seen, and at that point the values produced by *continuation* are returned as values from the input editor.

The important point is that functions such as **`accept`**, **`read-gesture`**, and **`unread-gesture`** read (or restore) the next gesture object from the buffer at the position pointed to by the scan pointer *sp*. However, insertion and input editing commands take place at the position pointed to by *ip*. The purpose of the rescanning operation is to ensure that all the input gestures issued by the user (typed characters, pointer button presses, and so forth) have been read by CLIM. During input editing, the input editor maintains some sort of visible cursor to remind the user of the position of *ip*.

The overall structure of **`stream-read-gesture`** on an input editing stream is:

```
(progn
  (rescan-if-necessary stream)
  (loop
   ;; If SP is less than FP
   ;;        Then get the next gesture from the input editor buffer at SP
   ;;        and increment SP
   ;;        Else read the next gesture from the encapsulated stream
   ;;        and insert it into the buffer at IP
   ;; Set the "rescan in progress" flag to false
   ;; Call STREAM-PROCESS-GESTURE on the gesture
   ;;        If it was a "real" gesture
   ;;        Then exit with the gesture as the result
   ;;        Else it was an input editing command (which has already been
   ;;        processed), so continue looping
   ))
```

A new gesture object is inserted into the input editor buffer at the insertion pointer *ip*. If *ip* = *fp*, this is accomplished by a **`vector-push-extend`**-like operation on the input buffer and *fp*, and then incrementing *ip*. If *ip* < *fp*, CLIM must first "make room" for the new gesture in the input buffer, then insert the gesture at *ip*, and finally increment both *ip* and *fp*.

When the user requests an input editor motion command, only the insertion pointer *ip* is affected. Motion commands do not need to request a rescan operation.

When the user requests an input editor deletion command, the sequence of gesture objects at *ip* is removed, and *ip* and *fp* must be modified to reflect the new state of the input buffer. Deletion commands (and other commands that modify the input buffer) must call **`immediate-rescan`** when they are done modifying the buffer.

CLIM is free to put special objects in the input editor buffer, such as "noise strings" and "accept results." A "noise string" is used to represent some sort of in-line prompt and is never seen as input; the **`prompt-for-accept`** method may insert a noise string into the input buffer. An "accept result" is an object in the input buffer that is used to represent some object that was inserted into the input buffer (typically via a pointer gesture) that has no readable representation (in the Lisp sense); **`presentation-replace-input`** may create accept results. Noise strings are skipped over by input editing commands, and accept results are treated as a single gesture.

See **16.7 Advanced Topics** for an in-depth discussion of the input editing stream protocol.

16.1.1 Operators for Input Editing

interactive-stream-p *Generic Function*

`interactive-stream-p` *object*

Summary: Returns **`t`** if *object* is an interactive stream, that is, a bidirectional stream intended for user interactions. Otherwise it returns **`nil`**. This is exactly the same function as in X3J13 Common Lisp, except that in CLIM it is a generic function.

The input editor is only fully implemented for interactive streams.

input-editing-stream *Protocol Class*

Summary: The protocol class that corresponds to an input editing stream. If you want to create a new class that behaves like an input editing stream, it should be a subclass of **`input-editing-stream`**. Subclasses of **`input-editing-stream`** must obey the input editing stream protocol.

input-editing-stream-p *Function*

`input-editing-stream-p` *object*

Summary: Returns **`t`** if *object* is an input editing stream (that is, a stream of the sort created by a call to

with-input-editing), otherwise returns **nil**.

standard-input-editing-stream *Class*

Summary: The class that implements CLIM's standard input editor. This is the class of stream created by calling **with-input-editing**.

Members of this class are mutable.

with-input-editing *Macro*

with-input-editing (&optional *stream* **&key** *input-sensitizer initial-contents***) &body** *body*

Summary: Establishes a context in which the user can edit the input typed in on the interactive stream *stream*. *body* is then executed in this context, and the values returned by *body* are returned as the values of **with-input-editing**. *body* may have zero or more declarations as its first forms.

The *stream* argument is not evaluated, and must be a symbol that is bound to an input stream. If *stream* is **t** (the default), ***query-io*** is used. If *stream* is a stream that is not an interactive stream, then **with-input-editing** is equivalent to **progn**.

input-sensitizer, if supplied, is a function of two arguments, a stream and a continuation function; the function has dynamic extent. The continuation, supplied by CLIM, is responsible for displaying output corresponding to the user's input on the stream. The *input-sensitizer* function will typically call **with-output-as-presentation** in order to make the output produced by the continuation sensitive.

If *initial-contents* is supplied, it must be either a string or a list of two elements, an object and a presentation type. If it is a string, it will be inserted into the input buffer using **replace-input**. If it is a list, the printed representation of the object will be inserted into the input buffer using **presentation-replace-input**.

with-input-editor-typeout *Macro*

with-input-editor-typeout (&optional *stream***) &body** *body*

Summary: Establishes a context inside of **with-input-editing** in which output can be done by *body* to the input editing stream *stream*. **with-input-editor-typeout** should call **fresh-line** before and after evaluating the body. *body* may have zero or more declarations as its first forms.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***query-io*** is used. If *stream* is a stream that is not an input editing stream, then **with-input-editor-typeout** is equivalent to calling **fresh-line**, evaluating the body, and then calling **fresh-line** again.

16.1.2 Input Editor Commands

Keyboard input to **accept** can be edited until an activation keystroke is typed to terminate it. If the input cannot be parsed after an activation keystroke is entered, it must be edited and re-activated. The input editor has several keystroke commands, as listed in **Input Editor Keystroke Commands** . Prefix numeric arguments to input editor commands can be entered using digits and the minus sign (-) with **CONTROL** and **META** (as in Emacs).

The function **:add-input-editor-command** can be used to bind one or more keys to an input editor command. Any keystroke can be an input editor command, but by convention only keystrokes that do not correspond to graphic characters should be used.

Input Editor Keystroke Commands

Command	Keystroke	Command	Keystroke
Forward character	**C-f**	Delete previous character	**Rubout**
Forward word	**M-f**	Delete previous word	**M-Rubout**
Backward character	**C-b**	Kill to end of line	**C-k**
Backward word	**M-b**	Clear input buffer	LispWorks: **C-backspace** Liquid CL: **C-M-delete**
Beginning of line	**C-a**	Insert new line	**C-o**
End of line	**C-e**	Transpose adjacent characters	**C-t**
Next line	**C-n**	Transpose adjacent words	**M-t**
Previous line	**C-p**	Yank from kill ring	**C-y**
Beginning of buffer	**M-<**	Yank from presentation history	**C-M-y**
End of buffer	**M->**	Yank next item	**M-y**
Delete next character	**C-d**	Scroll output history forward	**C-v**
Delete next word	**M-d**	Scroll output history backward	**M-v**

The input also supports "numeric arguments" (such as **C-0**, **C-1**, **M-0**, etc.) that modify the behavior of the input editing commands. For instance, the motion and deletion commands will be repeated as many times as specified by the numeric argument. Furthermore, the accumulated numeric argument will be passed to the command processor in such a way that **substitute-numerical-marker** can be used to insert the numeric argument into a command that was read via a keystroke accelerator.

16.2 Activation and Delimiter Gestures

Activation gestures terminate an input "sentence," such as a command or anything else being read by **accept**. When an activation gesture is entered by the user, CLIM will cease reading input and "execute" the input that has been entered.

Delimiter gestures terminate an input "word," such as a recursive call to **accept**.

activation-gestures *Variable*

Summary: The set of currently active activation gestures. The global value of this is **nil**. The exact format of ***activation-gestures*** is unspecified. ***activation-gestures*** and the elements in it may have dynamic extent.

standard-activation-gestures *Variable*

Summary: The default set of activation gestures. The exact set of standard activation is unspecified; it includes the gesture corresponding to the **#\Newline** character.

with-activation-gestures *Macro*

with-activation-gestures (*gestures* **&key** *override***) &body** *body*

Summary: Specifies a list of gestures that terminate input during the execution of *body*. *body* may have zero or more declarations as its first forms. *gestures* must be either a single gesture name or a form that evaluates to a list of gesture names.

If the boolean *override* is **t**, then *gestures* will override the current activation gestures. If it is **nil** (the default), then *gestures* will be added to the existing set of activation gestures. **with-activation-gestures** must bind ***activation-gestures*** to the new set of activation gestures.

See also the **:activation-gestures** and **:additional-activation-gestures** options to **accept**.

activation-gesture-p *Function*

activation-gesture-p *gesture*

Summary: Returns **t** if the gesture object *gesture* is an activation gesture; otherwise, it returns **nil**.

delimiter-gestures *Variable*

Summary: The set of currently active delimiter gestures. The global value of this is **nil**. The exact format of ***delimiter-gestures*** is unspecified. ***delimiter-gestures*** and the elements in it may have dynamic extent.

with-delimiter-gestures *Macro*

with-delimiter-gestures (*gestures* **&key** *override***) &body** *body*

Summary: Specifies a list of gestures that terminate an individual token, but not the entire input, during the execution of *body*. *body* may have zero or more declarations as its first forms. *gestures* must be either a single gesture name or a form that evaluates to a list of gesture names.

If the boolean *override* is **t**, then *gestures* will override the current delimiter gestures. If it is **nil** (the default), then *gestures* will be added to the existing set of delimiter gestures. **with-delimiter-gestures** must bind ***delimiter-gestures*** to the new set of delimiter gestures.

See also the **:delimiter-gestures** and **:additional-delimiter-gestures** options to **accept**.

delimiter-gesture-p *Function*

delimiter-gesture-p *gesture*

Summary: Returns **t** if the gesture object *gesture* is a delimiter gesture; otherwise, it returns **nil**.

16.3 Signalling Errors Inside accept Methods

Sometimes an **accept** method may wish to signal an error while it is parsing the user's input, or a nested call to **accept** may signal such an error itself. The following functions and conditions may be used:

parse-error *Condition Class*

Summary: The error that is signaled by **parse-error**. This is a subclass of **error.**

parse-error *Function*

parse-error *format-string* **&rest** *format-arguments*

Summary: Reports an error while parsing an input token. Does not return. *format-string* and *format-arguments* are as for the Common Lisp function **format**.

simple-parse-error *Condition Class*

Summary: The error that is signaled by **simple-parse-error**. This is a subclass of **parse-error.**

simple-parse-error *Function*

`simple-parse-error` *format-string* **`&rest`** *format-arguments*

Summary: Signals a **`simple-parse-error`** when CLIM does not know how to parse some sort of user input while inside **`accept`**. Does not return. *format-string* and *format-arguments* are as for the Common Lisp function **`format`**.

input-not-of-required-type *Condition Class*

`input-not-of-required-type` *object type*

Summary: This condition is signalled by **`input-not-of-required-type`**. This is a subclass of **`parse-error.`**

input-not-of-required-type *Function*

`input-not-of-required-type` *object type*

Summary: Reports that input does not satisfy the specified type by signalling an **`input-not-of-required-type`** error. *object* is a parsed object or an unparsed token (a string). *type* is a presentation type specifier. Does not return.

16.4 Reading and Writing Tokens

Sometimes after an **`accept`** method has read some input from the user, it may be necessary to insert a modified version of that input back into the input buffer. The following two functions can be used to modify the input buffer:

replace-input *Generic Function*

`replace-input` *stream new-input* **`&key`** *start end buffer-start rescan*

Summary: Replaces the part of the input editing stream *stream*'s input buffer that extends from *buffer-start* to its scan pointer with the string *new-input*. *buffer-start* defaults to the current input position of stream. *start* and *end* can be supplied to specify a subsequence of *new-input*; *start* defaults to 0 and *end* defaults to the length of *new-input*.

`replace-input` queues a rescan by calling **`queue-rescan`** if the new input does not match the old output, or if *rescan* is **`t`**.

The returned value is the position in the input buffer.

presentation-replace-input *Generic Function*

`presentation-replace-input` *stream object type view* **`&key`** *buffer-start rescan query-identifier for-context-type*

Summary: Like **`replace-input`**, except that the new input to insert into the input buffer is obtained by presenting the object *object* with the presentation type *type* and view *view*. *buffer-start* and *rescan* are as for **`replace-input`**, *query-identifier* is as for **`accept`**, and *for-context-type* is as for **`present`**.

If the object does not have a readable representation (in the Lisp sense), **`presentation-replace-input`** may create an "accept result" to represent the object and insert it into the input buffer. For the purposes of input editing, "accept results" must be treated as a single input gesture.

The following two functions are used to read or write a token (that is, a string):

read-token *Function*

`read-token` *stream* **`&key`** *input-wait-handler pointer-button-press-handler click-only*

Summary: Reads characters from the interactive steam *stream* until it encounters a delimiter, activation, or pointer gesture. Returns the accumulated string that was delimited by the delimiter or activation gesture, leaving the delimiter unread.

If the first character of typed input is a quotation mark (**#\"**), then **read-token** will ignore delimiter gestures until another quotation mark is seen. When the closing quotation mark is seen, **read-token** will proceed as discussed previously.

If the boolean *click-only* is **t**, then no keyboard input is allowed. In that case, **read-token** will simply ignore any typed characters.

input-wait-handler and *pointer-button-press-handler* are as for **stream-read-gesture**. Refer to **15.2.1 The Extended Input Stream Protocol** for details.

write-token

Function

write-token *token stream* **&key** *acceptably*

Summary: **write-token** is the opposite of **read-token**; given the string *token*, it writes it to the interactive stream *stream*. If *acceptably* is **t** and there are any characters in the token that are delimiter gestures (see **with-delimiter-gestures**), then **write-token** will surround the token with quotation marks (**#\"**).

Typically, present methods will use **write-token** instead of **write-string**.

16.5 Completion

CLIM provides a ***completion*** facility that completes a string provided by a user against some set of possible completions (which are themselves strings). Each completion is associated with some Lisp object. CLIM provides "chunkwise" completion; that is, if the user input consists of several tokens separated by "partial delimiters," CLIM completes each token separately against the set of possibilities.

completion-gestures

Variable

Summary: A list of the gesture names that cause **complete-input** to complete the user's input as fully as possible. The exact global contents of this list is unspecified; it includes the **:complete** gesture name. ***completion-gestures*** is bound to **(:complete)**.

help-gestures

Variable

Summary: A list of the gesture names that cause **accept** and **complete-input** to display a (possibly input context-sensitive) help message, and for some presentation types a list of possibilities as well. The exact global contents of this list is unspecified; it includes the **:help** gesture name. ***help-gestures*** is bound to **(:help)** in LispWorks CLIM and **#\Meta-?** in Liquid CL CLIM.

possibilities-gestures

Variable

Summary: A list of the gesture names that cause **complete-input** to display a (possibly input context-sensitive) help message and a list of possibilities. The exact global contents of this list is unspecified; it includes the **:possibilities** gesture name. ***possibilities-gestures*** is bound to **(:possibilities)**.

complete-input

Function

complete-input *stream function* **&key** *partial-completers allow-any-input possibility-printer* **(***help-displays-possibilities* **t)**

Summary: Reads input from the user from the input editing stream *stream*, completing over a set of possibilities. **complete-input** only works on input editing streams.

function is a function of two arguments. It is called to generate the completion possibilities that match the user's input; it has dynamic extent. Usually, programmers will pass a function which calls either **complete-from-possibilities** or **complete-from-generator** as the value of *function*. Its first argument is a string containing the user's input "so far." Its second argument is the completion mode, one of the following:

- **:complete-limited**—the function completes the input up to the next partial delimiter. This is the mode used when the user types a partial completer.
- **:complete-maximal**—the function completes the input as much as possible. This is the mode used when the user issues a gesture that matches any of the gesture names in ***completion-gestures***.
- **:complete**—the function completes the input as much as possible, except that if the user's input exactly matches one of the possibilities, even if it is a left substring of another possibility, the shorter possibility is returned as the result. This is the mode used when the user issues a delimiter or activation gesture that is not a partial completer.
- **:possibilities**—the function returns an alist of the possible completions as its fifth value. This is the mode used when the user a gesture that matches any of the gesture names in ***possibilities-gestures*** or ***help-gestures*** (if *help-displays-possibilities* is **t**).

function returns five values:

- *string*—the completed input string.
- *success*—**t** if completion was successful, otherwise **nil**.
- *object*—the object corresponding to the completion, otherwise **nil**.
- *nmatches*—the number of possible completions of the input.
- *possibilities*—a newly-created alist of completions (lists of a string and an object), returned only when the completion mode is **:possibilities**.

complete-input returns three values: *object*, *success*, and *string*. In addition, the printed representation of the completed input will be inserted into the input buffer of *stream* in place of the user-supplied string by calling **replace-input**.

partial-completers is a list of characters that delimit portions of a name that can be completed separately. The default is an empty list.

If the boolean *allow-any-input* is **t**, then **complete-input** returns as soon as the user issues an activation gesture, even if the input is not any of the possibilities. If the input is not one of the possibilities, the three values returned by **complete-input** will be **nil**, **t**, and the string. The default for *allow-any-input* is **nil**.

If *possibility-printer* is supplied, it must be a function of three arguments, a possibility, a presentation type, and a stream; it has dynamic extent and displays the possibility on the stream. The possibility will be a list of two elements, the first being a string and the second being the object corresponding to the string.

If *help-display-possibilities* is **t** (the default), then when the user issues a help gesture (a gesture that matches one of the gesture names in ***help-gestures***), CLIM will display all the matching possibilities. If it is **nil**, then CLIM will not display the possibilities unless the user issues a possibility gesture (a gesture that matches one of the gesture names in ***possibilities-gestures***).

Here is an example:

```
(defvar *my-possibilities* '(("Raspberry" :rasp)
                             ("Strawberry" :straw)
                             ("Blueberry" :blue)))
(flet ((possibilities-generator (string-so-far mode)
         (complete-from-possibilities string-so-far
                                      *my-possibilities*
                                      nil
                                      :action mode)))
  (complete-input stream #'possibilities-generator))
```

complete-from-generator *Function*

complete-from-generator *string generator delimiters* **&key (***action* **:***complete***)** *predicate*

Summary: Given an input string *string* and a list of delimiter characters *delimiters* that act as partial completion characters, **complete-from-generator** completes against possibilities that are generated by the function *generator*. *generator* is a function of two arguments, the string *string* and another function that it calls in order to process the possibility; it has dynamic extent.

action will be one of **:complete**, **:complete-maximal**, **:complete-limited**, or **:possibilities**. These are described under the function **complete-input**.

predicate is a function of one argument, an object. If the predicate returns **t**, the possibility corresponding to the object is processed. It has dynamic extent.

complete-from-generator returns five values, the completed input string, the success value (**t** if the completion was successful, otherwise **nil**), the object matching the completion (or **nil** if unsuccessful), the number of matches, and a list of possible completions if *action* was **:possibilities**.

A caller of this function will typically be passed as the second argument to **complete-input**.

complete-from-possibilities *Function*

complete-from-possibilities *string completions delimiters* **&key (***action* **:***complete***)** *predicate name-key value-key*

Summary: Given an input string *string* and a list of delimiter characters *delimiters* that act as partial completion characters, **complete-from-possibilities** completes against the possibilities in the sequence *completions*. The completion string is extracted from the possibilities by applying *name-key*, which is a function of one argument. The object is extracted by applying *value-key*, which is a function of one argument. *name-key* defaults to **first**, and *value-key* defaults to **second**.

action will be one of **:complete**, **:complete-maximal**, **:complete-limited**, or **:possibilities**. These are described under the function **complete-input**.

predicate must be a function of one argument, an object. If the predicate returns **t**, the possibility corresponding to the object is processed, otherwise it is not.

predicate, *name-key*, and *value-key* have dynamic extent.

complete-from-possibilities returns five values, the completed input string, the success value (**t** if the completion was successful, **nil** otherwise), the object matching the completion (or **nil** if unsuccessful), the number of matches, and a list of possible completions if *action* was **:possibilities**.

A caller of this function will typically be passed as the second argument to **complete-input**.

completing-from-suggestions *Macro*

completing-from-suggestions (*stream* **&key** *partial-completers allow-any-input possibility-printer***) &body** *body*

Summary: Reads input from input editing stream *stream*, completing over a set of possibilities generated by calls to **suggest** in *body*. Returns *object*, *success*, and *string*.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***query-io*** is used.

See **complete-input** for *partial-completers*, *allow-any-input*, and *possibility-printer*.

For example:

```
(completing-from-suggestions (stream)
                             (map nil
                                  #'(lambda (x)
                                      (suggest
                                        (car x) (cdr x)))
                                  '(("One" . 1)
                                    ("Two" . 2)
                                    ("Three" . 3))))
```

suggest *Function*

suggest *completion object*

Summary: Specifies one possibility for **completing-from-suggestions**. *completion* is a string, the printed representation. *object* is the internal representation.

This function has lexical scope and is defined only within the body of **completing-from-suggestions**.

accept generates help messages based on the name of the presentation type, but sometimes this is not enough. Use **with-accept-help** to create more complex help messages.

with-accept-help *Macro*

with-accept-help *options* **&body** *body*

Summary: Binds the dynamic environment to control the documentation produced by help and possibilities gestures during user input in calls to **accept** with the dynamic scope of *body*. *body* may have zero or more declarations as its first forms.

options is a list of option specifications. Each specification is itself a list of the form (*help-option help-string*). *help-option* is either a symbol that is a *help-type* or a list of the form (*help-type mode-flag*). *help-type* must be one of:

- **:top-level-help**—specifies that *help-string* be used instead of the default help documentation provided by **accept**.
- **:subhelp**—specifies that *help-string* be used in addition to the default help documentation provided by **accept**.

mode-flag must be one of:

- **:append**—specifies that the current help string be appended to any previous help strings of the same help type. This is the default mode.
- **:override**—specifies that the current help string is the help for this help type; no lower-level calls to **with-accept-help** can override this. (**:override** works from the outside in.)
- **:establish-unless-overridden**—specifies that the current help string be the help for this help type unless a higher-level call to **with-accept-help** has already established a help string for this help type in the **:override** mode. This is what **accept** uses to establish the default help.

help-string is a string or a function that returns a string. If it is a function, it receives three arguments, the stream, an action (either **:help** or **:possibilities**) and the help string generated so far.

None of the arguments are evaluated.

