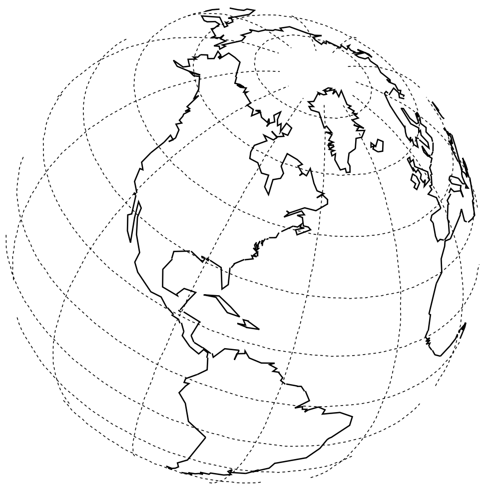
The **GeoSim** Interface Library (GIL)



Programmer's Manual, Version 2.0

Project **GeoSim**
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1 Introduction

The **GeoSim** Interface Library (**GIL**) is a small, easy to use set of functions for building a graphical user interface (GUI). It was originally designed to support the user interface needs of **Project GeoSim**, a series of interactive simulations for introductory geography classes. The original design for **GIL** was driven by the need to develop easy to use software that was portable to a variety of computing environments. It was used by a team of programmers engaged in rapid prototyping and frequent change to their user interfaces. Thus, **GIL** had to make it easy for the programmer to set up an interface quickly for experimentation, as well as allow easy changes to the positions of interface elements.

Many aspects of **GIL**'s functionality are limited as compared to full graphical user interface design systems such as Motif, the Macintosh Toolbox or Microsoft Windows API. **GIL** limits the application developer to a single, rectangular piece of real estate (640×480 pixels), a simple color model, and a truly crude font model. However, **GIL** successfully achieves its primary goals of being portable and easy to use. It currently runs under MS-DOS, the Macintosh Toolbox, and several implementations of X Window. It has been successfully used not only for the entire series of **GeoSim** simulations, but also as the prototype interface for several research projects and as the graphical user interface package for students in Computer Science programming courses. In addition, the price is right.[1]

GIL's relationship to a particular computing environment is illustrated by Figure 1. An application programmer writes an application using **GIL** for all user interface interactions. If no platform-dependent functionality has been introduced into the application code, then the program should compile and run without modification under any **GIL** supported programming environment. Porting **GIL** itself to a new computing environment requires that a small platform-dependent base library be re-written.

Typographic Conventions. The following typographic conventions are observed in this manual:

Italic Font is used for formal parameter names, emphasis, and to introduce new terms.

`Teletype Font` is used for actual parameter names, file excerpts, file names, and function prototypes.

Bold Font is used for proper titles, and for emphasis when necessary.

[1] **GIL** is freely available via anonymous FTP, gopher or any World Wide Web client from geosim.cs.vt.edu, URL http://geosim.cs.vt.edu

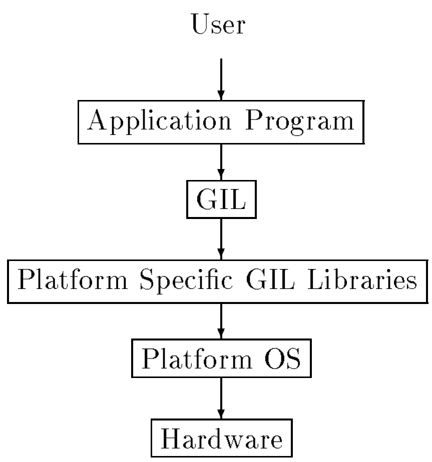

Figure 1: Abstraction layers for application programs using **GIL**: from User to Hardware.

2 GIL Basic Structure

2.1 Event Loop

GIL, like most GUI systems, is *event* driven. The core of **GIL** is the *event handler*, or *event loop.* From **GIL**'s point of view, events are low level, and correspond roughly to inputs from any one of several hardware devices. For purposes of exposition, an event viewed from this perspective will be referred to as a *system event.* The event loop is responsible for detecting and "handling" all system events. "Handling" a system event involves determining what application program function — if any — to execute in response to the event. This determination is made on the basis of a mapping, or table, declared in the application program. (See Section 3.14 for details about declaring this table.) Note that there may be many system events which do not execute an application program function.

From the application programmer's perspective, an event is generally any manipulation of an interface element by the user, such as a button press, a mouse "drag", a mouse "click", etc. The application programmer's connotation of the word event will be described by the term *user event.* Note that each user event must cause execution of an application program function. Functions associated with user events are sometimes known as *callback functions.* Each manipulable interface element is associated with exactly one application program function, which is executed in response to any user event associated with the element. Manipulable **GIL** interface elements are called *control* elements. Non-manipulable elements are called *static* elements.