16.6 Using with-accept-help: some examples

```
(clim:with-accept-help
    ((:subhelp "This is a test."))
  (clim:accept 'pathname))

[ACCEPT does this] ==>  You are being asked to enter a pathname.
[done via :SUBHELP]     This is a test.

(clim:with-accept-help ((:top-level-help "This is a test."))
  (clim:accept 'pathname))

[done via :TOP-LEVEL-HELP] ==> This is a test.

(clim:with-accept-help (((:subhelp :override) "This is a test."))
  (clim:accept 'pathname))

[ACCEPT does this]   ==> You are being asked to enter a pathname.
[done via :SUBHELP]      This is a test.

(clim:define-presentation-type test ())

(clim:define-presentation-method clim:accept
    ((type test) stream view &key)
  (values (clim:with-accept-help
              ((:subhelp "A test is made up of three things:"))
            (clim:completing-from-suggestions (...) ...))))

(clim:accept 'test)
==> You are being asked to enter a test.
    A test is made up of three things:
```

16.7 Advanced Topics

The material in this section is advanced; most CLIM programmers can skip to the next chapter. This section discusses the Input Editing Stream Protocol.

Input editing streams obey both the extended input and extended output stream protocols, and must support the generic functions that comprise those protocols. For the most part, this simply entails "trampolining" those operations to the encapsulated interactive stream. However, such generic functions as **`stream-read-gesture`** and **`stream-unread-gesture`** will need methods that observe the use of the input editor's scan pointer.

Input editing streams implement methods for **`prompt-for-accept`** (in order to provide in-line prompting that interacts correctly with input editing) and **`stream-accept`** (in order to cause **`accept`** to obey the scan pointer).

The following generic functions comprise the remainder of the input editing protocol, and must be implemented for all classes that inherit from **`input-editing-stream`**.

stream-input-buffer *Generic Function*

`stream-input-buffer (`*stream input-editing-stream***`)`**

Summary: Returns the input buffer (that is, the string being edited) associated with the input editing stream *stream*. This must be an unspecialized vector with a fill pointer. The fill pointer of the vector points past the last gesture object in the buffer. This buffer is affected during input editing. The effects of modifying the input buffer other than by the specified API (such as **`replace-input`**) are unspecified.

stream-insertion-pointer *Generic Function*

`stream-insertion-pointer` *stream*

Summary: Returns an integer corresponding to the current input position in the input editing stream *stream*'s buffer, that is, the point in the buffer at which the next user input gesture will be inserted. The insertion pointer will always be less than or equal to **`(fill-pointer (stream-input-buffer`** *stream***`))`**. The insertion pointer can also be thought of as an editing cursor.

(setf stream-insertion-pointer) *Generic Function*

`(setf stream-insertion-pointer)` *pointer stream*

Summary: Changes the input position of the input editing stream *stream* to *pointer*, an integer less than or equal to **`(fill-pointer (stream-input-buffer`** *stream***`))`**.

stream-scan-pointer *Generic Function*

`stream-scan-pointer` *stream*

Summary: Returns an integer corresponding to the current scan pointer in the input editing stream *stream*'s buffer, that is, the point in the buffer at which calls to **`accept`** have stopped parsing input. The scan pointer will always be less than or equal to **`(stream-insertion-pointer`** *stream***`)`**.

(setf stream-scan-pointer) *Generic Function*

`(setf stream-scan-pointer)` *pointer stream*

Summary: Changes the scan pointer of the input editing stream *stream* to *pointer*, an integer less than or equal to **`(stream-insertion-pointer`** *stream***`)`**.

stream-rescanning-p *Generic Function*

`stream-rescanning-p` *stream*

Summary: Returns the state of the input editing stream *stream*'s "rescan in progress" flag, which is **`t`** if *stream* is performing a rescan operation, but otherwise **`nil`**. All extended input streams must implement a method for this, but non -input editing streams will always returns **`nil`**.

reset-scan-pointer *Generic Function*

`reset-scan-pointer` *stream* **`&optional (`***scan-pointer* **`0)`**

Summary: Sets the input editing stream *stream*'s scan pointer to *scan-pointer*, and sets the state of **`stream-rescanning-p`** to **`t`**.

immediate-rescan *Generic Function*

`immediate-rescan` *stream*

Summary: Invokes a rescan operation immediately by "throwing" out to the most recent invocation of **`with-input-editing`**.

queue-rescan *Generic Function*

`queue-rescan` *stream*

Summary: Sets the "rescan queued" flag to **`t`**, meaning that the input editing stream *stream* should be rescanned after the next non-input editing gesture is read.

rescan-if-necessary *Generic Function*

`rescan-if-necessary` *stream*

Summary: Invokes a rescan operation on the input editing stream *stream* if **`queue-rescan`** was called on the same stream and no intervening rescan operation has taken place. Resets the state of the "rescan queued" flag to **`nil`**.

erase-input-buffer *Generic Function*

`erase-input-buffer` *stream* **`&optional (`***start-position* **`0)`**

Summary: Erases the part of the display that corresponds to the input editor's buffer, starting at the position *start-position*.

redraw-input-buffer *Generic Function*

`redraw-input-buffer` *stream* **`&optional (`***start-position* **`0)`**

Summary: Displays the input editor's buffer starting at the position *start-position* on the interactive stream that is encapsulated by the input editing stream *stream*.

stream-process-gesture *Generic Function*

`stream-process-gesture` *stream gesture type*

Summary: If *gesture* is an input editing command, **`stream-process-gesture`** performs the input editing operation on the input editing stream *stream* and returns **`nil`**. Otherwise, it returns the two values *gesture* and *type*.

stream-read-gesture *Generic Function*

`stream-read-gesture (`*stream standard-input-editing-stream***`) &allow-other-keys`**

Summary: Reads and returns a gesture from the user on the input editing stream *stream*.

The **`stream-read-gesture`** method calls **`stream-process-gesture`**, which will either return a "real" gesture (such as a typed character, a pointer gesture, or a timeout) or **`nil`** (indicating that some sort of input editing operation was performed). **`stream-read-gesture`** only returns when a real gesture has been read; if an input editing operation was performed, **`stream-read-gesture`** will loop until a "real" gesture is typed by the user.

stream-unread-gesture *Generic Function*

`stream-unread-gesture (`*stream standard-input-editing-stream***`)`** *gesture*

Summary: Inserts the gesture *gesture* back into the input editor's buffer, maintaining the scan pointer.

17 Formatted Output

17.1 Formatting Tables in CLIM

17.1.1 Conceptual Overview of Formatting Tables

CLIM makes it easy to construct tabular output. The usual way of making tables is by indicating what you want to put in the table and letting CLIM choose the placement of the row and column cells. CLIM also allows you to specify constraints on the placement of the table elements with some flexibility.

In the CLIM model of formatting tables, each cell of the table is handled separately:

- The code for a cell draws to a stream that has a "private" (local to that cell) drawing plane. The code puts ink on the drawing plane, in the form of text, graphics, or both.
- After output for a cell has finished, the bounding rectangle of all output on the "private" drawing plane is found. The region within that bounding rectangle forms the contents of a cell.
- Additional rectangular regions, containing only background ink, are attached to the edges of the cell contents. These regions ensure that the cells satisfy the tabular constraints that within a row all cells have the same height, and within a column all cells have the same width. CLIM may also introduce additional background for other purposes.
- The cells are assembled into rows and columns.

You are responsible only for specifying the contents of the cell. CLIM's table formatter will figure out how to lay out the table so that all the cells fit together properly. It derives the width of each column from the the widest cell within the column, and the height of each row from the the tallest cell within the row.

All the cells in a row have the same height. All the cells in a column have the same width. The contents of the cells can be of irregular shapes and sizes. You can impose both vertical and horizontal constraints on the objects within the cell, aligning them vertically at the top, bottom, or center of the cell, and horizontally at the left, right, or center of the cell.

Some tables are "multiple column" tables, in which two or more rows of the table are placed side by side (usually with intervening spacing) rather than all rows being aligned vertically. Multiple column tables are generally used to produce a table that is more esthetically pleasing, or to make more efficient use of space on the output device. When a table is a multiple column table, one additional step takes place in the formatting of the table: the rows of the table are rearranged into multiple columns in which some rows are placed side by side.

The programmer can give CLIM the following advice about assembling the table:

- How to place the contents of the cell within the cell (such as centered vertically, flush-left, and so forth). The possibilities for this advice are described later.
- Optionally, how much additional space to insert between columns and between rows of the table.
- Optionally, whether to make all columns the same size.

You can specify other constraints that affect the appearance of the table, such as the width or length of the table.

Note that table formatting is inherently two-dimensional from the point of view of the application. Item list formatting is inherently one-dimensional output that is presented two-dimensionally. The canonical example is a menu, where the programmer specifies a list of items to be presented. If the list is small enough, a single column or row of menu entries suffices. In this case, formatting is done when viewport requirements make it desirable.

These constraints affect the appearance of item lists:

- The number of rows (that is, allowing CLIM to choose the number of columns).
- The number of columns (that is, allowing CLIM to choose the number of rows).
- The maximum height (or width) of the column (that is, letting CLIM determine the number of rows and columns that satisfy that constraint).

See **17.5 Advanced Topics** for the table and item list formatting protocols.

17.1.2 CLIM Operators for Formatting Tables

This subsection covers the general-purpose table formatting operators.

formatting-table *Macro*

`formatting-table (&optional` *stream* **`&key`** *x-spacing y-spacing multiple-columns multiple-columns-x-spacing equalize-column-widths* **`(`***move-cursor* **`t)`** *record-type***`) &body`** *body*

Summary: Binds the local environment in such a way the output of *body* will be done in a tabular format. This must be used in conjunction with **`formatting-row`** or **`formatting-column`**, and **`formatting-cell`**. The table is placed so that its upper left corner is at the current text cursor position of *stream*. If the boolean *move-cursor* is **`t`** (the default), then the text cursor will be moved so that it immediately follows the last cell of the table.

The returned value is the output record corresponding to the table.

stream is an output recording stream to which output will be done. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **`t`** (the default), **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

x-spacing specifies the number of units of spacing to be inserted between columns of the table; the default is the width of a space character in the current text style. *y-spacing* specifies the number of units of spacing to be inserted between rows in the table; the default is the default vertical spacing of the stream. Possible values for these two options option are:

- An integer—a size in the current units to be used for spacing.
- A string or character—the spacing is the width or height of the string or character in the current text style.
- A function—the spacing is the amount of horizontal or vertical space the function would consume when called on the stream.
- A list—the list is of the form **`(`***number unit***`)`**, where *unit* is one of **`:point`**, **`:pixel`**, **`:mm`**, **`:character`**, or **`:line`**. When *unit* is **`:character`**, the width of an "M" in the current text style is used as the width of one character.

multiple-columns is either **`nil`**, **`t`**, or an integer. If it is **`t`** or an integer, the table rows will be broken up into a multiple columns. If it is **`t`**, CLIM will determine the optimal number of columns. If it is an integer, it will be interpreted as the desired number of columns. *multiple-columns-x-spacing* has the same format as *x-spacing*. It controls the spacing between the multiple columns. It defaults to the value of the *x-spacing* option.

When the boolean *equalize-column-widths* is **`t`**, all the columns will have the same width (the width of the widest cell in any column in the entire table).

record-type specifies the class of output record to create. The default is **`standard-table-output-record`**. This argument should only be supplied by a programmer if there is a new class of output record that supports the table formatting protocol.

formatting-row *Macro*

formatting-row (&optional *stream* **&key** *record-type***) &body** *body*

Summary: Binds the local environment in such a way the output of *body* will be grouped into a table row. All of the output performed by *body* becomes the contents of one row. This must be used inside of **formatting-table**, and in conjunction with **formatting-cell**.

stream is an output recording stream to which output will be done. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

Once a table has had a row added to it via **formatting-row**, no columns may be added to it.

record-type specifies the class of output record to create. The default is **standard-row-output-record**. This argument should only be supplied by a programmer if there is a new class of output record that supports the row formatting protocol.

formatting-column *Macro*

formatting-column (&optional *stream* **&key** *record-type***) &body** *body*

Summary: Binds the local environment in such a way the output of *body* will be grouped into a table column. All of the output performed by *body* becomes the contents of one column. This must be used inside of **formatting-table**, and in conjunction with **formatting-cell**.

stream is an output recording stream to which output will be done. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

Once a table has had a column added to it via **formatting-column**, no rows may be added to it.

record-type specifies the class of output record to create. The default is **standard-column-output-record**. This argument should only be supplied if there is a new class of output record that supports the column formatting protocol.

formatting-cell *Macro*

formatting-cell (&optional *stream* **&key (***align-x* **:***left***) (***align-y* **:***baseline***)** *min-width min-height record-type***) &body** *body*

Summary: Controls the output of a single cell inside a table row or column, or of a single item inside **formatting-item-list**. All of the output performed by *body* becomes the contents of the cell.

stream is an output recording stream to which output will be done. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

align-x specifies how the output in a cell will be aligned relative to other cells in the same table column. The default, **:left**, causes the cells to be flush-left in the column. The other possible values are **:right** (meaning flush-right in the column) and **:center** (meaning centered in the column). Each cell within a column may have a different alignment; thus it is possible, for example, to have centered legends over flush-right numeric data.

align-y specifies how the output in a cell will be aligned vertically. The default, **:baseline**, causes textual cells to be aligned along their baselines and graphical cells to be aligned at the bottom. The other possible values are **:bottom** (align at the bottom of the output), **:top** (align at the top of the output), and **:center** (center the output in the cell).

min-width and *min-height* are used to specify minimum width or height of the cell. The default, **nil**, causes the cell to be only as wide or high as is necessary to contain the cell's contents. Otherwise, *min-width* and *min-height* are specified in the same way as the **:x-spacing** and **:y-spacing** arguments to **formatting-table**.

record-type specifies the class of output record to create. The default is **standard-cell-output-record**. This argument should only be supplied by a programmer if there is a new class of output record that supports the cell formatting protocol.

formatting-item-list *Macro*

formatting-item-list (&optional *stream* **&key** *x-spacing y-spacing n-columns n-rows stream-width stream-height max-width max-height initial-spacing* **(***row-wise* **t) (***move-cursor* **t)** *record-type***) &body** *body*

Summary: Binds the local environment in such a way that the output of *body* will be done in an item list (that is, menu) format. This must be used in conjunction with **formatting-cell**, which delimits each item. The item list is placed so that its upper left corner is at the current text cursor position of *stream*. If the boolean *move-cursor* is **t** (the default), then the text cursor will be moved so that it immediately follows the last cell of the item list.

"Item list output" means that each row of the item list consists of a single cell. The first row is on top, and each succeeding row has its top aligned with the bottom of the previous row (plus the specified *y-spacing*). Multiple rows and columns are constructed after laying the item list out in a single column. Item list output takes place in a normalized +**y**-downward coordinate system.

The returned value is the output record corresponding to the table.

stream is an output recording stream to which output will be done. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **t** (the default), ***standard-output*** is used. *body* may have zero or more declarations as its first forms.

x-spacing specifies the number of units of spacing to be inserted between columns of the item list; the default is the width of a **#\Space** character in the current text style. *y-spacing* specifies the number of units of spacing to be inserted between rows in the item list; the default is default vertical spacing of the stream. The format of these arguments is as for **formatting-table**.

When the boolean *equalize-column-widths* is **t**, all the columns will have the same width (the width of the widest cell in any column in the entire item list).

n-columns and *n-rows* specify the number of columns or rows in the item list. The default for both is **nil**, which causes CLIM to pick an aesthetically pleasing layout, possibly constrained by the other options. If both *n-columns* and *n-rows* are supplied and the item list contains more elements than will fit according to the specification, CLIM will format the item list as if *n-rows* were supplied as **nil**.

max-width and *max-height* constrain the layout of the item list. *max-width* can be overridden by *n-rows*. *max-height* can be overridden by *n-columns*.

formatting-item-list normally spaces items across the entire width of the stream. When *initial-spacing* is **t**, it inserts some whitespace (about half as much space as is between each item) before the first item on each line. When it is **nil** (the default), the initial whitespace is not inserted. If *row-wise* is **t** (the default) and the item list requires multiple columns, each successive element in the item list is laid out from left to right. If *row-wise* is **nil** and the item list requires multiple columns, each successive element in the item list is laid out below its predecessor, as in a telephone book.

record-type specifies the class of output record to create. The default is **standard-item-list-output-record**. Supply this argument s only if there is a new class of output record that supports the item list formatting protocol.

format-items *Function*

format-items *items* **&key** *stream printer presentation-type x-spacing y-spacing n-columns n-rows max-width max-height cell-align-x cell-align-y initial-spacing* **(***move-cursor* **t)** *record-type*

Summary: This is a function interface to the item list formatter. The elements of the sequence *items* are formatted as separate cells within the item list.

stream is an output recording stream to which output will be done. It defaults to **`*standard-output*`**.

printer (default is **`prin1`**)is a function that takes two arguments, an item and a stream, and outputs the item on the stream. *printer* has dynamic extent.

presentation-type is a presentation-type. When *printer* is not supplied, the items will be printed as if *printer* were:

```
#'(lambda (item stream)
    (present item presentation-type :stream stream))
```

When *printer* is supplied, each item will be enclosed in a presentation whose type is *presentation-type*.

x-spacing, *y-spacing*, *n-columns*, *n-rows*, *max-width*, *max-height*, *initial-spacing*, and *move-cursor* are as for **`formatting-item-list`**.

cell-align-x and *cell-align-y* are used to supply **`:align-x`** and **`:align-y`** to an implicitly used **`formatting-cell`**.

record-type is as for **`formatting-item-list`**.

---

format-textual-list *Function*

`format-textual-list` *sequence printer* **`&key (`***stream* **`*`***standard-output***`*) (`***separator* **`", ")`** *conjunction*

Summary: Outputs a *sequence* of items as a textual list.

Note that **`format-items`** is similar to **`formatting-item-list`**. Both operators do the same thing, except they accept their input differently:

- **`formatting-item-list`** accepts its input as a body that calls **`formatting-cell`** for each item.
- **`format-items`** accepts its input as a list of items with a specification of how to print them.

Note that menus use the one-dimensional table formatting model.

17.1.3 Examples of Formatting Tables

17.1.3.1 Formatting a Table From a List

The **`example1`** function formats a simple table whose contents come from a list.

```
(defvar *alphabet* '(a b c d e f g h i j k l m n o p q r s t u v w x y z))

(defun example1 (&optional (items *alphabet*)
                 &key (stream *standard-output*) (n-columns 6)
                      y-spacing x-spacing)
  (clim:formatting-table
       (stream :y-spacing y-spacing
            :x-spacing x-spacing)

(do ()
    ((null items))
  (clim:formatting-row (stream)
    (do ((i 0 (1+ i)))
        ((or (null items) (= i n-columns)))
      (clim:formatting-cell (stream)
        (format stream "~A" (pop items))))))))
```

Evaluating **`(example1 *alphabet* :stream *my-window*)`** shows this table:

```
A B C D E F
G H I J K L
M N O P Q R
S T U V W X
Y Z
```

which demonstrates the result of evaluating the **example1** function call without providing the **:y-spacing** and **:x-spacing** keywords. The defaults for these keywords makes tables whose elements are characters look reasonable.

You can easily vary the number of columns, and the spacing between rows or between columns. In the following example, we provide keyword arguments that change the appearance of the table.

Evaluating this form:

```
(example1 *alphabet* :stream *my-window*
          :n-columns 10 :x-spacing 10
          :y-spacing 10)
```

shows this table with the **:y-spacing** keyword:

```
A  B  C  D  E  F  G  H  I  J
K  L  M  N  O  P  Q  R  S  T
U  V  W  X  Y  Z
```

(Note that this example can be done with **formatting-item-list** as shown in **example4**.)

17.1.3.2 Formatting a Table Representing a Calendar Month

The **calendar-month** function shows how you can format a table that represents a calendar month. The first row in the table acts as column headings representing the days of the week. The following rows are numbers representing the days of the month.

This example shows how you can align the contents of a cell. The column headings (Sun, Mon, Tue, etc.) are centered within the cells. However, the dates themselves (1, 2, 3, ... 31) are aligned to the right edge of the cells. The resulting calendar looks good because the dates are aligned in the natural way.

```
(in-package :clim-user)

(defvar *day-of-the-week-string* '((0 . "Mon")(1 . "Tue")
                                   (2 . "Wed")(3 . "Thu")
                                   (4 . "Fri")(5 . "Sat")
                                   (6 . "Sun")))

(defun day-of-the-week-string (day-of-week)
  (cdr (assoc day-of-week  *day-of-the-week-string*)))

(defvar *days-in-month* '((1 . 31)(2 . 28) ( 3 . 31)( 4 . 30)
                          (5 . 31)(6 . 30) ( 7 . 31)( 8 . 31)
                          (9 . 30)(10 . 31)(11 . 30)(12 . 31))
  "alist whose first element is numeric value returned by
decode-universal-time and second is the number of days in that month")

;; In a leap year, the month-length function increments the number of
;; days in February as required
(defun leap-year-p (year)
  (cond ((and (integerp (/ year 100))
              (integerp (/ year 400)))
         t)
        ((and (not (integerp (/ year 100)))
              (integerp (/ year 4)))
```

```
          t)
         (t nil)))

(defun month-length (month year)
  (let ((days (cdr (assoc month *days-in-month*))))
    (when (and (eql month 2)
               (leap-year-p year))
      (incf days))
    days))

(defun calendar-month (month year &key (stream *standard-output*))
  (let ((days-in-month (month-length month year)))
    (multiple-value-bind (sec min hour date month year start-day)
        (decode-universal-time (encode-universal-time
                                  0 0 0 1 month year))
      (setq start-day (mod (+ start-day 1) 7))
      (clim:formatting-table (stream)
        (clim:formatting-row (stream)
          (dotimes (d 7)
            (clim:formatting-cell (stream :align-x :center)
              (write-string (day-of-the-week-string
                              (mod (- d 1) 7)) stream))))
        (do ((date 1)
             (first-week t nil))
            ((> date days-in-month))
          (clim:formatting-row (stream)
            (dotimes (d 7)
              (clim:formatting-cell (stream :align-x :right)
                (when (and (<= date days-in-month)
                           (or (not first-week) (>= d start-day)))
                  (format stream "~D" date)
                  (incf date)))))))))))

(define-application-frame calendar ()
  ()
  (:panes
    (main :application
          :width :compute :height :compute
          :display-function 'display-main)))

(define-calendar-command (com-exit-calendar :menu "Exit") ()
  (frame-exit *application-frame*))

(defmethod display-main ((frame calendar) stream &key)
  (multiple-value-bind (sec min hour date month year start-day)
      (decode-universal-time (get-universal-time))
    (calendar-month month year :stream stream)))

(defun run ()
  (find-application-frame 'calendar))
```

Evaluating **(calendar-month 5 90 :stream *my-stream*)** shows this table:

```
Sun  Mon  Tue  Wed  Thu  Fri  Sat
               1    2    3    4    5
  6    7    8    9   10   11   12
 13   14   15   16   17   18   19
 20   21   22   23   24   25   26
 27   28   29   30   31
```

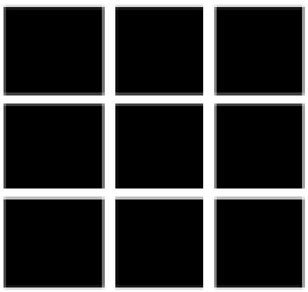
17.1.3.3 Formatting a Table With Regular Graphic Elements

The **example2** function shows how you can draw graphics within the cells of a table. Each cell contains a rectangle of the same dimensions.

```
(defun example2 (&key (stream *standard-output*)
                      y-spacing
                      x-spacing)
  (clim:formatting-table
   (stream :y-spacing y-spacing
           :x-spacing x-spacing)
   (dotimes (i 3)
     (clim:formatting-row
      (stream)
      (dotimes (j 3)
        (clim:formatting-cell
         (stream)
         (clim:draw-rectangle* stream 10 10 50 50)))))))
```

Evaluating **(example2 :stream *my-stream* :y-spacing 5)** shows this table:

Example2 Table



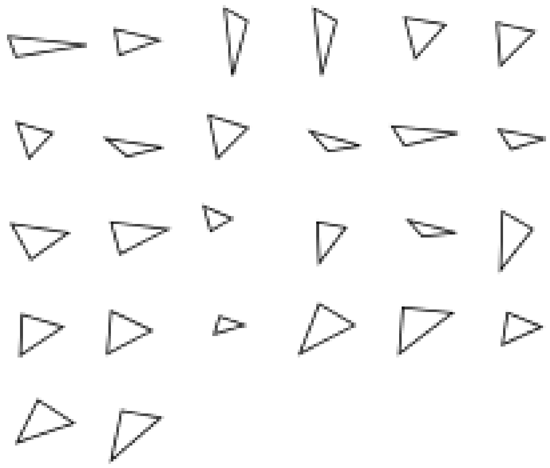
17.1.3.4 Formatting a Table With Irregular Graphics in the Cells

The **example3** function shows how you can format a table in which each cell contains graphics of different sizes.

```
(defun example3 (&optional (items *alphabet*)
                 &key (stream *standard-output*) (n-columns 6)
                      y-spacing x-spacing)
  (clim:formatting-table
      (stream :y-spacing y-spacing
              :x-spacing x-spacing)
   (do ()
       ((null items))
     (clim:formatting-row (stream)
        (do ((i 0 (1+ i)))
            ((or (null items) (= i n-columns)))
          (clim:formatting-cell (stream)
             (clim:draw-polygon* stream
                                (list 0 0 (* 10 (1+ (random 3)))
                                      5 5 (* 10 (1+ (random 3))))
                                :filled nil)
            (pop items)))))))
```

Evaluating **(example3 *alphabet* :stream *my-stream*)** shows this table:

Example3 Table



17.1.3.5 Formatting a Table of a Sequence of Items

The **example4** function shows how you can use **formatting-item-list** to format a table of a sequence of items when the exact arrangement of the items and the table is not important. Note that you use **formatting-cell** inside the body of **formatting-item-list** to output each item. You do not use **formatting-column** or **formatting-row**, because CLIM figures out the number of columns and rows automatically (or obeys a constraint given in a keyword argument).

```
(defun example4 (&optional (items *alphabet*)
                           &key (stream *standard-output*) n-columns n-rows
                           y-spacing x-spacing
                           max-width max-height)
  (clim:formatting-item-list
   (stream :y-spacing y-spacing
           :x-spacing x-spacing
           :n-columns n-columns :n-rows n-rows
           :max-width max-width :max-height max-height)
   (do ()
       ((null items))
     (clim:formatting-cell (stream)
                           (format stream "~A" (pop items))))))
```

Evaluating **(example4 :stream *my-window*)** shows this table:

```
A B C D
E F G H
I J K L
M N O P
Q R S T
U V W X
Y Z
```

You can easily add a constraint specifying the number of columns.

Evaluating **(example4 :stream *my-stream* :n-columns 8)** gives this:

```
A B C D E F G H
I J K L M N O P
Q R S T U V W X
Y Z
```

17.2 Formatting Graphs in CLIM

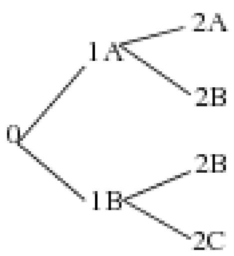
17.2.1 Conceptual Overview of Formatting Graphs

When you need to format a graph, you specify the nodes to be in the graph and the scheme for organizing them. The CLIM graph formatter does the layout automatically, obeying any constraints that you supply.

You can format any graph in CLIM. The CLIM graph formatter is most successful with directed acyclic graphs (***DAG***). "Directed" means that the arcs on the graph have a direction. "Acyclic" means that there are no loops in the graph.

Here is an example of such a graph:

A Directed Acyclic Graph



To specify the elements and the organization of the graph, you provide CLIM with the following information:

- The root node
- A "node printer," that is, a function used to display each node. The function is passed the object associated with a node and the stream on which to do output.
- An "inferior producer," a function that takes one node and returns its inferior nodes (the nodes to which it points).

Based on that information, CLIM lays out the graph for you. You can specify a number of options that control the appearance of the graph. For example, you can specify whether you want the graph to grow vertically (downward) or horizontally (to the right). Note that CLIM's algorithm does the best layout it can, but complicated graphs can be difficult to lay out in a readable way.

See **17.5 Advanced Topics** for the graph formatting protocol.

17.2.2 CLIM Operators for Graph Formatting

format-graph-from-roots *Function*

`format-graph-from-roots` *root-objects object-printer inferior-producer* **`&key`** *stream orientation cutoff-depth merge-duplicates duplicate-key duplicate-test generation-separation within-generation-separation center-nodes arc-drawer arc-drawing-options graph-type* **`(`***move-cursor* **`t)`**

Summary: Draws a graph whose roots are specified by the sequence *root-objects*. The nodes of the graph are displayed by calling the function *object-printer*, which takes two arguments, the node to display and a stream. *inferior-producer* is a function of one argument that is called on each node to produce a sequence of inferiors (or **`nil`** if there are none). Both *object-printer* and *inferior-producer* have dynamic extent.

The output from graph formatting takes place in a normalized +**`y`**-downward coordinate system. The graph is placed so that the upper left corner of its bounding rectangle is at the current text cursor position of *stream*. If the boolean *move-cursor* is **`t`** (the default), then the text cursor will be moved so that it immediately follows the lower right corner of the graph.

The returned value is the output record corresponding to the graph.

stream is an output recording stream to which output will be done. It defaults to **`*standard-output*`**.

orientation specifies the direction from root to leaves in the graph. *orientation* may be either **`:horizontal`** (the default) or **`:vertical`**. In LispWorks, it may also be **`:down`** or **`:up`**; **`:right`** is a synonym for **`:horizontal`** and **`:down`** is a synonym for **`:vertical`**.

cutoff-depth specifies the maximum depth of the graph. It defaults to **`nil`**, meaning that there is no cutoff depth. Otherwise it must be an integer, meaning that no nodes deeper than *cutoff-depth* will be formatted or displayed.

If the boolean *merge-duplicates* is **`t`**, then duplicate objects in the graph will share the same node in the display of the graph. That is, when *merge-duplicates* is **`t`**, the resulting graph will be a tree. If *merge-duplicates* is **`nil`** (the default), then duplicate objects will be displayed in separate nodes. *duplicate-key* is a function of one argument that is used to extract the node object component used for duplicate comparison; the default is **`identity`**. *duplicate-test* is a function of two arguments that is used to compare two objects to see if they are duplicates; the default is **`eql`**. *duplicate-key* and *duplicate-test* have dynamic extent.

generation-separation is the amount of space to leave between successive generations of the graph; the default is 20. *within-generation-separation* is the amount of space to leave between nodes in the same generation of the graph; the default is 10. *generation-separation* and *within-generation-separation* are specified in the same way as the *y-spacing* argument to **`formatting-table`**.

When *center-nodes* is **`t`**, each node of the graph is centered with respect to the widest node in the same generation. The default is **`nil`**.

arc-drawer is a function of seven positional and some unspecified keyword arguments that is responsible for drawing the arcs from one node to another; it has dynamic extent. The positional arguments are the stream, the "from" node, the "to" node, the "from" **x** and **y** position, and the "to" **x** and **y** position. The keyword arguments gotten from *arc-drawing-options* are typically line drawing options, such as for **`draw-line*`**. If *arc-drawer* is unsupplied, the default behavior is to draw a thin line from the "from" node to the "to" node using **`draw-line*`**.

graph-type is a keyword that specifies the type of graph to draw. CLIM supports graphs of type **`:tree`**, **`:directed-graph`** (and its synonym **`:digraph`**), and **`:directed-acyclic-graph`** (and its synonym **`:dag`**). *graph-type* defaults to **`:tree`** when *merge-duplicates* is **`t`**; otherwise, it defaults to **`:digraph`**.

The following is an example demonstrating the use of **`format-graph-from-roots`** to draw an arrow. Note that **`draw-arrow*`** is available internally.

```
(define-application-frame graph-it ()
  ((root-node :initform (find-class 'clim:design)
              :initarg :root-node
              :accessor root-node)
   (app-stream :initform nil :accessor app-stream))
  (:panes  (display :application
                    :display-function 'draw-display
                    :display-after-commands :no-clear))
  (:layouts
   (:defaults
    (horizontally () display))))

(defmethod draw-display ((frame graph-it) stream)
  (format-graph-from-roots (root-node *application-frame*)
                           #'draw-node
                           #'clos:class-direct-subclasses
                           :stream stream
                           :arc-drawer
                           #'(lambda (stream from-object
                                             to-object x1 y1
                                             x2 y2
                                             &rest
```

```
                                                   drawing-options)
                                   (declare (dynamic-extent
                                             drawing-options))
                                   (declare (ignore from-object
                                                    to-object))
                                   (apply #'draw-arrow* stream
                                          x1 y1 x2 y2 drawing-options))
                               :merge-duplicates t)
  (setf (app-stream frame) stream))

(define-presentation-type node ())

(defun draw-node (object stream)
  (with-output-as-presentation (stream object 'node)
                                   (surrounding-output-with-border
                                    (stream :shape :rectangle)
                                    (format stream "~A"
                                            (class-name object)))))

(define-graph-it-command (exit :menu "Exit") ()
  (frame-exit *application-frame*))

(defun graph-it (&optional (root-node (find-class 'basic-sheet))
                           (port (find-port)))
  (if (atom root-node) (setf root-node (list root-node)))
  (let ((graph-it (make-application-frame 'graph-it
                                              :frame-manager
                                              (find-frame-manager
                                               :port port)
                                              :width 800
                                              :height 600
                                              :root-node root-node)))
    (run-frame-top-level graph-it)))
```

17.2.3 Examples of CLIM Graph Formatting

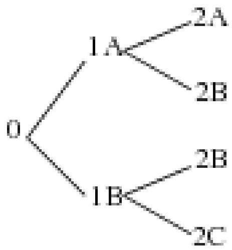
```
(defstruct node (name "") (children nil))

(defvar g1 (let* ((2a (make-node :name "2A"))
                  (2b (make-node :name "2B"))
                  (2c (make-node :name "2C"))
                  (1a (make-node :name "1A" :children (list 2a 2b)))
                  (1b (make-node :name "1B" :children (list 2b 2c))))
             (make-node :name "0" :children (list 1a 1b))))

(defun test-graph (root-node &rest keys)
  (apply #'clim:format-graph-from-root root-node
         #'(lambda (node s)
             (write-string (node-name node) s))
         #'node-children keys))
```

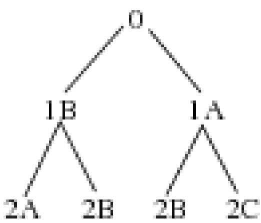
Evaluating **`(test-graph g1 :stream *my-window*)`** results in the following graph:

A Horizontal Graph



In **A Horizontal Graph**, the graph has a horizontal orientation and grows toward the right by default. We can supply the **:orientation** keyword to control this. Evaluating **(test-graph g1 :stream *my-window* :orientation :vertical)** results in the following graph:

A Vertical Graph



The following example uses **format-graph-from-roots** to create a graph with multiple parents, that is, a graph in which node D is a child of both nodes B and C. Note that it interprets its first argument as a list of top-level graph nodes, so we have wrapped the root node inside a list.

```
(defun test-graph (win)
  (window-clear win)
  (format-graph-from-roots '((a (b (d)) (c (d))))
                           #'(lambda (x s) (princ (car x) s))
                           #'cdr
                           :stream win
                           :orientation :vertical
                           :merge-duplicates t
                           :duplicate-key #'car)
  (force-output win))
```

17.3 Formatting Text in CLIM

CLIM provides the following three forms for creating textual lists, indenting output, and breaking up lengthy output into multiple lines.

---

format-textual-list *Function*

format-textual-list *sequence printer* **&key** *stream separator conjunction*

Summary: Outputs the sequence of items in *sequence* as a "textual list." For example, the list **(1 2 3 4)** might be printed as:

```
1, 2, 3, and 4
```

printer is a function of two arguments: an element of the sequence and a stream; it has dynamic extent. It is called to output each element of the sequence.

stream specifies the output stream. The default is **`*standard-output*`**.

The *separator* and *conjunction* arguments control the appearance of each element of the sequence and the separators used between each pair of elements. *separator* is a string that is output after every element but the last one; the default for *separator* is "`,`" (a comma followed by a space). *conjunction* is a string that is output before the last element. The default is **`nil`**, meaning that there is no conjunction. Typical values for *conjunction* are the strings "**`and`**" and "**`or`**".

indenting-output *Macro*

`indenting-output (`*stream indentation* **`&key (`***move-cursor* **`t)) &body`** *body*

Summary: Binds *stream* to a stream that inserts whitespace at the beginning of each line of output produced by *body*, and then writes the indented output to the stream that is the original value of *stream*.

The *stream* argument is not evaluated, and must be a symbol that is bound to an output recording stream. If *stream* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

indentation specifies how much whitespace should be inserted at the beginning of each line. It is specified in the same way as the **`:x-spacing`** option to **`formatting-table`**.

If the boolean *move-cursor* is **`t`** (the default), CLIM moves the cursor to the end of the table.

Programmers using **`indenting-output`** should begin the body with a call to *fresh-line* (or some equivalent) to position the stream to the indentation initially. There is a restriction on interactions between **`indenting-output`** and **`filling-output`**: a call to **`indenting-output`** should appear outside of a call to **`filling-output`**.

filling-output *Macro*

`filling-output (`*stream* **`&key`** *fill-width break-characters after-line-break after-line-break-initially***`) &body`** *body*

Summary: Binds *stream* to a stream that inserts line breaks into the textual output written to it (by such functions as **`write-char`** and **`write-string`**) so that the output is usually no wider then *fill-width*. The filled output is then written on the original stream.

The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **`t`**, **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

fill-width specifies the width of filled lines, and defaults to 80 characters. It is specified the same way as the **`:x-spacing`** option for **`formatting-table`**. **17.1.2 CLIM Operators for Formatting Tables**.

"Words" are separated by the characters specified in the list *break-characters*. When a line is broken to prevent wrapping past the end of a line, the line break is made at one of these separators. That is, **`filling-output`** does not split "words" across lines, so it might produce output wider than *fill-width*.

after-line-break specifies a string to be sent to *stream* after line breaks; the string appears at the beginning of each new line. The string must not be wider than *fill-width*.

If the boolean *after-line-break-initially* is **`t`**, then the *after-line-break* text is to be written to *stream* before executing *body*, that is, at the beginning of the first line. The default is **`nil`**.

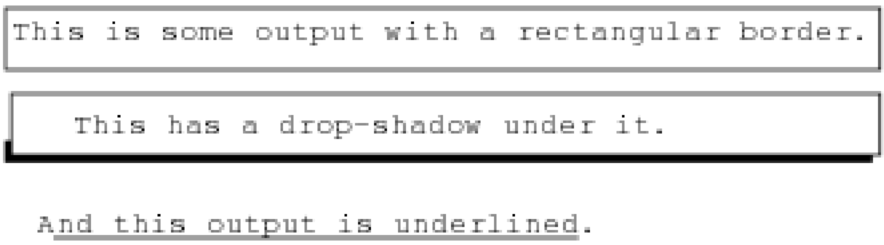
17.4 Bordered Output in CLIM

CLIM provides a mechanism for surrounding arbitrary output with some kind of a border. The programmer annotates some output-generating code with an advisory macro that describes the type of border to be drawn. The following code produces the output shown in **Examples of Bordered Output**.

For example, the following produces three pieces of output, which are surrounded by a rectangle, highlighted with a dropshadow, and underlined, respectively.

```
(defun border-test (stream)
  (fresh-line stream)
  (surrounding-output-with-border
   (stream :shape :rectangle)
   (format stream "This is some output with a rectangular border"))
  (terpri stream) (terpri stream)
  (surrounding-output-with-border
   (stream :shape :drop-shadow)
   (format stream "This has a drop-shadow under it"))
  (terpri stream) (terpri stream)
  (surrounding-output-with-border
   (stream :shape :underline)
   (format stream "And this output is underlined")))
```

Examples of Bordered Output



surrounding-output-with-border *Macro*

`surrounding-output-with-border (&optional` *stream* **`&key`** *shape* **`(`***move-cursor* **`t)) &body`** *body*

Summary: Binds the local environment in such a way the output of *body* will be surrounded by a border of the specified shape. Supported shapes are **`:rectangle`** (the default), **`:oval`**, **`:drop-shadow`**, and **`:underline`**. **`:rectangle`** draws a rectangle around the bounding rectangle of the output. **`:oval`** draws an oval around the bounding rectangle of the output. **`:drop-shadow`** draws a "drop shadow" around the lower right edge of the bounding rectangle of the output. **`:underline`** draws a thin line along the baseline of all of the text in the output, but does not draw anything underneath non-textual output.

If the boolean *move-cursor* is **`t`** (the default), then the text cursor will be moved so that it immediately follows the lower right corner of the bordered output.

You can also supply extra keywords, which will be used when drawing the specified shape.

stream is an output recording stream to which output will be done. The *stream* argument is not evaluated, and must be a symbol that is bound to a stream. If *stream* is **`t`** (the default), **`*standard-output*`** is used. *body* may have zero or more declarations as its first forms.

define-border-type *Macro*

`define-border-type` *shape arglist* **`&body`** *body*

Summary: Defines a new kind of border named *shape*. *arglist* must be a subset of the "canonical" arglist (using **`string-equal`** to do the comparison) (**`&key`** *stream record left top right bottom*). If *arglist* does not contain **`&rest`** then an anonymous one as added. Any extra keywords that you want to supply in calls to **`surrounding-output-with-border`** for the named *shape* should also be added to *arglist* using **`&key`**. *body* is the code that actually draws the border. It has lexical access to **`stream`**, **`record`**, **`left`**, **`top`**, **`right`**, and **`bottom`**, which are respectively, the stream being drawn on, the output record being surrounded, and the coordinates of the left, top, right, and bottom edges of the bounding rectangle of the record. *body* may have zero or more declarations as its first forms.

17.5 Advanced Topics

The material in this subsection is advanced; most CLIM programmers can skip to the next section. This section discusses Table, Item List, and Graph Formatting Protocols.

All of table, item list, and graph formatting is implemented on top of the basic output recording protocol, using **with-new-output-record** to specify the appropriate type of output record. The following examples show specifically how tables and graphs are implemented.

Example 1: Tables — **formatting-table** first collects all the output that belongs in the table into a collection of row, column, and cell output records, all of which are children of a single table output record. During this phase, **stream-drawing-p** is bound to **nil** and **stream-recording-p** is bound to **t**. When all the output has been generated, the table layout constraint solver (**adjust-table-cells** or **adjust-item-list-cells**) is called to compute the table layout, taking into account such factors as the widest cell in a given column. If the table is to be split into multiple columns, **adjust-multiple-columns** is now called. Finally, the table output record is positioned on the stream at the current text cursor position and then displayed by calling **replay** on the table (or item list) output record.

Example 2: Graphs — **format-graph-from-roots** first collects all the graph node output records that belong in the graph by calling **generate-graph-nodes**. All these output records are children of a single graph output record. During this phase, **stream-drawing-p** is bound to **nil** and **stream-recording-p** is bound to **t**. When all the output has been generated, the graph layout code (**layout-graph-nodes** and **layout-graph-edges**) is called to compute the graph layout. Finally, the graph output record is positioned on the stream at the current text cursor position and then displayed by calling **replay** on the graph output record.

17.5.1 The Table Formatting Protocol

Any output record class that implements the following generic functions is said to support the table formatting protocol.

In the following subsections, the term "non-table output records" will be used to mean any output record that is not a table, row, column, cell, or item list output record. When CLIM "skips over intervening non-table output records," this means that it will bypass all the output records between two such table output records (such as a table and a row, or a row and a cell) that are not records of those classes (most notably, presentation output records). CLIM detects invalid nesting of table output records, such as a row within a row, a cell within a cell, or a row within a cell. Note that this does not prohibit the nesting of calls to **formatting-table**, it simply requires that programmers include the inner table within one of the cells of the outer table.

table-output-record — *Protocol Class*

Summary: The protocol class that represents tabular output records; a subclass of **output-record**. If you want to create a new class that behaves like a table output record, it should be a subclass of **table-output-record**. Subclasses of **table-output-record** must obey the table output record protocol.

table-output-record-p — *Function*

table-output-record-p *object*

Summary: Returns **t** if *object* is a table output record; otherwise, it returns **nil**.

:x-spacing

:y-spacing

:multiple-columns-x-spacing

:equalize-column-widths *Initargs*

Summary: All subclasses of **`table-output-record`** must handle these initargs, which are used to specify, respectively, the **x** and **y** spacing, the multiple column **x** spacing, and equal-width columns attributes of the table.

standard-table-output-record *Class*

Summary: The instantiable class of output record that represents tabular output. Its children will be a sequence of either rows or columns, with presentation output records possibly intervening. This is a subclass of **`table-output-record`**.

map-over-table-elements *Generic Function*

`map-over-table-elements` *function table-record type*

Summary: Applies *function* to all the rows or columns of *table-record* that are of type *type*. *type* is either **`:row`**, **`:column`**, or **`:row-or-column`**. *function* is a function of one argument, an output record; it has dynamic extent. **`map-over-table-elements`** ensures that rows, columns, and cells are properly nested. It skips over intervening non-table output record structure, such as presentations.

adjust-table-cells *Generic Function*

`adjust-table-cells` *table-record stream*

Summary: This function is called after the tabular output has been collected, but before it has been replayed. The method on **`standard-table-output-record`** implements the usual table layout constraint solver by moving the rows or columns of the table output record *table-record* and the cells within the rows or columns. *stream* is the stream on which the table is displayed.

adjust-multiple-columns *Generic Function*

`adjust-multiple-columns` *table-record stream*

Summary: This is called after **`adjust-table-cells`** to account for the case where the programmer wants to break the entire table up into multiple columns. Each of those columns will have some of the rows of the "original" table, and those rows may each have several columns. For example:

Original table:

```
a   1   alpha
b   2   beta
c   3   gamma
d   4   delta
```

Multiple column version:

```
a     1    alpha         c    3    gamma
b     2    beta          d    4    delta
```

table-record and *stream* are as for **`adjust-table-cells`**.

17.5.1.1 The Row and Column Formatting Protocol

Any output record class that implements the following generic functions is said to support the row (or column) formatting protocol.

row-output-record *Protocol Class*

Summary: The protocol class that represents one row in a table; a subclass of **`output-record`**. If you want to create a new class that behaves like a row output record, it should be a subclass of **row-output-record**. Subclasses of **row-output-record** must obey the row output record protocol.

row-output-record-p *Function*

row-output-record-p *object*

Summary: Returns **t** if *object* is a row output record; otherwise, it returns **nil**.

standard-row-output-record *Class*

Summary: The instantiable class of output record that represents a row of output within a table. Its children will be a sequence of cells, and its parent (skipping intervening non-tabular records such as presentations) will be a table output record. This is a subclass of **row-output-record**.

map-over-row-cells *Generic Function*

map-over-row-cells *function row-record*

Summary: Applies *function* to all the cells in the row *row-record*, skipping intervening non-table output record structure. *function* is a function of one argument, an output record corresponding to a table cell within the row; it has dynamic extent.

column-output-record *Protocol Class*

Summary: The protocol class that represents one column in a table; a subclass of **output-record**. If you want to create a new class that behaves like a column output record, it should be a subclass of **column-output-record**. Subclasses of **column-output-record** must obey the column output record protocol.

column-output-record-p *Function*

column-output-record-p *object*

Summary: Returns **t** if *object* is a column output record; otherwise, it returns **nil**.

standard-column-output-record *Class*

Summary: The instantiable class of output record that represents a column of output within a table. Its children will be a sequence of cells, and its parent (skipping intervening non-tabular records such as presentations) will be a table output record; presentation output records may intervene. This is a subclass of **column-output-record**.

map-over-column-cells *Generic Function*

map-over-column-cells *function column-record*

Summary: Applies *function* to all the cells in the column *column-record*, skipping intervening non-table output record structure. *function* is a function of one argument, an output record corresponding to a table cell within the column; it has dynamic extent.

17.5.1.2 The Cell Formatting Protocol

Any output record class that implements the following generic functions is said to support the cell formatting protocol.

cell-output-record *Protocol Class*

Summary: The protocol class that represents one cell in a table or an item list; a subclass of **output-record**. If you want to create a new class that behaves like a cell output record, it should be a subclass of **cell-output-record**. Subclasses of **cell-output-record** must obey the cell output record protocol.

cell-output-record-p *Function*

`cell-output-record-p` *object*

Summary: Returns **`t`** if *object* is a cell output record; otherwise. it returns **`nil`**.

:align-x

:align-y

:min-width

:min-height *Initargs*

Summary: All subclasses of **`cell-output-record`** must handle these initargs, which are used to specify, respectively, the **x** and **y** alignment, and the minimum width and height attributes of the cell.

standard-cell-output-record *Class*

Summary: The instantiable class of output record that represents a single piece of output within a table row or column, or an item list. Its children will either be presentations or output records that represent displayed output. This is a subclass of **`cell-output-record`**.

cell-align-x *Generic Function*

`cell-align-x` *cell*

cell-align-y *Generic Function*

`cell-align-y` *cell*

cell-min-width *Generic Function*

`cell-min-width` *cell*

cell-min-height *Generic Function*

`cell-min-height` *cell*

Summary: These functions return, respectively, the **x** and **y** alignment and minimum width and height of the cell output record *cell*.

17.5.2 The Item List Formatting Protocol

item-list-output-record *Protocol Class*

Summary: The protocol class that represents an item list; a subclass of **`output-record`**. If you want to create a new class that behaves like an item list output record, it should be a subclass of **`item-list-output-record`**. Subclasses of **`item-list-output-record`** must obey the item list output record protocol.

item-list-output-record-p *Function*

`item-list-output-record-p` *object*

Summary: Returns **`t`** if *object* is an item list output record; otherwise, it returns **`nil`**.

:x-spacing

:y-spacing

:initial-spacing

:n-rows

:n-columns

:max-width

:max-height *Initargs*

Summary: All subclasses of **item-list-output-record** must handle these initargs, which specify, respectively, the **x** and **y** spacing, the initial spacing, the desired number of rows and columns, and maximum width and height attributes of the item list.

standard-item-list-output-record *Class*

Summary: The output record that represents item list output. Its children will be a sequence of cells, with presentations possibly intervening. This is a subclass of **item-list-output-record**.

map-over-item-list-cells *Generic Function*

map-over-item-list-cells *function item-list-record*

Summary: Applies *function* to all of the cells in *item-list-record*. **map-over-item-list-cells** skips over intervening non-table output record structure, such as presentations. *function* is a function of one argument, an output record corresponding to a cell in the item list; it has dynamic extent.

adjust-item-list-cells *Generic Function*

adjust-item-list-cells *item-list-record stream*

Summary: This function is called after the item list output has been collected, but before the record has been replayed. The method on **standard-item-list-output-record** implements the usual item list layout constraint solver. *item-list-record* is the item list output record, and *stream* is the stream on which the item list is displayed.

17.5.3 The Graph Formatting Protocol

graph-output-record *Protocol Class*

Summary: The protocol class that represents a graph; a subclass of **output-record**. If you want to create a new class that behaves like a graph output record, it should be a subclass of **graph-output-record**. Subclasses of **graph-output-record** must obey the graph output record protocol.

graph-output-record-p *Function*

graph-output-record-p *object*

Summary: Returns **t** if *object* is a graph output record, otherwise returns **nil**.

:orientation

:center-nodes

:cutoff-depth

:merge-duplicates

:generation-separation

:within-generation-separation

:hash-table *Initargs*

Summary: All the graph output records must handle these seven initargs, which are used to specify, respectively, the orientation, node centering, cutoff depth, merge duplicates, generation and within-generation spacing, and the node hash table of a graph output record.

define-graph-type *Macro*

`define-graph-type` *graph-type class*

Summary: Defines a new graph type *graph-type* that is implemented by the class *class* (a subclass of **`graph-output-record`**). Neither of the arguments is evaluated.

graph-root-nodes *Generic Function*

`graph-root-nodes` *graph-record*

Summary: Returns a sequence of the graph node output records corresponding to the root objects for the graph output record *graph-record*.

(setf graph-root-nodes) *Generic Function*

`(setf graph-root-nodes)` *roots graph-record*

Summary: Sets the root nodes of *graph-record* to *roots*.

generate-graph-nodes *Generic Function*

`generate-graph-nodes` *graph-record stream root-objects object-printer inferior-producer* **`&key`** *duplicate-key duplicate-test*

Summary: This function is responsible for generating all the graph node output records of the graph. *graph-record* is the graph output record, and *stream* is the output stream. The graph node output records are generating by calling the object printer on the root objects, then (recursively) calling the inferior producer on the root objects and calling the object printer on all inferiors. After all the graph node output records have been generated, the value of **`graph-root-nodes`** of *graph-record* must be set to be a sequence of those graph node output records that correspond to the root objects.

root-objects, *object-printer*, *inferior-producer*, *duplicate-key*, and *duplicate-test* are as for **`format-graph-from-roots`**.

layout-graph-nodes *Generic Function*

`layout-graph-nodes` *graph-record stream*

Summary: This function is responsible for laying out the nodes in the graph contained in the output record *graph-record*. It is called after the graph output has been collected, but before the graph record has been displayed. The method on **`standard-graph-output-record`** implements the usual graph layout constraint solver. *stream* is the stream on which the graph is displayed.

layout-graph-edges *Generic Function*

`layout-graph-edges` *graph-record stream arc-drawer arc-drawing-options*

Summary: This function is responsible for laying out the edges in the graph. It is called after the graph nodes have been laid out, but before the graph record has been displayed. The method on **`standard-graph-output-record`** simply causes thin lines to be drawn from each node to all of its children. *graph-record* and *stream* are as for **`layout-graph-nodes`**.

graph-node-output-record *Protocol Class*

Summary: The protocol class that represents a node in graph; a subclass of **`output-record`**. If you want to create a new class that behaves like a graph node output record, it should be a subclass of **`graph-node-output-record`**. Subclasses of **`graph-node-output-record`** must obey the graph node output record protocol.

graph-node-output-record-p *Function*

`graph-node-output-record-p` *object*

Summary: Returns **`t`** if *object* is a graph node output record; otherwise, it returns **`nil`**.

standard-graph-node-output-record *Class*

Summary: The instantiable class of output record that represents a graph node. Its parent will be a graph output record. This is a subclass of **`graph-node-output-record`**.

graph-node-parents *Generic Function*

`graph-node-parents` *graph-node-record*

Summary: Returns a sequence of the graph node output records whose objects are "parents" of the object corresponding to the graph node output record *graph-node-record*. This differs from **`output-record-parent`**, as **`graph-node-parents`** can return output records that are not the parent records of *graph-node-record*.

(setf graph-node-parents) *Generic Function*

`(setf graph-node-parents)` *parents graph-node-record*

Summary: Sets the parents of *graph-node-record* to be *parents*. *parents* must be a list of graph node records.

graph-node-children *Generic Function*

`graph-node-children` *graph-node-record*

Summary: Returns a sequence of the graph node output records whose objects are "children" of the object corresponding to the graph node output record *graph-node-record*. This differs from **`output-record-children`**, as **`graph-node-children`** can return output records that are not child records of *graph-node-record*.

(setf graph-node-children) *Generic Function*

`(setf graph-node-children)` *children graph-node-record*

Summary: Sets the children of *graph-node-record* to be *children*. *children* must be a list of graph node records.

graph-node-object *Generic Function*

`graph-node-object` *graph-node-record*

Summary: Returns the object that corresponds to the output record *graph-node-record*. This function only works correctly while inside the call to **`format-graph-from-roots`**. Unspecified results are returned outside **`format-graph-from-roots`**, as CLIM does not capture application objects that might have dynamic extent.

18 Sheets

18.1 Overview of Window Facilities

A central notion in organizing user interfaces is allocating screen regions to particular tasks and recursively subdividing these regions into subregions. The windowing layer of CLIM defines an extensible framework for constructing, using, and managing such ***hierarchies of interactive regions***. This framework allows uniform treatment of the following things:

- Window objects like those in X or NeWS.
- Lightweight gadgets typical of toolkit layers, such as Motif or OpenLook.
- Structured graphics such as output records and an application's presentation objects.
- Objects that act as Lisp handles for windows or gadgets implemented in a different language (such as OpenLook gadgets implemented in C).

From the perspective of most CLIM users, CLIM's windowing layer plays the role of a window system. However, CLIM usually uses the services of a window system platform to provide efficient windowing, input, and output facilities. We will refer to such window system platforms as host window systems or as display servers.

The fundamental window abstraction defined by CLIM is called a ***sheet***. A sheet can participate in a relationship called a ***windowing relationship***. This relationship is one in which one sheet called the ***parent*** provides space to a number of other sheets called ***children***. Support for establishing and maintaining this kind of relationship is the essence of what window systems provide. At any point in time, CLIM allows a sheet to be a child in one relationship and a parent in another relationship.

Programmers can manipulate unrooted hierarchies of sheets (those without a connection to any particular display server). However, a sheet hierarchy must be attached to a display server to make it visible. ***Ports*** and ***grafts*** provide the functionality for managing this capability. A port is an abstract connection to a display service that is responsible for managing host display server resources and for processing input events received from the host display server. A graft is a special kind of sheet that represents a host window, typically a root window (that is, a screen-level window). A sheet is attached to a display by making it a child of a graft, which represents an appropriate host window. The sheet will then appear to be a child of that host window. In other words, a sheet is put onto a particular screen by making it a child of an appropriate graft and enabling it. Ports and grafts are described in detail in **19 Ports, Grafts, and Mirrored Sheets**.

As has been discussed previously, CLIM users will typically be dealing with ***panes***, rather than with sheets, ports, grafts, or mediums, as a call to **`make-application-frame`** automatically results in a port specification, a graft instantiation, and the allocation of a medium, to which output directed to the pane will be forwarded.

18.1.1 Properties of Sheets

Sheets have the following properties:

- A coordinate system—Provides the ability to refer to locations in a sheet's abstract plane.
- A region—Defines an area within a sheet's coordinate system that indicates the area of interest within the plane, that is, a clipping region for output and input. This typically corresponds to the visible region of the sheet on the display.
- A parent—A sheet that is the parent in a windowing relationship in which this sheet is a child.

- Children—An ordered set of sheets that are each children in a windowing relationship in which this sheet is a parent. The ordering of the set corresponds to the stacking order of the sheets. Not all sheets have children.
- A transformation—Determines how points in this sheet's coordinate system are mapped into points in its parents' coordinate system.
- An enabled flag—Indicates whether the sheet is currently actively participating in the windowing relationship with its parent and siblings.
- An event handler—A procedure invoked when the display server wishes to inform CLIM of external events.
- Output state—A set of values used when CLIM causes graphical or textual output to appear on the display. This state is often represented by a medium.

18.1.2 Sheet Protocols

A sheet is a participant in a number of protocols. Every sheet must provide methods for the generic functions that make up these protocols. These protocols are:

- The windowing protocol—Describes the relationships between the sheet and its parent and children (and, by extension, all of its ancestors and descendants).
- The input protocol—Provides the event handler for a sheet. Events may be handled synchronously, asynchronously, or not at all.
- The output protocol—Provides graphical and textual output, and manages descriptive output state such as color, transformation, and clipping.
- The repaint protocol—Invoked by the event handler and by user programs to ensure that the output appearing on the display device appears as the program expects it to appear.
- The notification protocol—Invoked by the event handler and user programs to ensure that CLIM's representation of window system information is equivalent to the display server's.

These protocols may be handled directly by a sheet, queued for later processing by some other agent, or passed on to a delegate sheet for further processing.

18.2 Basic Sheet Classes

There are no standard sheet classes in CLIM, and no pre-packaged way to create sheets in general. If a programmer needs to create an instance of some class of sheet, **`make-instance`** must be used. In most cases, application programmers will not deal with sheets directly, but instead will use a subclass of sheets known as panes. Panes can be created by calling the **`make-pane`** function. For a more detailed discussion on panes, see **10 Panes and Gadgets**.

---

sheet *Protocol Class*

Summary: The protocol class that corresponds to a sheet, a subclass of **`bounding-rectangle`**. If you want to create a new class that behaves like a sheet, it should be a subclass of **`sheet`**. Subclasses of **`sheet`** must obey the sheet protocol.

All of the subclasses of **`sheet`** are mutable.

---

sheetp *Function*

`sheetp` *object*

Summary: Returns **`t`** if *object* is a sheet; otherwise, it returns **`nil`**.

basic-sheet *Class*

Summary: The basic class on which all CLIM sheets are built, a subclass of **sheet**. This class is an abstract class intended only to be subclassed, not instantiated.

18.3 Relationships Between Sheets

Sheets are arranged in a tree-structured, acyclic, top-down hierarchy. Thus, in general, a sheet has one or no parents and zero or more children. A sheet may have zero or more siblings (that is, other sheets that share the same parent). In order to describe the relationships between sheets, we define the following terms.

- Adopted—A sheet is said to be ***adopted*** if it has a parent. A sheet becomes the parent of another sheet by adopting that sheet.
- Disowned—A sheet is said to be ***disowned*** if it does not have a parent. A sheet ceases to be a child of another sheet by being disowned.
- Grafted—A sheet is said to be ***grafted*** when it is part of a sheet hierarchy whose highest ancestor is a graft. In this case, the sheet may be visible on a particular window server.
- Degrafted—A sheet is said to be ***degrafted*** when it is part of a sheet hierarchy that cannot be visible on a server, that is, the highest ancestor is not a graft.
- Enabled—A sheet is said to be ***enabled*** when it is actively participating in the windowing relationship with its parent. If a sheet is enabled and grafted, and all its ancestors are enabled (they are grafted by definition), then the sheet will be visible if it occupies a portion of the graft region that isn't clipped by its ancestors or ancestor's siblings.
- Disabled—The opposite of enabled is ***disabled***.

18.3.1 Sheet Relationship Functions

The generic functions in this section comprise the sheet protocol. All sheet objects must implement or inherit methods for each of these generic functions.

sheet-parent *Generic Function*

sheet-parent *sheet*

Summary: Returns the parent of the sheet *sheet*, or **nil** if the sheet has no parent.

sheet-children *Generic Function*

sheet-children *sheet*

Summary: Returns a list of sheets that are the children of the sheet *sheet*. Some sheet classes support only a single child; in this case, the result of **sheet-children** will be a list of one element. This function returns objects that reveal CLIM's internal state; do not modify those objects.

sheet-adopt-child *Generic Function*

sheet-adopt-child *sheet child*

Summary: Adds the child sheet *child* to the set of children of the sheet *sheet*, and makes the *sheet* the child's parent. If *child* already has a parent, an

Some sheet classes support only a single child. For such sheets, attempting to adopt more than a single child will cause the **sheet-supports-only-one-child** error to be signaled.

sheet-disown-child *Generic Function*

`sheet-disown-child` *sheet child* **`&key (`***errorp* **`t)`**

Summary: Removes the child sheet *child* from the set of children of the sheet *sheet*, and makes the parent of the child be **`nil`**. If *child* is not actually a child of *sheet* and *errorp* is **`t`**, then the **`sheet-is-not-child`** error will be signaled.

sheet-siblings *Generic Function*

`sheet-siblings` *sheet*

Summary: Returns a list of all of the siblings of the sheet *sheet*. The sibling are all of the children of *sheet*'s parent excluding *sheet* itself. This function returns fresh objects that may be modified.

sheet-enabled-children *Generic Function*

`sheet-enabled-children` *sheet*

Summary: Returns a list of those children of the sheet *sheet* that are enabled. This function returns fresh objects that may be modified.

sheet-ancestor-p *Generic Function*

`sheet-ancestor-p` *sheet putative-ancestor*

Summary: Returns **`t`** if the the sheet *putative-ancestor* is in fact an ancestor of the sheet *sheet*; otherwise, it returns **`nil`**.

raise-sheet *Generic Function*

`raise-sheet` *sheet*

bury-sheet *Generic Function*

`bury-sheet` *sheet*

Summary: These functions reorder the children of a sheet by raising the sheet *sheet* to the top or burying it at the bottom. Raising a sheet puts it at the beginning of the ordering; burying it puts it at the end. If sheets overlap, the one that appears "on top" on the display device is earlier in the ordering than the one underneath.

This may change which parts of which sheets are visible on the display device.

reorder-sheets *Generic Function*

`reorder-sheets` *sheet new-ordering*

Summary: Reorders the children of the sheet *sheet* to have the new ordering specified by *new-ordering*. *new-ordering* is an ordered list of the child sheets; elements at the front of *new-ordering* are "on top" of elements at the rear.

If *new-ordering* does not contain all of the children of *sheet*, the **`sheet-ordering-underspecified`** error will be signaled. If *new-ordering* contains a sheet that is not a child of *sheet*, the **`sheet-is-not-child`** error will be signaled.

sheet-enabled-p *Generic Function*

`sheet-enabled-p` *sheet*

Summary: Returns **`t`** if the the sheet *sheet* is enabled by its parent; otherwise, it returns **`nil`**. Note that all of a sheet's ancestors must be enabled before the sheet is viewable.

(setf sheet-enabled-p) *Generic Function*

`(setf sheet-enabled-p)` *enabled-p sheet*

Summary: When *enabled-p* is **`t`**, this enables the the sheet *sheet*. When *enabled-p* is **`nil`**, this disables the sheet.

Note that a sheet is not visible unless it and all of its ancestors are enabled.

sheet-viewable-p *Generic Function*

`sheet-viewable-p` *sheet*

Summary: Returns **`t`** if the sheet *sheet* and all its ancestors are enabled, and if one of its ancestors is a graft. See **19 Ports, Grafts, and Mirrored Sheets** for further information on grafts.

sheet-occluding-sheets *Generic Function*

`sheet-occluding-sheets` *sheet child*

Summary: Returns a list of the sheet *child*'s siblings that occlude part or all of the region of the *child*. In general, these are the siblings that are enabled and appear earlier in the sheet *sheet*'s children. If *sheet* does not permit overlapping among its children, **`sheet-occluding-sheets`** will return **`nil`**.

This function returns fresh objects that may be modified.

18.3.2 Sheet Genealogy Classes

Different "mix-in" classes are provided that implement the relationship protocol.

sheet-parent-mixin *Class*

Summary: This class is mixed into sheet classes that have a parent.

sheet-leaf-mixin *Class*

Summary: This class is mixed into sheet classes that will never have children.

sheet-single-child-mixin *Class*

Summary: This class is mixed into sheet classes that have at most a single child.

sheet-multiple-child-mixin *Class*

Summary: This class is mixed into sheet classes that may have zero or more children.

18.4 Sheet Geometry

Every sheet has a region and a coordinate system. The region refers to its position and extent on the display device. It is represented by a region object, frequently a rectangle. A sheet's coordinate system is represented by a coordinate transformation that converts coordinates in its coordinate system to coordinates in its parent's coordinate system.

18.4.1 Sheet Geometry Functions

sheet-transformation *Generic Function*

`sheet-transformation` *sheet*

(setf sheet-transformation) *Generic Function*

`(setf sheet-transformation)` *transformation sheet*

Summary: Returns a transformation that converts coordinates in the sheet *sheet*'s coordinate system into coordinates in its parent's coordinate system. Using **`setf`** on this accessor will modify the sheet's coordinate system, including moving its region in its parent's coordinate system. When the the transformation is changed, **`note-sheet-region-changed`** is called to notify the sheet of the change.

sheet-region *Generic Function*

`sheet-region` *sheet*

(setf sheet-region) *Generic Function*

`(setf sheet-region)` *region sheet*

Summary: Returns a region object that represents the set of points to which the sheet *sheet* refers. The region is in the sheet's coordinate system. Using **`setf`** on this accessor modifies the sheet's region. When the region is changed, **`note-sheet-region-region`** is called to notify the sheet of the change.

move-sheet *Generic Function*

`move-sheet` *sheet x y*

Summary: Moves the sheet *sheet* to the new position (*x*, *y*). *x* and *y* are expressed in the coordinate system of *sheet*'s parent.

resize-sheet *Generic Function*

`resize-sheet` *sheet width height*

Summary: Resizes the sheet *sheet* to have a new width *width* and height *height*. *width* and *height* are real numbers.

move-and-resize-sheet *Generic Function*

`move-and-resize-sheet` *sheet x y width height*

Summary: Moves the sheet *sheet* to the new position (*x*, *y*) and changes its size to the new width *width* and height *height*. *x* and *y* are expressed in the coordinate system of *sheet*'s parent. *width* and *height* are real numbers.

map-sheet-position-to-parent *Generic Function*

`map-sheet-position-to-parent` *sheet x y*

Summary: Applies the sheet *sheet*'s transformation to the point (*x*, *y*), returning the coordinates of that point in *sheet*'s parent's coordinate system.

map-sheet-position-to-child *Generic Function*

`map-sheet-position-to-child` *sheet x y*

Summary: Inverts *sheet*'s transformation of the point (*x*, *y*) in *sheet*'s parent's coordinate system. It returns the coordinates of the point in *sheet*'s coordinate system.

map-sheet-rectangle*-to-parent *Generic Function*

`map-sheet-rectangle*-to-parent` *sheet x1 y1 x2 y2*

Summary: Applies *sheet*'s transformation to the bounding rectangle specified by the corner points (*x1*, *y1*) and (*x2*, *y2*), returning the bounding rectangle of the transformed region as four values, *min-x*, *min-y*, *max-x*, and *max-y*. The arguments *x1*, *y1*, *x2*, and *y2* are canonicalized in the same way as for **make-bounding-rectangle**.

map-sheet-rectangle*-to-child *Generic Function*

map-sheet-rectangle*-to-child *sheet x1 y1 x2 y2*

Summary: Applies the inverse of the sheet *sheet*'s transformation to the bounding rectangle delimited by the corner points (*x1*, *y1*) and (*x2*, *y2*) (represented in *sheet*'s parent's coordinate system), returning the bounding rectangle of the transformed region as four values, *min-x*, *min-y*, *max-x*, and *max-y*. The arguments *x1*, *y1*, *x2*, and *y2* are canonicalized in the same way as for **make-bounding-rectangle**.

child-containing-position *Generic Function*

child-containing-position *sheet x y*

Summary: Returns the topmost enabled direct child of the sheet *sheet* whose region contains the position (*x*, *y*). The position is expressed in *sheet*'s coordinate system.

children-overlapping-region *Generic Function*

children-overlapping-region *sheet region*

children-overlapping-rectangle* *Generic Function*

children-overlapping-rectangle* *sheet x1 y1 x2 y2*

Summary: Returns the list of enabled direct children of the sheet *sheet* whose region overlaps the region *region*. **children-overlapping-rectangle*** is a special case of **children-overlapping-region** in which the region is a bounding rectangle whose corner points are (*x1*, *y1*) and (*x2*, *y2*). The region is expressed in *sheet*'s coordinate system. This function returns fresh objects that may be modified.

sheet-delta-transformation *Generic Function*

sheet-delta-transformation *sheet ancestor*

Summary: Returns a transformation that is the composition of all the sheet transformations between the sheets *sheet* and *ancestor*. If *ancestor* is **nil**, this returns the transformation to the root of the sheet hierarchy. If *ancestor* is not an ancestor of sheet, the **sheet-is-not-ancestor** error will be signaled.

The computation of the delta transformation is likely to be cached.

sheet-allocated-region *Generic Function*

sheet-allocated-region *sheet child*

Summary: Returns the visible region of the sheet *child* in the sheet *sheet*'s coordinate system. If *child* is occluded by any of its siblings, those siblings' regions are subtracted (using **region-difference**) from *child*'s actual region.

18.4.2 Sheet Geometry Classes

Each of the following implements the sheet geometry protocol in a different manner, according to the sheet's requirements.

sheet-identity-transformation-mixin *Class*

Summary: This class is mixed into sheet classes whose coordinate systems are identical to that of their parent.

sheet-translation-mixin *Class*

Summary: This class is mixed into sheet classes whose coordinate systems are related to that of their parent by a simple translation.

sheet-y-inverting-transformation-mixin *Class*

Summary: This class is mixed into sheet classes whose coordinate systems are related to that of their parent by inverting the **y** coordinate system, and optionally translating by some amount in **x** and **y**.

sheet-transformation-mixin *Class*

Summary: This class is mixed into sheet classes whose coordinate systems are related to that of their parent by an arbitrary affine transformation.

18.5 Sheet Protocols: Input

CLIM's windowing substrate provides an input architecture and standard functionality for notifying clients of input that is distributed to their sheets. Input includes such events as the pointer entering and exiting sheets, pointer motion (whose granularity is defined by performance limitations), and pointer button and keyboard events. At this level, input is represented as event objects.

Sheets either participate fully in the input protocol or are mute for input. If any functions in the input protocol are called on a sheet that is mute for input, the **`sheet-is-mute-for-input`** error will be signaled.

In addition to handling input event, a sheet is also responsible for providing other input services, such as controlling the pointer's appearance, and polling for current pointer and keyboard state.

Input is processed on a per-port basis.

The event-processing mechanism has three main tasks when it receives an event. First, it must determine to which ***client*** the event is addressed; this process is called ***distributing***. Typically, the client is a sheet, but there are other special-purpose clients to which events can also be dispatched. Next, it formats the event into a standard format, and finally it ***dispatches*** the event to the client. A client may then either handle the event synchronously, or it may queue it for later handling by another process.

Input events can be broadly categorized into ***pointer events*** and ***keyboard events***. By default, pointer events are dispatched to the lowest sheet in the hierarchy whose region contains the location of the pointer. Keyboard events are dispatched to the port's keyboard input focus; the accessor **`port-keyboard-input-focus`** contains the event client that receives the port's keyboard events.

18.5.1 Input Protocol Functions

In the functions listed here, the *client* argument is typically a sheet, but it may be another object that supports event distribution, dispatching, and handling.

port-keyboard-input-focus *Generic Function*

`port-keyboard-input-focus` *port*

(setf port-keyboard-input-focus) *Generic Function*

`(setf port-keyboard-input-focus)` *focus port*

Summary: Returns the client to which keyboard events are to be dispatched.

distribute-event *Generic Function*

`distribute-event` *port event*

> *Summary:* The *event* is distributed to the *port*'s proper client. In general, this will be the keyboard input focus for keyboard events, and the lowest sheet under the pointer for pointer events.

dispatch-event *Generic Function*

`dispatch-event` *client event*

> *Summary:* This function is called to inform a client about an event of interest. Most methods for this function will simply queue the event for later handling. Certain classes of clients and events may cause this function to call either **`queue-event`** or **`handle-event`** immediately, or else to ignore the event entirely.

queue-event *Generic Function*

`queue-event` *client event*

> *Summary:* Places the event *event* into the queue of events for the client *client*.

handle-event *Generic Function*

`handle-event` *client event*

> *Summary:* Implements the client's policy with respect to the event. For example, if the programmer wishes to highlight a sheet in response to an event that informs it that the pointer has entered its territory, there would be a method to carry out the policy that specializes the appropriate sheet and event classes.

In addition to **`queue-event`**, the queued input protocol handles the following generic functions:

event-read *Generic Function*

`event-read` *client*

> *Summary:* Takes the next event out of the queue of events for this client.

event-read-no-hang *Generic Function*

`event-read-no-hang` *client*

> *Summary:* Takes the next event out of the queue of events for this client. It returns **`nil`** if there are no events in the queue.

event-peek *Generic Function*

`event-peek` *client* **`&optional`** *event-type*

> *Summary:* Returns the next event in the queue without removing it from the queue. If *event-type* is supplied, events that are not of that type are first removed and discarded.

event-unread *Generic Function*

`event-unread` *client event*

> *Summary:* Places the *event* at the head of the *client*'s event queue, to be the event read next.

event-listen *Generic Function*

`event-listen` *client*

Summary: Returns **t** if there are any events queued for *client*; otherwise, it returns **nil**.

apply-in-sheet-process *Function*

apply-in-sheet-process *sheet function* **&rest** *args*

Summary: Applies *function* to *args* on the process that displays *sheet*.

The function **apply-in-sheet-process** arranges for *function* to apply to *args*, by **(apply** *function args***)**, in the process that displays *sheet*.

The application occurs only if *sheet* is inside a hierarchy of sheets that is currently displayed.

The result is **t** if **apply-in-sheet-process** "succeeded", which means it dispatched an event to perform the application. The application may still not happen if the process that display sheet does not reach the point of handling the event (e.g. the user closes the window).

apply-in-sheet-process is especially useful for using the display functions of CLIM (drawing and stream output), which need to happen on the correct process.

For example:

```
(apply-in-sheet-process sheet
      `draw-rectangle* sheet 10 10 100 100)
```

18.5.2 Input Protocol Classes

Most classes of sheets will have one of the following irun timenput protocol classes mixed in. Of course, a sheet can always have a specialized method for a specific class of event that will override the default. For example, a sheet may need to have only pointer click events dispatched to itself, and may delegate all other events to some other input client. Such a sheet should have **delegate-sheet-input-mixin** as a superclass, and have a more specific method for **dispatch-event** on its class and **pointer-button-click-event**.

standard-sheet-input-mixin *Class*

Summary: This class of sheet provides a method for **dispatch-event** that calls **queue-event** on each device event. Configuration events invoke **handle-event** immediately.

immediate-sheet-input-mixin *Class*

Summary: This class of sheet provides a method for **dispatch-event** that calls **handle-event** immediately for all events.

mute-sheet-input-mixin *Class*

Summary: This is mixed into any sheet class that does not handle any input events.

delegate-sheet-input-mixin *Class*

Summary: This class of sheet provides a method for **dispatch-event** that calls **dispatch-event** on a designated substitute and the event. The initialization argument **:delegate** or the accessor **delegate-sheet-delegate** may be used to set the recipient of dispatched events. A value of **nil** will cause input events to be discarded.

delegate-sheet-delegate *Generic Function*

delegate-sheet-delegate *sheet*

(setf delegate-sheet-delegate) *Generic Function*

`(setf delegate-sheet-delegate)` *delegate sheet*

Summary: This may be set to another recipient of events dispatched to a sheet of class **`delegate-sheet-input-mixin`**. If the delegate is **`nil`**, events are discarded.

18.6 Standard Device Events

An ***event*** is a CLIM object that represents some sort of user gesture (such as moving the pointer or pressing a key on the keyboard) or that corresponds to some sort of notification from the display server. Event objects store such things as the sheet associated with the event, the **`x`** and **`y`** position of the pointer within that sheet, the key name or character corresponding to a key on the keyboard, and so forth.

The following shows all the event classes, with all classes indented to the right of their superclasses:

```
event
  device-event
    keyboard-event
        key-press-event
        key-release-event
    pointer-event
      pointer-button-event
        pointer-button-press-event
          pointer-mouse-wheel-event
        pointer-button-release-event
        pointer-button-hold-event
      pointer-motion-event
        pointer-enter-event
        pointer-exit-event
    window-event
      window-configuration-event
      window-repaint-event
  timer-event
```

event *Protocol Class*

Summary: The protocol class that corresponds to any sort of event. If you want to create a new class that behaves like an event, it should be a subclass of **`event`**. Subclasses of **`event`** must obey the event protocol.

All of the event classes are immutable.

eventp *Function*

`eventp` *object*

Summary: Returns **`t`** if *object* is an event; otherwise, it returns **`nil`**.

:timestamp *Initarg*

Summary: All subclasses of **`event`** must take a **`:timestamp`** initarg, which is used to specify the timestamp for the event.

event-timestamp *Generic Function*

`event-timestamp` *event*

Summary: Returns an integer that is a monotonically increasing timestamp for the event *event*. The timestamp must have at least as many bits of precision as a fixnum.

event-type *Generic Function*

`event-type` *event*

Summary: For the event *event*, returns a keyword with the same name as the class name, except stripped of the "-event" ending. For example, the keyword **`:key-press`** is returned by **`event-type`** for an event whose class is **`key-press-event`**.

All event classes must implement methods for **`event-type`** and **`event-timestamp`**.

device-event *Class*

:sheet
:modifier-state *Initargs*

Summary: The class that corresponds to any sort of device event. This is a subclass of **`event`**.

All subclasses of **`device-event`** must take the **`:sheet`** and **`:modifier-state`** initargs, which are used to specify the sheet and modifier state components for the event.

event-sheet *Generic Function*

`event-sheet` *device-event*

Summary: Returns the sheet associated with the event *device-event*.

event-modifier-state *Generic Function*

`event-modifier-state` *device-event*

Summary: Returns a value that encodes the state of all the modifier keys on the keyboard. This will be a mask consisting of the **`logical-or`** of **`+shift-key+`**, **`+control-key+`**, **`+meta-key+`**, **`+super-key+`**, and **`+hyper-key+`**.

All device event classes must implement methods for **`event-sheet`** and **`event-modifier-state`**.

keyboard-event *Class*

:key-name *Initarg*

Summary: The class corresponding to any keyboard event; a subclass of **`device-event`**.

All subclasses of **`keyboard-event`** must take the **`:key-name`** initarg, which is used to specify the key name component for the event.

keyboard-event-key-name *Generic Function*

`keyboard-event-key-name` *keyboard-event*

Summary: Returns the name of the key pressed or released in a keyboard event. This will be a symbol whose value is port-specific. Key names corresponding to standard characters such as the alphanumerics will be symbols in the keyword package.

keyboard-event-character *Generic Function*

`keyboard-event-character` *keyboard-event*

Summary: Returns the character associated with the event *keyboard-event*, if there is any.

All keyboard event classes must implement methods for **`keyboard-event-key-name`** and **`keyboard-event-character`**.

key-press-event
key-release-event *Classes*

Summary: The classes corresponding to key press or release events. They are subclasses of **`keyboard-event`**.

pointer-event *Class*

:pointer
:button
:x
:y *Initargs*

Summary: The class corresponding to any pointer event. This is a subclass of **`device-event`**.

All subclasses of **`pointer-event`** must take the **`:pointer`**, **`:button`**, **`:x`**, and **`:y`** initargs, which are used to specify the pointer object, pointer button, and native **x** and **y** position of the pointer at the time of the event. The sheet's **x** and **y** positions are derived from the supplied native **x** and **y** positions and the sheet itself.

pointer-event-x *Generic Function*

`pointer-event-x` *pointer-event*

pointer-event-y *Generic Function*

`pointer-event-y` *pointer-event*

Summary: Returns the **x** and **y** position of the pointer at the time the event occurred, in the coordinate system of the sheet that received the event. All pointer events must implement a method for these generic functions.

pointer-event-native-x *Generic Function*

`pointer-event-native-x` *pointer-event*

pointer-event-native-y *Generic Function*

`pointer-event-native-y` *pointer-event*

Summary: Returns the **x** and **y** position of the pointer at the time the event occurred, in the pointer's native coordinate system. All pointer events must implement a method for these generic functions.

pointer-event-pointer *Generic Function*

`pointer-event-pointer` *pointer-event*

Summary: Returns the pointer object to which this event refers.

pointer-event-button *Generic Function*

`pointer-event-button` *pointer-event*

Summary: Returns an integer, the number of the pointer button that was pressed. Programs should compare this against the constants **`+pointer-left-button+`**, **`+pointer-middle-button+`**, **`+pointer-right-button+`** and **`+pointer-wheel+`** to see what value was returned.

All pointer event classes must implement methods for **`pointer-event-x`**, **`pointer-event-y`**, **`pointer-event-native-x`**, **`pointer-event-native-y`**, **`pointer-event-pointer`**, and **`pointer-event-button`**.

pointer-event-shift-mask *Generic Function*

pointer-event-shift-mask *pointer-button-event*

Summary: Returns the state of the keyboard's shift keys when *pointer-button-event* occurred.

pointer-button-event *Class*

Summary: The class corresponding to any sort of pointer button event. It is a subclass of **pointer-event**.

pointer-button-press-event

pointer-button-release-event

pointer-button-hold-event *Classes*

Summary: The classes that correspond to a pointer button press, button release, and click-and-hold events. These are subclasses of **pointer-button-event**.

pointer-mouse-wheel-event *Class*

Summary: The class that corresponds to rotating the wheel on a mouse with modifiers, which can be shift, control or both. This is a subclass of **pointer-button-press-event**.

When **pointer-event-button** is called on an instance of **pointer-mouse-wheel-event** it returns **+pointer-wheel+**.

pointer-mouse-wheel-event-amount *Generic Function*

pointer-mouse-wheel-event-amount *pointer-mouse-wheel-event*

Summary: Returns the number of ticks that the wheel rotated. It is positive when the top of the wheel is pushed away from the user, and negative when it is pulled towards the user.

pointer-button-click-event

pointer-button-double-click-event

pointer-button-click-and-hold-event *Classes*

Summary: The classes that correspond to a pointer button press followed by (respectively) a button release, another button press, or pointer motion. These are subclasses of **pointer-button-event**. Ports are not required to generate these events.

pointer-motion-event *Class*

Summary: The class that corresponds to any sort of pointer motion event. This is a subclass of **pointer-event**.

pointer-enter-event

pointer-exit-event *Classes*

Summary: The classes that correspond to a pointer enter or exit event. This is a subclass of **pointer-motion-event**.

window-event *Class*

:region *Initarg*

Summary: The class that corresponds to any sort of windowing event. This is a subclass of **device-event**.

All subclasses of **window-event** must take a **:region** initarg, which is used to specify the damage region associated with the event.

window-event-region *Generic Function*

`window-event-region` *window-event*

Summary: Returns the region of the sheet that is affected by a window event.

window-event-native-region *Generic Function*

`window-event-native-region` *window-event*

Summary: Returns the region of the sheet in native coordinates.

window-event-mirrored-sheet *Generic Function*

`window-event-mirrored-sheet` *window-event*

Summary: Returns the mirrored sheet that is attached to the mirror on which the event occurred.

All window event classes must implement methods for **`window-event-region`**, **`window-event-native-region`**, and **`window-event-mirrored-sheet`**.

window-configuration-event *Class*

Summary: The class that corresponds to a window changing its size or position. This is a subclass of **`window-event`**.

window-repaint-event *Class*

Summary: The class that corresponds to a request to repaint the window. This is a subclass of **`window-event`**.

timer-event *Class*

Summary: The class that corresponds to a timeout event. This is a subclass of **`event`**.

+pointer-left-button+

+pointer-middle-button+

+pointer-right-button+

+pointer-wheel+ *Constants*

Summary: Constants that correspond to the left, middle, right button and wheel on a pointing device. **`pointer-event-button`** will returns one of these four values.

+shift-key+

+control-key+

+meta-key+

+super-key+

+hyper-key+ *Constants*

Summary: Constants that correspond to the **`SHIFT`**, **`CONTROL`**, **`META`**, **`SUPER`**, and **`HYPER`** modifier keys being held down on the keyboard. These constants must be powers of 2 so that they can be combined with **`logical-or`** and tested with **`logtest`**. **`event-modifier-state`** will return some combination of these values.

CLIM does not provide default key mappings for **`META`**, **`HYPER`**, or **`SUPER`** modifier keys, as they are keyboard/X-server specific.

key-modifier-state-match-p *Macro*

key-modifier-state-match-p *button modifier-state* **&body** *clauses*

Summary: This macro generates code that will check whether the modifier state *modifier-state* and the pointer button *button* match all of the clauses. *clauses* are implicitly grouped by **and**. Matching a button or a modifier means that the modifier state indicates that the button or modifier is pressed.

A clause may be one of:

- A pointer button (one of **:left**, **:middle**, or **:right**)
- A modifier key (one of **:shift**, **:control**, **:meta**, **:super**, or **:hyper**)
- **(and [***clause***]+)**
- **(or [***clause***]+)**
- **(not** *clause***)**

18.6.1 The mouse wheel

When the mouse wheel is used without a modifier key, it is interpreted as scrolling. The innermost pane that has a scroll bar and contains the mouse is scrolled vertically if it has a vertical scroll bar, otherwise it is scrolled horizontally.

Note: For gadgets, in particular for **list-pane**, the focus must be on the gadget for it to scroll.

If the mouse wheel is used with a modifier key, which can be shift or control, then an event is generated. The event is of type **pointer-mouse-wheel-event**, which is a subtype **pointer-button-press-event**. **pointer-event-button** returns **+pointer-wheel+** for such an event.

In addition to all the information that **pointer-button-press-event** contains, **pointer-mouse-wheel-event** also contains the amount of wheel rotation. This can be found by the reader **pointer-mouse-wheel-event-amount**, which returns a number. The number is positive when the top of the wheel is pushed away from the user, and negative when it is pulled towards the user. The units of the number are ticks of the wheel, and normally it is either 1 or -1.

The function **add-gesture-name** and macro **define-gesture-name**, when used with *type* **:pointer-button**, can also take **:wheel** as *button-name* (in addition to **:left**, **:middle** and **:right**). CLIM adds (by using **add-gesture-name**) two gestures, **:zoom** for **(:wheel :control)**, and **:rotate** for **(:wheel :shift)**. However, it does not make any assumptions about what these gestures actually do. You can define your own gestures as well.

The *arglist*, *tester-arglist* and *doc-arglist* arguments in the translator macros (**define-presentation-translator**, **define-presentation-to-command-translator** and **define-presentation-action**) can also contain *amount*, in addition to the already documented "canonical" symbols that are listed in the documentation of **define-presentation-translator**. When the *gesture* argument specifies a gesture that is mapped to a wheel event (such as **:zoom** or **:rotate** above), the variable *amount* is bound to the amount that **pointer-mouse-wheel-event-amount** would return for the event. In another cases it is always 0.

For example, assuming you have a frame *my-frame*, and two functions *my-zoom-function-up* and *my-zoom-function-down* that know how to zoom windows in this frame, then the two forms below can be used to invoke these functions when the user moves the mouse wheel while pressing the control button:

```
(define-frame-command my-frame my-zoom-command ((window window)
                                                (amount t))
  (if (> amount 0)
      (my-zoom-function-up window)
    (my-zoom-function-down window)))

(define-presentation-to-command-translator my-zoom-trans
```

```
        (t my-zoom-command my-frame
         :gesture :zoom)
        (window amount)
      (list window amount))
```

18.7 Sheet Protocols: Output

The output protocol is concerned with the appearance of displayed output on the window associated with a sheet. The sheet output protocol is responsible for providing a means of doing output to a sheet, and for delivering repaint requests to the sheet's client.

Sheets either participate fully in the output protocol or are mute for output. If any functions in the output protocol are called on a sheet that is mute for output, the **sheet-is-mute-for-output** error will be signaled.

18.7.1 Mediums and Output Properties

Each sheet retains some output state that logically describes how output is to be rendered on its window. Such information as the foreground and background ink, line thickness, and transformation to be used during drawing are provided by this state. This state may be stored in a ***medium*** associated with the sheet itself, may be derived from a parent, or may have some global default, depending on the sheet itself.

If a sheet is mute for output, it is an error to set any of these values.

---

medium *Protocol Class*

Summary: The protocol class that corresponds to the output state for some kind of sheet. There is no single advertised standard medium class. If you want to create a new class that behaves like a medium, it should be a subclass of **medium**. Subclasses of **medium** must obey the medium protocol.

---

mediump *Function*

mediump *object*

Summary: Returns **t** if *object* is a medium; otherwise, it returns **nil**.

---

basic-medium *Class*

Summary: The basic class on which all CLIM mediums are built, a subclass of **medium**. This class is an abstract class intended only to be subclassed, not instantiated.

The following generic functions comprise the basic medium protocol. All mediums must implement methods for these generic functions. Often, a sheet class that supports the output protocol will implement a "trampoline" method that passes the operation on to **sheet-medium** of the sheet.

---

medium-foreground *Generic Function*

medium-foreground *medium*

(setf medium-foreground) *Generic Function*

(setf medium-foreground) *ink medium*

Summary: Returns (or sets) the current foreground ink for the medium *medium*. For details, see **3.1 CLIM Mediums**.

---

medium-background *Generic Function*

medium-background *medium*

(setf medium-background)

Generic Function

`(setf medium-background)` *ink medium*

Summary: Returns (or sets) the current background ink for the medium *medium*. This is described in detail in **3.1 CLIM Mediums**.

medium-ink

Generic Function

`medium-ink` *medium*

(setf medium-ink)

Generic Function

`(setf medium-ink)` *ink medium*

Summary: Returns (or sets) the current drawing ink for the medium *medium*. This is described in detail in **3.1 CLIM Mediums**.

medium-transformation

Generic Function

`medium-transformation` *medium*

(setf medium-transformation)

Generic Function

`(setf medium-transformation)` *transformation medium*

Summary: Returns (or sets) the user transformation that converts the coordinates presented to the drawing functions by the programmer to the medium *medium*'s coordinate system. By default, it is the identity transformation. This is described in detail in **3.1 CLIM Mediums**.

medium-clipping-region

Generic Function

`medium-clipping-region` *medium*

(setf medium-clipping-region)

Generic Function

`(setf medium-clipping-region)` *region medium*

Summary: Returns (or sets) the clipping region that encloses all output performed on the medium *medium*. It is returned and set in user coordinates. That is, to convert the user clipping region to medium coordinates, it must be transformed by the value of **`medium-transformation`**. For example, the values returned by:

```
(let (cr1 cr2)
  ;; Ensure that the sheet's clipping region
  ;; and transformation will be reset:
  (with-drawing-options
   (sheet :transformation +identity-transformation+
          :clipping-region +everywhere+)
   (setf (medium-clipping-region sheet)
         (make-rectangle* 0 0 10 10))
   (setf (medium-transformation sheet)
         (clim:make-scaling-transformation 2 2))
   (setf cr1 (medium-clipping-region sheet))
   (setf (medium-clipping-region sheet)
         (make-rectangle* 0 0 10 10))
   (setf (medium-transformation sheet) +identity-transformation+)
   (setf cr2 (medium-clipping-region sheet)))
  (values cr1 cr2))
```

are two rectangles. The first one has edges of (0, 0, 5, 5), while the second one has edges of (0, 0, 20, 20).

By default, the user clipping region is the value of **+everywhere+**.

medium-line-style *Generic Function*

medium-line-style *medium*

(setf medium-line-style) *Generic Function*

(setf medium-line-style) *line-style medium*

Summary: Returns (or sets) the current line style for the medium *medium*. This is described in detail in **3.1 CLIM Mediums**.

medium-text-style *Generic Function*

medium-text-style *medium*

(setf medium-text-style) *Generic Function*

(setf medium-text-style) *text-style medium*

Summary: Returns (or sets) the current text style for the medium *medium* of any textual output that may be displayed on the window. This is described in detail in **3.1 CLIM Mediums**.

medium-default-text-style *Generic Function*

medium-default-text-style *medium*

(setf medium-default-text-style) *Generic Function*

(setf medium-default-text-style) *text-style medium*

Summary: Returns (or sets) the default text style for output on the medium *medium*. This is described in detail in **3.2 Using CLIM Drawing Options**.

medium-merged-text-style *Generic Function*

medium-merged-text-style *medium*

Summary: Returns the actual text style used in rendering text on the medium *medium*. It returns the result of:

```
(merge-text-styles (medium-text-style medium)
                   (medium-default-text-style medium))
```

Those components of the current text style that are not **nil** will replace the defaults from medium's default text style. Unlike the preceding text style function, **medium-merged-text-style** is read-only.

18.7.2 Output Protocol Functions

The output protocol functions on mediums (and sheets that support the standard output protocol) include those functions described in **2.4 Graphics Protocols**.

18.7.3 Output Protocol Classes

The following classes implement the standard output protocols.

standard-sheet-output-mixin *Class*

Summary: This class is mixed into any sheet that provides the standard output protocol, such as repainting and graphics.

mute-sheet-output-mixin *Class*

Summary: This class is mixed into any sheet that provides none of the output protocol.

permanent-medium-sheet-output-mixin *Class*

Summary: This class is mixed into any sheet that always has a medium associated with it.

temporary-medium-sheet-output-mixin *Class*

Summary: This class is mixed into any sheet that may have a medium associated with it, but does not necessarily have a medium at any given instant.

18.7.4 Associating a Medium With a Sheet

Before a sheet may be used for output, it must be associated with a medium. Some sheets are permanently associated with mediums for output efficiency; for example, CLIM window stream sheets have mediums that are permanently allocated to windows.

However, many kinds of sheets only perform output infrequently, and therefore do not need to be associated with a medium except when output is actually required. Sheets without a permanently associated medium can be much more lightweight than they otherwise would be. For example, in a program that creates a sheet for the purpose of displaying a border for another sheet, the border sheet receives output only when the window's shape is changed.

To associate a sheet with a medium, use the macro **`with-sheet-medium`**.

Usually CLIM application programmers will not deal with mediums directly. In most cases, panes will automatically be associated with a medium upon creation. The specific medium object is chosen based on the port being used. An exception is when a "special" medium is created and used with sheets that normally default to a different medium.

with-sheet-medium *Macro*

`with-sheet-medium (`*medium sheet***`) &body`** *body*

Summary: Within the body, the variable *medium* is bound to the sheet's medium. If the sheet does not have a medium permanently allocated, one will be allocated, associated with the sheet for the duration of the body, and deallocated when the body has been exited. The values of the last form of the body are returned as the values of **`with-sheet-medium`**.

The *medium* argument is not evaluated, and must be a symbol that is bound to a medium. *body* may have zero or more declarations as its first forms.

with-sheet-medium-bound *Macro*

`with-sheet-medium-bound (`*sheet medium***`) &body`** *body*

Summary: **`with-sheet-medium-bound`** is used to associate the specific medium *medium* with the sheet *sheet* for the duration of the body *body*. Typically, a single medium will be allocated and passed to several different sheets that can use the same medium.

If the sheet already has a medium allocated to it, the new medium will not be given to the sheet. If the value of *medium* is **`nil`**, **`with-sheet-medium-bound`** is exactly equivalent to **`with-sheet-medium`**. The values of the last form of the body are returned as the values of **`with-sheet-medium-bound`**.

body may have zero or more declarations as its first forms.

sheet-medium *Generic Function*

sheet-medium *sheet*

Summary: Returns the medium associated with the sheet *sheet*. If *sheet* does not have a medium allocated to it, **sheet-medium** returns **nil**.

18.8 Repaint Protocol

The repaint protocol is the mechanism whereby a program keeps the display up-to-date, reflecting the results of both synchronous and asynchronous events. The repaint mechanism may be invoked by user programs each time through their top-level command loop. It may also be invoked directly or indirectly as a result of events received from the display server host. For example, if a window is on display with another window overlapping it and the second window is buried, a "damage notification" event may be sent by the server. CLIM would then cause a repaint to be executed for the newly-exposed region.

18.8.1 Repaint Protocol Functions

queue-repaint *Generic Function*

queue-repaint *sheet region*

Summary: Requests that a repaint event for the region *region* be placed in the input queue of the sheet *sheet*. A program that reads events out of the queue will be expected to call **handle-event** for the repaint region; the method for that generic function on repaint events will generally call **repaint-sheet**.

handle-repaint *Generic Function*

handle-repaint *sheet region*

Summary: Implements repainting for a given sheet class. It may only be called on a sheet that has an associated medium. *sheet* and *region* are as for **dispatch-repaint**.

repaint-sheet *Generic Function*

repaint-sheet *sheet medium region*

Summary: Recursively causes repainting of the sheet *sheet* and any of its children that overlap the region *region*. *medium* is the medium to use for the repainting; if it is **nil**, **handle-repaint** will allocate a medium and associate it with the sheet. **handle-repaint** will call **repaint-sheet** on *sheet*, and then call **handle-repaint** on all of the children of *sheet*.

18.8.2 Repaint Protocol Classes

standard-repainting-mixin *Class*

Summary: Defines a **dispatch-repaint** method that calls **queue-repaint**.

immediate-repainting-mixin *Class*

Summary: Defines a **dispatch-repaint** method that calls **handle-repaint**.

mute-repainting-mixin *Class*

Summary: Defines a **dispatch-repaint** method that calls **queue-repaint**, and a method on **repaint-sheet** that does nothing. This means that its children will be recursively repainted when the repaint event is handled.

18.9 Sheet Notification Protocol

The notification protocol allows sheet clients to be notified when a sheet hierarchy is changed. Sheet clients can observe modification events by providing **`:after`** methods for functions defined by this protocol.

18.9.1 Relationship to Window System Change Notifications

note-sheet-grafted *Generic Function*

`note-sheet-grafted` *sheet*

note-sheet-degrafted *Generic Function*

`note-sheet-degrafted` *sheet*

note-sheet-adopted *Generic Function*

`note-sheet-adopted` *sheet*

note-sheet-disowned *Generic Function*

`note-sheet-disowned` *sheet*

note-sheet-enabled *Generic Function*

`note-sheet-enabled` *sheet*

note-sheet-disabled *Generic Function*

`note-sheet-disabled` *sheet*

Summary: These notification functions are invoked when a state change has been made to the sheet *sheet*.

18.9.2 Sheet Geometry Notifications

note-sheet-region-changed *Generic Function*

`note-sheet-region-changed` *sheet*

note-sheet-transformation-changed *Generic Function*

`note-sheet-transformation-changed` *sheet*

Summary: These notification functions are invoked when the region or transformation of the sheet *sheet* has been changed. When the regions and transformations of a sheet are changed directly, the client is required to call **`note-sheet-region-changed`** or **`note-sheet-transformation-changed`**.

19 Ports, Grafts, and Mirrored Sheets

19.1 Introduction

A sheet hierarchy must be attached to a display server so as to permit input and output. This is managed by the use of objects known as ***ports*** and ***grafts***.

19.2 Ports

A ***port*** is a logical connection to a display server. It is responsible for managing display output and server resources and for handling incoming input events. Typically, the programmer will create a single port that will manage all of the windows on the display.

A port is described by a ***server path***. A server path is a list whose first element is a keyword that selects the kind of port. The remainder of the server path is a list of alternating keywords and values whose interpretation is specific to the port type.

port *Protocol Class*

Summary: The protocol class that corresponds to a port. If you want to create a new class that behaves like a port, it should be a subclass of **port**. Subclasses of **port** must obey the medium protocol.

portp *Function*

portp *object*

Summary: Returns **t** if *object* is a port; otherwise, it returns **nil**.

basic-port *Class*

Summary: The basic class on which all CLIM ports are built, a subclass of **port**. This class is an abstract class intended only to be subclassed, not instantiated.

find-port *Function*

find-port &key (*server-path* ******default-server-path****)**

Summary: Finds a port that provides a connection to the window server addressed by *server-path*. If no such connection exists, a new connection will be constructed and returned. **find-port** is called automatically by **make-application-frame**.

The following server paths are currently supported on the appropriate platforms:

:motif
:win32 *Server Paths*

:motif &key *host display-number screen-id*

Summary: Given this server path, **find-port** finds a port for the X server on the given *host*, using the *display-id* and *screen-id*.

On a Unix host, if these values are not supplied, the defaults are derived from the **DISPLAY** environment variable.

default-server-path *Variable*

Summary: This special variable is used by **find-port** and its callers to default the choice of a display service to locate. Binding this variable in a dynamic context will affect the defaulting of this argument to these functions. This variable will be defaulted according to the environment. In the Unix environment, for example, CLIM tries to set this variable based on the value of the **DISPLAY** environment variable.

port *Generic Function*

port *object*

Summary: Returns the port associated with *object*. **port** is defined for all sheet classes (including grafts and streams that support the CLIM graphics protocol), mediums, and application frames. For degrafted sheets or other objects that are not currently associated with particular ports, **port** will return **nil**.

with-port-locked *Macro*

with-port-locked *port* **&body** *body*

Summary: Executes *body* after grabbing a lock associated with the port *port*, which may be a port or any object on which the function **port** works. If *object* currently has no port, *body* will be executed without locking.

body may have zero or more declarations as its first forms.

port-server-path *Generic Function*

port-server-path *port*

Summary: Returns the server path associated with the port *port*.

port-properties *Generic Function*

port-properties *port indicator*

(setf port-properties) *Generic Function*

(setf port-properties) *property port indicator*

Summary: These functions provide a port-based property list. They are primarily intended to support users of CLIM who may need to associate certain information with ports. For example, the implementor of a special graphics package may need to maintain resource tables for each port on which it is used.

map-over-ports *Function*

map-over-ports *function*

Summary: Invokes *function* on each existing port. *function* is a function of one argument, the port; it has dynamic extent.

restart-port *Generic Function*

restart-port *port*

Summary: In a multi-process Lisp, **restart-port** restarts the global input processing loop associated with the port *port*. All pending input events are discarded. Server resources may or may not be released and reallocated during or after this action.

destroy-port *Generic Function*

destroy-port *port*

Summary: Destroys the connection with the window server represented by the port *port*. All sheet hierarchies that are associated with *port* are forcibly degrafted by disowning the children of grafts on *port* using **`sheet-disown-child`**. All server resources utilized by such hierarchies or by any graphics objects on *port* are released as part of the connection shutdown.

19.3 Grafts

A ***graft*** is a special sheet that is directly connected to a display server. Typically, a graft is the CLIM sheet that represents the root window of the display. There may be several grafts that are all attached to the same root window but that have differing coordinate systems.

To display a sheet on a display, it must have a graft as an ancestor. In addition, the sheet and all of its ancestors must be enabled, including the graft. In general, a sheet becomes grafted when it (or one of its ancestors) is adopted by a graft.

sheet-grafted-p *Generic Function*

`sheet-grafted-p` *sheet*

Summary: Returns **`t`** if any of the sheet's ancestors is a graft; otherwise, it returns **`nil`**.

find-graft *Function*

`find-graft &key (`*port* **`(`***find-port***`))`** **`(`***server-path* **`*`***default-server-path***`*)`** **`(`***orientation* **`:`***default***`)`** **`(`***units* **`:`***device***`)`**

Summary: Finds a graft that represents the display device on the port *port* that also matches the other supplied parameters. If no such graft exists, a new graft is constructed and returned. **`find-graft`** is called automatically by **`make-application-frame`**.

If *server-path* is supplied, **`find-graft`** finds a graft whose port provides a connection to the window server addressed by *server-path*.

It is an error to provide both *port* and *server-path* in a call to **`find-graft`**.

orientation specifies the orientation of the graft's coordinate system. It is one of:

- **`:default`**—a coordinate system with its origin is in the upper left hand corner of the display device with **y** increasing from top to bottom and **x** increasing from left to right.
- **`:graphics`**—a coordinate system with its origin in the lower left hand corner of the display device with **y** increasing from bottom to top and **x** increasing from left to right.

units specifies the units of the coordinate system and defaults to **`:device`**, which means the device units of the host window system (such as pixels). Other supported values include **`:inches`**, **`:millimeters`**, and **`:screen-sized`**, which means that one unit in each direction is the width and height of the display device.

graft *Generic Function*

`graft` *object*

Summary: Returns the graft currently associated with *object*. **`graft`** is defined for all sheet classes (including streams that support the CLIM graphics protocol), mediums, and application frames. For degrafted sheets or other objects that are not currently associated with a particular graft, **`graft`** will return **`nil`**.

map-over-grafts *Function*

`map-over-grafts` *function port*

Summary: Invokes *function* on each existing graft associated with the port *port*. *function* is a function of one argument, the graft; it has dynamic extent.

with-graft-locked *Macro*

`with-graft-locked` *graft* **`&body`** *body*

> *Summary:* Executes *body* after grabbing a lock associated with the graft *graft*, which may be a graft or any object on which the function **`graft`** works. If *object* currently has no graft, *body* will be executed without locking.
>
> *body* may have zero or more declarations as its first forms.

graft-orientation *Generic Function*

`graft-orientation` *graft*

> *Summary:* Returns the orientation of the graft *graft*'s coordinate system. The returned value is either **`:default`** or **`:graphics`**; see the *orientation* argument to **`find-graft`**.

graft-units *Generic Function*

`graft-units` *graft*

> *Summary:* Returns the units of *graft*'s coordinate system, which will be one of **`:device`**, **`:inches`**, **`:millimeters`**, or **`:screen-sized`**; see the *units* argument to **`find-graft`**.

graft-width *Generic Function*

`graft-width` *graft* **`&key (`***units* **`:`***device***`)`**

graft-height *Generic Function*

`graft-height` *graft* **`&key (`***units* **`:`***device***`)`**

> *Summary:* Returns the width and height of *graft* (and by extension the associated host window) in the units indicated. *units* may be any of **`:device`**, **`:inches`**, **`:millimeters`**, or **`:screen-sized`**; see the *units* argument to **`find-graft`**. Note that if a *unit* of **`:screen-sized`** is specified, both of these functions will return a value of **`1`**.

graft-pixels-per-millimeter *Function*

`graft-pixels-per-millimeter` *graft*

graft-pixels-per-inch *Function*

`graft-pixels-per-inch` *graft*

> *Summary:* Returns the number of pixels per millimeter or inch of *graft*. These are only for convenience; you can write similar functions with **`graft-width`** or **`graft-height`**.

19.4 Mirrors and Mirrored Sheets

A ***mirrored sheet*** is a special class of sheet that is attached directly to a window on a display server. Grafts, for example, are always mirrored sheets. However, any sheet anywhere in a sheet hierarchy may be a mirrored sheet. A mirrored sheet will usually contain a reference to a window system object, called a mirror. For example, a mirrored sheet attached to a Motif server might have an X window system object stored in one of its slots. Allowing mirrored sheets at any point in the hierarchy enables the adaptive toolkit facilities.

Since not all sheets in the hierarchy have mirrors, there is no direct correspondence between the sheet hierarchy and the mirror hierarchy. However, on those display servers that support hierarchical windows, the hierarchies must be parallel. If a mirrored sheet is an ancestor of another mirrored sheet, their corresponding mirrors must have a similar ancestor/descendant relationship.

CLIM interacts with mirrors when it must display output or process events. On output, the mirrored sheet closest in ancestry to the sheet on which we wish to draw provides the mirror on which to draw. The mirror's drawing clipping region is set up to be the intersection of the user's clipping region and the sheet's region (both transformed to the appropriate coordinate system) for the duration of the output. On input, events are delivered from mirrors to the sheet hierarchy. The CLIM port must determine which sheet shall receive events based on information such as the location of the pointer.

In both of these cases, we must have a coordinate transformation that converts coordinates in the mirror (so-called "native" coordinates) into coordinates in the sheet and vice-versa.

19.4.1 Mirror Functions

A mirror is the Lisp object that is the handle to the actual toolkit window or gadget.

sheet-direct-mirror *Generic Function*

`sheet-direct-mirror` *sheet*

Summary: Returns the mirror of the sheet *sheet*. If the sheet is not mirrored (or does not currently have a mirror), **`sheet-mirror`** returns **`nil`**.

sheet-mirrored-ancestor *Generic Function*

`sheet-mirrored-ancestor` *sheet*

Summary: Returns the nearest mirrored ancestor of the sheet *sheet*.

sheet-mirror *Generic Function*

`sheet-mirror` *sheet*

Summary: Returns the mirror of the sheet *sheet*. If the sheet is not itself mirrored, **`sheet-mirror`** returns the direct mirror of its nearest mirrored ancestor. **`sheet-mirror`** could be implemented as:

```
(defun sheet-mirror (sheet)
  (sheet-direct-mirror (sheet-mirrored-ancestor sheet)))
```

realize-mirror *Generic Function*

`realize-mirror` *port mirrored-sheet*

Summary: Creates a mirror for the sheet *mirrored-sheet* on the port *port*, if it does not already have one. The returned value is the sheet's mirror.

19.4.2 Internal Interfaces for Native Coordinates

sheet-native-transformation *Generic Function*

`sheet-native-transformation` *sheet*

Summary: Returns the transformation for the sheet *sheet* that converts sheet coordinates into native coordinates. The object returned by this function is volatile, so programmers must not depend on the components of the object remaining constant.

sheet-native-region *Generic Function*

`sheet-native-region` *sheet*

Summary: Returns the region for the sheet *sheet* in native coordinates. The object returned by this function is volatile, so programmers must not depend on the components of the object remaining constant.

sheet-device-transformation *Generic Function*

`sheet-device-transformation` *sheet*

Summary: Returns the transformation used by the graphics output routines when drawing on the mirror. This is the composition of the sheet's native transformation and the user transformation. The object returned by this function is volatile, so programmers must not depend on the components of the object remaining constant.

sheet-device-region *Generic Function*

`sheet-device-region` *sheet*

Summary: Returns the actual clipping region to be used when drawing on the mirror. This is the intersection of the user's clipping region (transformed by the device transformation) with the sheet's native region. The object returned by this function is volatile, so programmers must not depend on the components of the object remaining constant.

invalidate-cached-transformations *Generic Function*

`invalidate-cached-transformations` *sheet*

Summary: **`sheet-native-transformation`** and **`sheet-device-transformation`** typically cache the transformations for performance reasons. **`invalidate-cached-transformations`** clears the cached native and device values for the sheet *sheet*'s transformation and clipping region. It is invoked when a sheet's native transformation changes, which happens when a sheet's transformation is changed or when **`invalidate-cached-transformations`** is called on any of its ancestors.

invalidate-cached-regions *Generic Function*

`invalidate-cached-regions` *sheet*

Summary: **`sheet-native-region`** and **`sheet-device-region`** typically cache the regions for performance reasons. **`invalidate-cached-regions`** clears the cached native and device values for the sheet *sheet*'s native clipping region. It is invoked when a sheet's native clipping region changes, which happens when the clipping region changes or when **`invalidate-cached-regions`** is called on any of its ancestors.

Appendix A: Glossary

abstract panes

Panes that are defined only in terms of their programmer interface or behavior. The protocol for an abstract pane specifies the pane in terms of its overall purpose, rather than in terms of its specific appearance or particular interactive details, so that multiple implementations of the pane are possible, each defining its own look and feel. CLIM selects the appropriate pane implementation, based on factors outside the control of the application. See *adaptive panes*.

adaptive panes

A subset of the *abstract panes* (q.v.), adaptive panes are defined to integrate well across all CLIM operating platforms.

adaptive toolkit

A uniform interface to the standard "widget" or "gadget" toolkits available in many environments. The adaptive toolkit enables a single user interface to adopt the individual look and feel of a variety of host systems.

adopted

A sheet is said to be adopted when it has a parent sheet. A sheet becomes the child of another sheet by adoption.

affine transformation

See *transformation*.

ancestors

The parent of a sheet or an output record, and all of its ancestors, recursively.

applicable

A presentation translator is said to be applicable when the pointer is pointing to a presentation whose presentation type matches the current input context, and the other criteria for translator matching have been met.

application frame

1. A program that interacts directly with a user to perform some specific task.
2. A Lisp object that holds the information associated with such a program, including the panes of the user interface and application state variables.

area

A region that has two dimensions, length and width.

background ink

Ink that has the same design as the background, so that drawing with it results in erasure.

bounded design

A design that is transparent everywhere beyond a certain distance from a certain point. Drawing a bounded design has no effect on the drawing plane outside that distance.

bounded region

A region that contains at least one point and for which there exists a number, **d**, called the region's diameter, such that if **p1** and **p2** are points in the region, the distance between **p1** and **p2** is always less than or equal to **d**.

bounding rectangle

1. The smallest rectangle that surrounds a bounded region and contains every point in the region, and that may contain additional points as well. The sides of a bounding rectangle are parallel to the coordinate axes.
2. A Lisp object that represents a bounding rectangle.

cache value

A value used during incremental redisplay to determine whether or not a piece of output has changed.

callback

A function that informs an application that one of its gadgets has been used.

children

The direct descendants of a sheet or an output record.

clip, clipping region

A parent window is said to clip its child when only the part of the child window that overlaps the parent is viewable. A clipping region is that part of a window to which the output of a bitmap or a list of rectangles has been restricted.

color

1. An object representing the intuitive definition of a color, such as black or red.
2. A Lisp object that represents a color.

colored design

A design whose points have color.

colorless design

A design whose points have no color. Drawing a colorless design uses the default color specified by the medium's foreground design.

command

1. The way CLIM represents a user interaction.
2. A Lisp object that represents a command.

command name

A symbol that designates a particular command.

command table

1. A way of collecting and organizing a group of related commands and defining the interaction styles that can be used to invoke those commands.
2. A Lisp object that represents a command table.

command table designator

A Lisp object that is either a command table or a symbol that names a command table.

completion

A facility provided by CLIM for completing user input over a set of possibilities.

composite pane

A pane that can have a child pane (cf. *leaf pane*).

compositing

The creation of a design whose appearance at each point is a composite of the appearances of two other designs at that point. There are three varieties of compositing: composing over, composing in, and composing out.

composition

The transformation from one coordinate system to another, then from the second to a third, can be represented by a single transformation that is the composition of the two component transformations. Transformations are closed under composition. Composition is not commutative. Any arbitrary transformation can be built up by composing a number of simpler transformations, but that composition is not unique.

context-dependent input

In the presentation-type system, presentation input is context-dependent because only presentations that match the requirements of the application are accepted as input.

DAG

See *directed acyclic graph*.

degrafted

Not grafted; see *grafted*.

descendants

All of the children of a sheet or an output record, and all of their descendants, recursively.

design

An object that represents a way of arranging colors and opacities in the drawing plane. A mapping from an (**x**, **y**) pair into color and opacity values.

device transformation

The transformation used by the graphics output routines when drawing on the mirror. It is the composition of the sheet's native transformation and the user transformation.

directed acyclic graph

A graph with no closed paths whose arcs have direction.

disowned

Having no parent. An object ceases being the child of another object by being disowned. See also *adopted*.

disabled

Not enabled; See *enabled*.

dispatching

The process of sending an input event to the client to which it is addressed.

display server

A window system; a screen and its input devices, together with the combination of graphics display, hardware, and X server software that drives them.

displayed output record

1. An output record that corresponds to a visible piece of output, such as text or graphics.
2. The leaves of the output record tree.

distributing

The process of determining to which client an input **`event`** (q.v.) is addressed.

drawing plane

An infinite two-dimensional plane on which graphical output occurs. A drawing plane contains an arrangement of colors and opacities that is modified by each graphical output operation.

enabled

A sheet is said to be enabled when its parent has provided space for it. If a sheet and its ancestors are enabled and *grafted* (q.v.), then the sheet will be visible if it occupies a portion of the graft region that is not *clipped* (q.v.) by its ancestors or their siblings.

event

1. A significant action, such as a user gesture (e.g., moving the pointer, pressing a pointer button, or typing a keystroke) or a window configuration change (e.g., resizing a window).
2. A Lisp object that represents an event.

extended input stream

A kind of sheet that supports CLIM's extended input stream protocol, e.g., by supporting a pointing device.

extended output stream

A kind of sheet that supports CLIM's extended output stream protocol, e.g., by supporting a variable line-height text rendering.

false

1. The boolean value false.
2. The Lisp object **`nil`**.

flipping ink

1. An ink that interchanges occurrences of two designs, such as might be done by **`(xor)`** on a monochrome display.
2. A Lisp object that represents a flipping ink.

foreground

The design used when drawing with **`+foreground-ink+`**.

formatted output

1. Output that obeys some high-level constraints on its appearance, such as being arranged in a tabular format or justified within some margins.
2. The CLIM facility that provides a programmer with the tools to produce such output.

frame

See *application frame*.

frame manager

An object that controls the realization of the look and feel of an application frame.

fully specified

A text style is said to be fully specified when none of its components are **`nil`** and when its size is not relative (that is, neither **`:smaller`** nor **`:larger`**).

gesture

Some sort of input action by a user, such as typing a character or clicking a pointer button.

gesture name

A symbol that designates a particular gesture, e.g., **`:select`** is commonly used to indicate a left pointer button click.

graft

A kind of mirrored sheet (q.v.) that represents a host window, typically a root window. The graft is where the CLIM window hierarchy is "spliced" onto that of the host system. The graft maintains screen invariants, such as the number of pixels per inch.

grafted

A sheet is said to be grafted when it has an ancestor sheet that is a graft.

highlighting

Making some piece of output stand out, for example by changing its color or drawing a colored line around it. CLIM often highlights the presentation under the pointer to indicate that it is sensitive.

immutable

1. (of an object) Having components that cannot be modified once the object has been created, such as regions, colors and opacities, text styles, and line styles.
2. (of a class) An immutable class is a class all of whose objects are immutable.

implementor

A programmer who implements CLIM.

incremental redisplay

1. Redrawing part of some output (typically the portion that has been changed) while leaving other output as is.
2. The CLIM facility that implements this behavior.

indirect ink

An ink such as **`+foreground-ink+`** or **`+background-ink+`**, whose value is some other ink.

ink

Any *design* supplied as the **`:ink`** argument to a CLIM drawing function.

input context

The input requirements of a particular application. Also an object used to implement *context-dependent input* (q.v.).

input editor

The CLIM facility allowing a user to modify typed-in input.

input editing stream

A CLIM stream that supports input editing.

input stream designator

A Lisp object that is either an input stream or the symbol **`t`**, which is taken to mean **`*query-io*`**.

interactive stream

A stream that both accepts input from and supports output to the user.

layout

1. The arrangement of panes within an application frame.
2. A kind of pane that is responsible for allocating space to its children, taking their preferred sizes into account.

leaf pane

A pane that cannot have a child pane (cf. *composite pane*).

line style

1. Advice to CLIM's rendering substrate on how to render a path, such as a line or an unfilled ellipse or polygon.
2. A Lisp object that represents a line style.

medium

1. A destination for output, having a drawing plane, two designs called the medium's foreground and background, a transformation, a clipping region, a line style, and a text style.
2. A Lisp object that represents a medium.

mirror

The host window system object associated with a mirrored sheet, such as a window object on an X11 display server.

mirrored sheet

A special class of sheet attached directly to a window on a display server. A **`graft`** (q.v.) is one kind of a mirrored sheet.

mutable

1. A mutable object has components that can be modified (via **`setf`** accessors) once the object has been created, such as streams and output records.
2. A mutable class is a class all of whose objects are mutable.

non-uniform design

See *uniform design*.

opacity

1. An object that controls how graphical output appears to cover previous output. Opacity ranges from fully opaque through various levels of translucency to completely transparent.
2. A Lisp object that represents an opacity.

output history

The highest level output record for an output recording stream.

output record

1. An object that remembers the output performed to a stream or medium; the result of an output recording.
2. A Lisp object that represents an output record.

output recording

The process of documenting the output performed to a stream.

output recording stream

A CLIM stream that supports output recording.

output stream designator

A Lisp object that is either an output stream or the symbol **`t`**, which is taken to mean **`*standard-output*`**.

pane

A specialized sheet that understands issues pertaining to space requirements. A pane appears as the child of a frame or of another pane. Composite panes can hold other panes; leaf panes cannot.

parent

The direct ancestor of a sheet or an output record.

path

A region that has one dimension, length.

patterning

The process of creating a bounded rectangular arrangement of designs, such as a checkerboard. A pattern is a design created by this process.

pixmap

An "off-screen window," that is, a sheet that can be used for graphical output but that is not visible on any display device.

point

1. A region that has dimensionality 0; i.e., has only a position.
2. A Lisp object that represents a point.

pointer

A physical device used for pointing, such as a mouse, or the cursor that shows the position of the mouse on the screen.

pointer documentation

Text that describes something about what the mouse is over; the mechanism for displaying that text, which appears in a pointer-documentation-pane.

port

An abstract connection to a display server that is responsible for managing host display server resources and for processing input events received from the host display server.

position

1. A location on a plane such as the abstract drawing plane.
2. Two real number values **x** and **y** that represent a location.

presentation

1. An association between an object and a presentation type with some output on a output recording stream.
2. A Lisp object that represents a presentation.

presentation tester

A predicate that restricts the applicability of a presentation translator.

presentation translator

A mapping from an object of one presentation type, input context, and gesture to an object of another presentation type.

presentation type

1. A description of a class of presentations.
2. An extension to CLOS that implements this.

presentation type specifier

A Lisp object used to specify a presentation type.

programmer

A person who writes application programs using CLIM.

protocol class

An "abstract" class having no methods or slots that is used to indicate that a class obeys a certain protocol. For example, all classes that inherit from the **`bounding-rectangle`** class obey the bounding rectangle protocol.

rectangle

1. A four-sided polygon whose sides are parallel to the coordinate axes.
2. A Lisp object that represents a rectangle.

redisplay

See *incremental redisplay*.

reflection

A transformation in which each point is mapped to a symmetric point with respect to a line; reflections preserve length and magnitude of angles.

region

1. A set of mathematical points in a plane; a mapping from an (**`x`**, **`y`**) pair into either **`t`** or **`nil`** (meaning member or not a member, respectively, of the region). In CLIM, all regions include their boundaries (i.e., are closed) and have infinite resolution.
2. A Lisp object that represents a region.

region set

1. A "compound" region, that is, a region consisting of several other regions related by one of the operations union, intersection, or difference.
2. A Lisp object that represents a region set.

rendering

The process of drawing a shape (such as a line or a circle) on a display device. Rendering is an approximate process, as abstract shapes exists in a continuous coordinate system having infinite precision, whereas display devices must necessarily draw discrete points having some measurable size.

replaying

The process of redrawing a set of output records.

repainting

Redrawing a window that has been exposed or uncovered.

rotation

A transformation that moves all points around the center of rotation. A rotation maintains each point's distance to the center of rotation and to each other.

sensitive

A presentation is sensitive if some action will take place when the user clicks on it with the pointer. Sensitive presentations are usually highlighted.

server path

A server path is a list used to specify a port. The first element is a keyword that selects the kind of port. The remainder of the server path is a list of alternating keywords and values whose interpretation is port-type-specific.

sheet

1. A visible interface object that specifies the destination for graphical output. A sheet has properties including a coordinate system, a region, an enabled flag, an event handler, an output state, and optionally a parent, a transformation, and children.
2. A Lisp class, a subclass of **`bounding-rectangle`**, that represents a sheet.

sheet region

The area within a sheet's coordinate system where actions take place, that is, a clipping region for output and input. This typically corresponds to the visible region of the sheet on the display.

sheet transformation

Describes how points in a sheet's coordinate system are mapped onto points in its parents' coordinate system.

solid design

A design comprising completely opaque and/or completely transparent points. A solid design can be opaque at some points and transparent at others.

spread point argument

Functions that take spread point arguments take a pair of arguments that correspond to the *x* and *y* coordinates of the point. Such functions have an asterisk in their name: **`draw-line*`**. Cf. *structured point argument*.

stencil

A kind of pattern that contains only opacities.

stencil opacity

The opacity at one point in a design that would result from drawing the design onto a fictitious medium whose drawing plane is initially completely transparent black (opacity and all color components are zero), and whose foreground and background are both opaque black. The stencil opacity of an opacity is simply its value.

stream

A kind of sheet that implements the stream protocol (such as maintaining a text cursor).

structured point argument

Functions that take structured point arguments take the argument as a single point object. Cf. *spread point argument*.

text cursor

The visible underscore or block that shows where user input will appear on the command line or in a text editor. Cf. **`pointer`**, the cursor that tracks the movement of the mouse.

text style

1. A description of how textual output should appear with respect to its font family, face code, and size.
2. A Lisp object that represents a text style.

tiling

The process of repeating a rectangular portion of a design throughout the drawing plane. A tile is a design so created.

trampoline

A function is said to trampoline when the only thing it does is call the corresponding function in the object's superclass.

transformation

1. A mapping from one coordinate system onto another that preserves straight lines, such as a translation, scaling, rotation, or reflection.
2. A Lisp object that represents a transformation.

translation

A transformation in which the new coordinate axes are parallel to the original ones. A translation preserves length, angle, and orientation of all geometric entities.

translucent design

A design that is not solid, that is, that has at least one point with an opacity somewhere between completely opaque and transparent.

true, t

1. The boolean value true; not false.
2. Any Lisp object that is not **`nil`**.

unbounded design

A design that has at least one point of non-zero opacity arbitrarily far from the origin. Drawing an unbounded design affects the entire drawing plane.

unbounded region

A region that either contains no points or contains points arbitrarily far apart.

uniform design

A design that has the same color and opacity at every point in the drawing plane. Uniform designs are always unbounded, unless they are completely transparent.

unique id

During incremental redisplay, the unique id is an object used to identify each piece of output. The output named by the unique id will often have a cache value associated with it.

user

A person using an application program written with CLIM.

user transformation

A transformation that is apparent to the user (as opposed to an internal transformation, such as that used to deal with disparate display devices). A user transformation may be set by the user and is associated with a medium.

view

1. A way of displaying data (e.g., as numbers, bars in a bar graph, etc.).
2. A Lisp object that represents a view.

viewport

The portion of the drawing plane of a sheet's medium that is visible on a display device.

volatile

An immutable object is said to be volatile if it has components that cannot be modified by the programmer at the protocol level, but which may be modified internally by CLIM. Volatile objects reflect the internal state of CLIM.

window

A pane that is a subclass of **`clim-stream-pane`**. A window is another name for a stream pane or other pane that supports the stream protocol.

Appendix B: Implementation Specifics

B.1 Setting Up Your Packages to Use CLIM

You can set up your user packages to use CLIM as follows:

```
(in-package :user)

(defpackage "FOO"
  (:use :clim-lisp :clim ))
```

The package **`:clim-lisp`** is a version of the **`:lisp`** package that shadows some of the Common Lisp symbols. The **`:clim`** package is the exported CLIM interface.

B.2 CLIM Packages

LispWorks and Liquid CL CLIM both make use of the following packages:

- CLIM-USER—This is analogous to the USER package. It uses CLIM and CLIM-LISP.
- COMMON-LISP-USER—The USER package has been renamed.
- COMMON-LISP—The LISP package has been renamed.
- CLIM-INTERNALS—For internal use only.
- CLIM-SILICA—For internal use only.
- CLIM-SYS—Exported, portable Lisp system utilities not officially part of CLIM, such as multitasking, resources, etc.
- CLIM—The official, exported CLIM functionality.
- CLIM-LISP—CLIM's carefully constructed LISP package. It imports, shadows, and adds symbols to create a portable namespace for CLIM.
- CLIM-DEMO—An example of a newly-defined, user-level package that uses CLIM and CLIM-LISP.
- CLIM-UTILS—Contains unexported Lisp utilities used by the Lisp system.

The official way to make a package for CLIM is as follows:

```
(defpackage "MY-CLIM-PACKAGE" (:use :CLIM-LISP :CLIM :CLIM-SYS))
```

Appendix C: The CLIM-SYS Package

The CLIM-SYS package contains useful, "system-like" utilities such as resources and multi-processing primitives. These utilities are neither part of Common Lisp nor conceptually within the province of CLIM itself.

All of the symbols documented in this appendix are accessible as external symbols in the CLIM-SYS package.

C.1 Resources

CLIM provides a facility called ***resources*** that allows you to reuse objects. A resource describes how to construct an object, how to initialize and deinitialize it, and how an object should be selected from the resource of objects based on a set of parameters.

defresource *Macro*

defresource *name parameters* **&key** *constructor initializer deinitializer matcher initial-copies*

Summary: Defines a resource named *name*, which must be a symbol. *parameters* is a lambda-list giving names and default values (for optional and keyword parameters) of parameters to an object of this type.

constructor is a form that creates an object; it is called when someone tries to allocate an object from the resource and no suitable free objects exist. The constructor form can access the parameters as variables. This argument is required.

initializer is a form used to initialize an object gotten from the resource. It can access the parameters as variables, and also has access to a variable called *name*, which is the object to be initialized. The initializer is called both on newly created objects and objects that are being reused.

deinitializer is a form used to deinitialize an object when it is about to be returned to the resource. It can access the parameters as variables, and also has access to a variable called *name*, the object to be deinitialized. It is called whenever an object is deallocated back to the resource, but is not called by **clear-resource**. Deinitializers are typically used to clear references to other objects.

matcher is a form that ensures that an object in the resource "matches" the specified parameters, which it can access as variables. The matcher also has access to a variable called *name*, which is the object in the resource being matched against. If no matcher is supplied, the system remembers the values of the parameters (including optional ones that defaulted) that were used to construct the object, and assumes that it matches those particular values for all time. This comparison is done with **equal**. The matcher returns **t** if there is a match, and otherwise **nil**.

initial-copies specifies the number of objects to be initially put into the resource. It must be an integer or **nil** (the default), meaning that no initial copies should be made. If initial copies are made and there are parameters, all the parameters must be optional; the initial copies will then have the default values of the parameters.

using-resource *Macro*

using-resource (*variable name* **&rest** *parameters***) &body** *body*

Summary: The forms in *body* are evaluated with *variable* bound to an object allocated from the resource named *name*, using the parameters given by *parameters*. The parameters (if any) are evaluated, but *name* is not.

After *body* has been evaluated, **using-resource** returns the object in *variable* to the resource. If a form in the body sets *variable* to **nil**, the object is not returned to the resource. Otherwise, the body should not change the value of *variable*.

allocate-resource *Function*

allocate-resource *name* **&rest** *parameters*

> *Summary:* Allocates an object from the resource *name*, using the parameters given by *para-meters*. *name* must be a symbol naming a resource. It returns the allocated object.

deallocate-resource *Function*

deallocate-resource *name object*

> *Summary:* Returns the object *object* to the resource *name*. *name* must be a symbol naming a resource. *object* must be an object originally allocated from the same resource.

clear-resource *Function*

clear-resource *name*

> *Summary:* Clears the resource named *name*, that is, removes all of the resourced object from the resource. *name* must be a symbol that names a resource.

map-resource *Function*

map-resource *function name*

> *Summary:* Calls *function* once on each object in the resource named *name*. *function* is a function of three arguments, the object, a boolean value that is **t** if the object is in use or **nil** if it is free, and *name*. *function* has dynamic extent.

C.2 Multi-Processing

Most Lisp implementations provide some form of multi-processing. CLIM provides a set of functions that implement a uniform interface to the multi-processing functionality.

make-process *Function*

make-process *function* **&key** *name*

> *Summary:* Creates a process named *name*. The new process will evaluate the function *function*. On systems that do not support multi-processing, **make-process** will signal an error.

destroy-process *Function*

destroy-process *process*

> *Summary:* Terminates the process *process*. *process* is an object returned by **make-process**.

current-process *Function*

> *Summary:* Returns the currently running process, which will be the same kind of object as would be returned by **make-process**.

all-processes *Function*

> *Summary:* Returns a sequence of all of the processes.

process-wait *Function*

process-wait *reason predicate*

Summary: Causes the current process to wait until *predicate* returns **`t`**. *reason* is a string or symbol that gives an explanation for the wait. On systems that do not support multi-processing, **`process-wait`** will loop until *predicate* returns **`t`**.

process-wait-with-timeout *Function*

`process-wait-with-timeout` *reason timeout predicate*

Summary: Causes the current process to wait until *predicate* returns **`t`** or the number of seconds specified by *timeout* has elapsed. *reason* is a string or symbol that gives an explanation for the wait. On systems that do not support multi-processing, **`process-wait-with-timeout`** loops until *predicate* returns **`t`** or the timeout elapses.

process-yield *Function*

Summary: Allows other processes to run. On systems that do not support multi-processing, this does nothing.

process-interrupt *Function*

`process-interrupt` *process function*

Summary: Interrupts the process *process* and causes it to evaluate the function *function*. On systems that do not support multi-processing, this is equivalent to **`funcall`**'ing *function*.

without-scheduling *Macro*

`without-scheduling &body` *body*

Summary: Evaluates *body* in a context that is guaranteed to be free from interruption by other processes. On systems that do not support multi-processing, **`without-scheduling`** is equivalent to **`progn`**.

C.3 Locks

In the course of multi-processing, it is important to ensure that two processes do not modify the same data simultaneously. This is done by creating a lock, which is an extra memory location in a data structure that can be checked to determine whether that structure is in use. If the value of a lock is **`nil`**, no process is using the data structure; otherwise, the value should be a process that is currently using the structure.

The following symbols for creating locks will work with all CLIM ports.

with-lock-held *Macro*

`with-lock-held (`*place* **`&optional`** *state***`) &body`** *body*

Summary: Evaluates *body* with the lock named by *place*. *place* is a reference to a lock created by **`make-lock`**. *state* specifies the process to store in the *place* location; the default value is the value of the variable **`*current-process*`**.

On systems that do not support locking, **`with-lock-held`** is equivalent to **`progn`**.

make-lock *Function*

`make-lock &optional` *name*

Summary: Creates a lock whose name is *name*. On systems that do not support locking, this will return a new list of one element, **`nil`**.

with-recursive-lock-held *Macro*

`with-recursive-lock-held (`*place* **`&optional`** *state***`) &body`** *body*

Summary: Evaluates *body* with the recursive lock named by *place*. *place* is a reference to a recursive lock created by **make-recursive-lock**. A recursive lock differs from an ordinary lock in that a process that already holds the recursive lock can call **with-recursive-lock-held** on the same lock without blocking.

On systems that do not support locking, **with-recursive-lock-held** is equivalent to **progn**.

make-recursive-lock *Function*

make-recursive-lock &optional *name*

Summary: Creates a recursive lock whose name is *name*. On systems that do not support locking, this will return a new list of one element, **nil**.

C.4 Multiple-Value Setf

CLIM provides a facility, sometimes referred to as **setf***, that allows **setf** to be used on "places" that name multiple values. For example, **output-record-position** returns the position of an output record as two values that correspond to the **x** and **y** coordinates. In order to change the position of an output record, the programmer would like to invoke **(setf output-record-position)**. However, **setf** only takes a single value with which to modify the specified place. The **setf*** facility provides a "multiple-value" version of **setf** that allows an expression that returns multiple values to be used to update the specified place.

defgeneric* *Macro*

defgeneric* *name lambda-list* **&body** *options*

Summary: Defines a **setf*** generic function named *name*. The last argument in *lambda-list* is intended to be class specialized, just as normal **setf** generic functions are. *options* are as for **defgeneric**.

Note that **defgeneric*** does not define a generic function named **(setf** *name***)** or **(setf*** *name***)**. The actual name of the generic function is implementation dependent and **setf*** generic functions have their own namespace.

defmethod* *Macro*

defmethod* *name* **(***method-qualifier****** *specialized-lambda-list* **&body** *body***)**

Summary: Defines a method for the **setf*** generic function named *name*. The last argument in *specialized-lambda-list* is intended to be class specialized, just as normal **setf** methods are. (*method-qualifier*)* and *body* are as for **defgeneric**. For example, **output-record-position** and its **setf*** method for a class called **sample-output-record** might be defined as follows:

```
(defgeneric output-record-position (record)
  (declare (values x y)))
(defgeneric* (setf output-record-position) (x y record))
(defmethod output-record-position ((record sample-output-record))
  (with-slots (x y)
              (values x y)))
(defmethod* (setf output-record-position)
  (nx ny (record sample-output-record))
  (with-slots (x y)
              (setf x nx
                    y ny)))
```

The position of such an output record could then be changed as follows:

```
(setf (output-record-position record) (values nx ny))
(setf (output-record-position record1)
      (output-record-position record2))
```

Appendix D: Common Lisp Streams

CLIM performs all of its character-based input and output operations on objects called ***streams***. Streams are divided into two layers, the ***basic stream protocol***, which is character-based and compatible with existing Common Lisp programs, and the ***extended stream protocol***, which introduces extended gestures such as pointer gestures and synchronous window-manager communication.

This appendix describes the basic stream-based input and output protocol used by CLIM. The protocol is taken from the **`STREAM-DEFINITION-BY-USER`** proposal to the X3J13 committee, made by David Gray of TI. This proposal was not accepted as part of the ANSI Common Lisp language definition, but CLIM provides an implementation of the basic output stream facilities. For a description of the CLIM specialization of this protocol, see **15 Extended Stream Input Facilities**.

Note that in CLIM, many of the generic functions described in the following sections are called by Common Lisp stream functions. For example, **`force-output`** calls **`stream-force-output`**.

D.1 Stream Classes

The following classes are used as superclasses of user-defined stream classes. They are not intended to be directly instantiated; they just provide places to hang default methods.

The predicate functions may return **`t`** for other objects that are not members of the **`fundamental-stream`** class (or its subclasses) but that claim to serve as streams.

fundamental-stream *Class*

Summary: This class is the base class for all CLIM streams. It is a subclass of **`stream`** and of **`standard-object`**.

streamp *Generic Function*

`streamp` *object*

Summary: Returns **`t`** if *object* is a member of the class **`fundamental-stream`**.

fundamental-input-stream *Class*

Summary: A subclass of **`fundamental-stream`** that implements input streams.

input-stream-p *Generic Function*

`input-stream-p` *object*

Summary: Returns **`t`** when called on any object that is a member of the class **`fundamental-input-stream`**.

fundamental-output-stream *Class*

Summary: A subclass of **`fundamental-stream`** that implements output streams.

output-stream-p *Generic Function*

`output-stream-p` *object*

Summary: Returns **`t`** when called on any object that is a member of the class **`fundamental-output-stream`**.

Bidirectional streams can be formed by including both **`fundamental-input-stream`** and

fundamental-output-stream.

fundamental-character-stream *Class*

Summary: A subclass of **fundamental-stream**. It provides a method for **stream-element-type**, which returns **character**.

fundamental-binary-stream *Class*

Summary: A subclass of **fundamental-stream.** Any instantiable class that includes this needs to define a method for **stream-element-type**.

fundamental-character-input-stream *Class*

Summary: A subclass of **fundamental-input-stream** and **fundamental-character-stream**, providing default methods for generic functions for character input.

fundamental-character-output-stream *Class*

Summary: A subclass of **fundamental-output-stream** and **fundamental-character-stream**, providing default methods for generic functions for character output.

fundamental-binary-input-stream *Class*

Summary: A subclass of **fundamental-input-stream** and **fundamental-binary-stream**.

fundamental-binary-output-stream *Class*

Summary: A subclass of **fundamental-output-stream** and **fundamental-binary-stream**.

D.2 Basic Stream Functions

These generic functions must be defined for all stream classes.

stream-element-type *Generic Function*

stream-element-type *stream*

Summary: This existing Common Lisp function is made generic, but otherwise behaves the same. Class **fundamental-character-stream** provides a default method that returns **character**.

open-stream-p *Generic Function*

open-stream-p *stream*

Summary: This function is made generic. A default method is provided by class **fundamental-stream** that returns **t** if **close** has not been called on the stream.

close *Generic Function*

close *stream* **&key** *abort*

Summary: The existing Common Lisp function **close** is redefined to be a generic function, but otherwise it behaves the same. The default method provided by the class **fundamental-stream** sets a flag used by **open-stream-p**. The value returned by **close** will be as specified by the X3J13 issue **closed-stream-operations**.

stream-pathname *Generic Function*

stream-pathname *stream*

stream-truename *Generic Function*

`stream-truename` *stream*

Summary: These are used to implement **`pathname`** and **`truename`**. There is no default method because these are not valid for all streams.

D.3 Character Input

A character input stream can be created by defining a class that includes **`fundamental-character-input-stream`** and defining methods for the following generic functions.

stream-read-char *Generic Function*

`stream-read-char` *stream*

Summary: Reads one character from *stream*, and returns either a character object or the symbol **`:eof`** if the stream is at end-of-file. There is no default method for this generic function, so every subclass of **`fundamental-character-input-stream`** must define a method.

stream-unread-char *Generic Function*

`stream-unread-char` *stream character*

Summary: Undoes the last call to **`stream-read-char`**, as in **`unread-char`**, and returns **`nil`**. There is no default method for this, so every subclass of **`fundamental-character-input-stream`** must define a method.

stream-read-char-no-hang *Generic Function*

`stream-read-char-no-hang` *stream*

Summary: Returns either a character, or **`nil`** if no input is currently available, or **`:eof`** if end-of-file is reached. This is used to implement **`read-char-no-hang`**. The default method provided by **`fundamental-character-input-stream`** simply calls **`stream-read-char`**; this is sufficient for file streams, but interactive streams should define their own method.

stream-peek-char *Generic Function*

`stream-peek-char` *stream*

Summary: Returns either a character or **`:eof`** without removing the character from the stream's input buffer. This is used to implement **`peek-char`**; this corresponds to peek-type of **`nil`**. The default method calls **`stream-read-char`** and **`stream-unread-char.`**

stream-listen *Generic Function*

`stream-listen` *stream*

Summary: Returns **`t`** if there is any input pending on *stream*; otherwise, it returns **`nil`**. This is used by **`listen`**. The default method uses **`stream-read-char-no-hang`** and **`stream-unread-char`**. Most streams should define their own method, as it will usually be trivial and will generally be more efficient than the default method.

stream-read-line *Generic Function*

`stream-read-line` *stream*

Summary: Returns a string as the first value, and **`t`** as the second value if the string was terminated by end-of-file instead of the end of a line. This is used by **`read-line`**. The default method uses repeated calls to **`stream-read-char`**.

stream-clear-input *Generic Function*

stream-clear-input *stream*

> *Summary:* Clears any buffered input associated with *stream*, and returns **nil**. This is used to implement **clear-input**. The default method does nothing.

D.4 Character Output

A character output stream can be created by defining a class that includes **fundamental-character-output-stream** and defining methods for the following generic functions.

stream-write-char *Generic Function*

stream-write-char *stream character*

> *Summary:* Writes *character* to *stream*, and returns *character* as its value. Every subclass of **fundamental-character-output-stream** must have a method defined for this function.

stream-line-column *Generic Function*

stream-line-column *stream*

> *Summary:* This function returns the column number where the next character will be written on *stream*, or **nil** if that is not meaningful. The first column on a line is numbered 0. This function is used in the implementation of **pprint** and the **format** **~T** directive. Every character output stream class must define a method for this, although it is permissible for it to always return **nil**.

stream-start-line-p *Generic Function*

stream-start-line-p *stream*

> *Summary:* Returns **t** if *stream* is positioned at the beginning of a line; otherwise, it returns **nil**. It is permissible to always return **nil**. This is used in the implementation of **fresh-line**.
>
> Note that while a value of 0 from **stream-line-column** also indicates the beginning of a line, there are cases where **stream-start-line-p** can be meaningfully implemented when **stream-line-column** cannot. For example, for a window using variable-width characters, the column number isn't very meaningful, but the beginning of the line does have a clear meaning. The default method for **stream-start-line-p** on class **fundamental-character-output-stream** uses **stream-line-column**, so if that is defined to return **nil**, a method should be provided for either **stream-start-line-p** or **stream-fresh-line**.

stream-write-string *Generic Function*

stream-write-string *stream string* **&optional (***start* **0)** *end*

> *Summary:* Writes the string *string* to *stream*. If *start* and *end* are supplied, they specify what part of *string* to output. *string* is returned as the value. This is used by **write-string**. The default method provided by **fundamental-character-output-stream** uses repeated calls to **stream-write-char**.

stream-terpri *Generic Function*

stream-terpri *stream*

> *Summary:* Writes an end-of-line character on *stream* and returns **nil**. This is used by **terpri**. The default method does **stream-write-char** of **#\Newline**.

stream-fresh-line *Generic Function*

`stream-fresh-line` *stream*

Summary: Writes an end-of-line character on *stream* only if the stream is not at the beginning of the line. This is used by **`fresh-line`**. The default method uses **`stream-start-line-p`** and **`stream-terpri`**.

stream-finish-output *Generic Function*

`stream-finish-output` *stream*

Summary: Ensures that all the output sent to *stream* has reached its destination, and only then return **`nil`**. This is used by **`finish-output`**. The default method does nothing.

stream-force-output *Generic Function*

`stream-force-output` *stream*

Summary: Like **`stream-finish-output`**, except that it may return **`nil`** without waiting for the output to complete. This is used by **`force-output`**. The default method does nothing.

stream-clear-output *Generic Function*

`stream-clear-output` *stream*

Summary: Aborts any outstanding output operation in progress and returns **`nil`**. This is used by **`clear-output`**. The default method does nothing.

stream-advance-to-column *Generic Function*

`stream-advance-to-column` *stream column*

Summary: Writes enough blank space on *stream* so that the next character will be written at the position specified by *column*. Returns **`t`** if the operation is successful, or **`nil`** if it is not supported for this stream. This is intended for use by **`pprint`** and **`format`** **`~T`**. The default method uses **`stream-line-column`** and repeated calls to **`stream-write-char`** with a **`#\Space`** character; it returns **`nil`** if **`stream-line-column`** returns **`nil`**.

D.5 Binary Streams

Binary streams can be created by defining a class that includes either **`fundamental-binary-input-stream`** or **`fundamental-binary-output-stream`** (or both) and defining a method for **`stream-element-type`** and for one or both of the following generic functions.

stream-read-byte *Generic Function*

`stream-read-byte` *stream*

Summary: Returns either an integer or the symbol **`:eof`** if *stream* is at end-of-file. This is used by **`read-byte`**.

stream-write-byte *Generic Function*

`stream-write-byte` *stream integer*

Summary: Writes *integer* to *stream* and returns *integer* as the result. This is used by **`write-byte`**.

D.6 Hardcopy Streams in CLIM

CLIM supports hardcopy output through the macro **with-output-to-postscript-stream**.

with-output-to-postscript-stream *Macro*

with-output-to-postscript-stream (*stream-var file-stream* **&key (***display-device clim::*******postscript-device****)** *header-comments multi-page***) &body** *body*

Summary: Within *body*, *stream-var* is bound to a stream that produces PostScript code.

The following example writes a PostScript program that draws a square, a circle, and a triangle to a file named **icons-of-high-tech.ps**.

```
(defun print-icons-of-high-tech-to-file ()
  (with-open-file
      (file-stream "icons-of-high-tech.ps" :direction :output)
    (clim:with-output-to-postscript-stream
     (stream file-stream)
     (let* ((x1 150) (y 250) (size 100)
            (x2 (+ x1 size))
            (radius (/ size 2))
            (base-y (+ y (/ (* size (sqrt 3)) 2))))
      (clim:draw-rectangle* stream
                            (- x1 size) (- y size)
                            x1 y)
      (clim:draw-circle* stream
                         (+ x2 radius) (- y radius)
                         radius)
      (clim:draw-triangle* stream
                           (+ x1 radius) y
                           x1 base-y
                           x2 base-y)))))
```

The second example uses multi-page mode to draw a graph of the superclasses of the class **window-stream** by writing a PostScript program to the file *some-pathname*.

```
(with-open-file (file some-pathname :direction :output)
  (clim:with-output-to-postscript-stream
   (stream file :multi-page t)
   (clim:format-graph-from-root
    (clos:find-class 'clim-internals::window-stream)
    #'(lambda (object s)
       (write-string (string (clos:class-name object)) s))
    #'clos:class-direct-superclasses
    :stream stream)))
```

Note that **with-output-to-postscript-stream** is defined in the loadable module "clim-postscript". See **1.5 Loading CLIM** for details of how to load CLIM and associated modules.

Appendix E: Windows

E.1 Window Stream Operations in CLIM

A ***window*** is a CLIM stream pane that supports all window and stream operations. Windows are primarily included for compatibility with CLIM 1.1, although it is sometimes useful to be able to perform operations directly on a window.

E.1.1 Clearing and Refreshing the Drawing Plane

CLIM supports the following operators for clearing and refreshing the drawing plane:

window-clear *Generic Function*

`window-clear` *window*

Summary: Clears the entire drawing plane of *window*, filling it with the background ink.

window-erase-viewport *Generic Function*

`window-erase-viewport` *window*

Summary: Clears the visible part of *window*'s drawing plane, filling it with background ink.

window-refresh *Generic Function*

`window-refresh` *window*

Summary: Clears the visible part of the drawing plane of *window*, and then replays all of the output records in the visible part of the drawing plane.

E.1.2 The Viewport and Scrolling

A window stream ***viewport*** is the region of the drawing plane that is visible through the window. You can change the viewport by scrolling or by reshaping the window. The viewport does not change if the window is covered by another window (that is, the viewport is the region of the drawing plane that would be visible if the window were on top).

A window stream has an **`end-of-line`** action and an **`end-of-page`** action, which control what happens when the cursor position moves out of the viewport (**`with-end-of-line-action`** and **`with-end-of-page-action`**, respectively).

E.1.3 Viewport and Scrolling Operators

window-viewport *Generic Function*

`window-viewport` *window*

Summary: Returns a region that is the *window*'s current viewport, an object of type **`area`**. (**10.2.3 Composite Pane Generic Functions** for the generic function **`pane-viewport`**, which returns a viewport.)

window-viewport-position*

Generic Function

window-viewport-position* *window*

Summary: Returns the *x* and *y* coordinates of the top-left corner of the *window*'s viewport.

window-set-viewport-position*

Generic Function

window-set-viewport-position* *window x y*

Summary: Moves the top-left corner of the *window*'s viewport. Use this to scroll a window.

E.2 Functions for Operating on Windows Directly

You can use **open-window-stream** to give you a CLIM window without incorporating it into a frame. After calling **open-window-stream**, call **window-expose** to make the resulting window stream visible.

The following operators are available for manipulating the CLIM primitive layer for window streams.

open-window-stream

Function

open-window-stream &key *port left top right bottom width height borders console default-text-margin default-text-style depth display-device-type draw-p end-of-line-action end-of-page-action initial-cursor-visibility input-buffer label name output-record record-p save-under scroll-bars stream-background stream-foreground text-cursor text-margin viewport vsp window-class*

Summary: A handy function for creating a CLIM window, but one not normally used. Most often windows are created by an application frame or by the menu and dialog functions.

window-parent

Generic Function

window-parent *window*

Summary: Returns the window that is the parent (superior) of *window*.

window-children

Generic Function

window-children *window*

Summary: Returns a list of all of the windows that are children (inferiors) of *window*.

window-label

Generic Function

window-label *window*

Summary: Returns the label (a string) associated with *window*, or **nil** if there is none.

with-input-focus

Macro

with-input-focus (*stream***) &body** *body*

Summary: Temporarily gives the keyboard input focus to the given window, most often an interactor pane. By default, a frame will give the input focus to the **frame-query-io** pane.

The following functions are most usefully applied to the top level sheet of a frame. For example: **(clim:frame-top-level-sheet clim:*application-frame*)**.

window-expose

Generic Function

window-expose *window*

Summary: Makes the *window* visible on the screen.

window-stack-on-bottom *Generic Function*

`window-stack-on-bottom` *window*

Summary: Puts the *window* underneath all other windows that it overlaps.

window-stack-on-top *Generic Function*

`window-stack-on-top` *window*

Summary: Puts the *window* on top of all the others it overlaps so that you can see all of it.

window-visibility *Generic Function*

`window-visibility` *stream*

Summary: A predicate that returns **`t`** if the window is visible. You can use **`setf`** on **`window-visibility`** to expose or deexpose the window.

The following operators can be applied to a window to determine its position and size.

window-inside-edges *Generic Function*

`window-inside-edges` *window*

Summary: Returns four values, the coordinates of the left, top, right, and bottom inside edges of the window *window*.

window-inside-left *Function*

`window-inside-left` *window*

Summary: Returns the coordinate of the left edge of the window *window*.

window-inside-top *Function*

`window-inside-top` *window*

Summary: Returns the coordinate of the top edge of the window *window*.

window-inside-right *Function*

`window-inside-right` *window*

Summary: Returns the coordinate of the right edge of the window *window*.

window-inside-bottom *Function*

`window-inside-bottom` *window*

Summary: Returns the coordinate of the bottom edge of the window *window*.

window-inside-size *Generic Function*

`window-inside-size` *window*

Summary: Returns the inside width and height of *window* as two values.

window-inside-width *Function*

`window-inside-width` *window*

Summary: Returns the inside width of *window*.

window-inside-height *Function*

`window-inside-height` *window*

Summary: Returns the inside height of *window*.

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