So, if **GIL** is responsible for handling events, what is the application programmer's role? Rather broadly, the application programmer is responsible for the following:

1. Declaring all *interface elements.* This is done via the *interface file*, which is described in Section 2.3. Interface files can be written by hand with any text editor. Also, interface files can be generated with *Graphical Builder* a **GIL** development tool. *Graphical Builder* allows the developer to "draw" an interface. *Graphical Builder* then produces an interface file matching the user's drawing. Usually, generating interface files with *Graphical Builder* is faster and less error-prone than writing them by hand.

2. Writing an application program function for each control element. The **GIL** functions are available to make this easier, and to make the application code portable among several computing environments. The **GIL** functions are described in Section 8.

3. Mapping each interface element to its function. This is done via the `FuncNames` table, which is described in Section 3.14.

2.2 GIL Basic Interface Elements

A graphical user interface is composed of *elements.* A GUI element is roughly analogous to a discrete physical object in the real world; for that reason, the word "object" is often used in place of "element" in interface descriptions. However, "object" has its own connotations in the world of computer science, so we prefer to use "element". **GIL** offers the following simple types of graphical user interface elements:

Windows are named, rectangular regions of the screen within which other elements may be grouped.

Menus are lists of functions or program attributes from which a user may select.

Buttons are graphical elements to be "pressed" by the mouse. "Pressing" a button causes some function in the application program to be called. Each button belongs to a particular window.

Fields are rectangular regions in which output is displayed.

Drag Areas are rectangular regions of the screen within which a user may perform mouse operations such as pointing, dragging, and clicking.

Labels are static text phrases which are fixed in a particular position within a window, and are drawn automatically by **GIL** whenever the window which contains them is drawn.

Rectangles and **Lines** which are declared in the interface file are drawn automatically by **GIL** whenever the window which contains them is drawn. Rectangles and lines may also be generated on-the-fly by an application program.

2.3 Interface File

GIL is characterized by the use of a separate file for declaring GUI elements. The advantage of using a text file is that changes can be made to the elements without recompiling source code, thus allowing these changes to be made much faster. This text file is referred to as the *interface file*. The extension `.inf` is conventionally used to designate an interface file name.

The general syntax of a declaration in an interface file is:

interface-element-variable (*argument-list*)

where the arguments in *argument-list* are separated from each other by commas or whitespace (an arbitrary number of tabs or blank spaces). A declaration may span multiple lines; however, each argument in the declaration can occupy only one line. The interface file parser is case insensitive. Section 4 presents an example of an interface file.

Interface File Argument Types. There are three types of arguments in an interface file argument list:

Integers are sequences of digits, optionally preceded by a unary minus ('`-`'). Negative integers are uncommon in interface files.

Names consist of letters, numbers, and the underscore ('`_`'). Names must start with a letter.

Strings begin and end with the '`|`' delimiter. A string may contain any ASCII printing character except '`|`'.

Several names are *reserved*; they cannot be used in a **name** argument. Reserved names are:

ALIAS	HIGHLIGHT	MSG
BUTTON	FIELD	PALETTE
BUTTONS	FUNCTION	PLABEL
BUTTONSTUFF	HIGHLIGHT	POPUP
CANCEL	LABEL	RECT
COLORLIST	LABELS	REDRAWFUNC
DRAGAREA	LINE	WINDOW

Reserved names are *case-insensitive*. For example, `redrawfunc` and `RedrawFunc` are reserved.

3 GIL Features

3.1 Look and Feel of GIL Buttons

The *look and feel* of an interface element is how it looks on the screen, and how it responds when a user manipulates it. The buttons in **GIL** have been designed to resemble push buttons on real mechanical devices. Their edges can be shaded to give the appearance of light falling on a three-dimensional object. The top and left edges are usually given a bright color, to resemble light; the bottom and right edges are usually given a dark color, to resemble shadow. Thus, the buttons appear to be "sticking out" from their windows. The `BUTTONSTUFF` declaration in the interface file sets the button edge colors for all buttons in the interface.

A button's shading changes when it is pressed: the edge colors are inverted, so that the button looks as though it is pushed in, or depressed. When the button is released, it's appearance reverts back to normal. A depressed button also regains its normal appearance if the mouse cursor is moved away from it while the mouse button is still down (i.e, the button essentially becomes "undepressed"). If the cursor is placed back on the mouse before the mouse button is released, however, the **GIL** button will again look pushed in.

GIL buttons respond in one of two ways, depending on whether or not they are *repeatable*. The function associated with a non-repeatable **GIL** button is executed *only* when the mouse button is released while the **GIL** button is depressed. The cursor must still be on the **GIL** button when the mouse button is released in order for the button's function to be called.

A repeatable **GIL** button causes its function to be executed *before* the mouse button is released. Furthermore, the function will be executed repeatedly until the mouse button is released. The rate at which the function is repeated starts out slow, and gradually increases over a few seconds. The speed-up rate is controlled by the `SPEEDUP` declaration in the interface file. (The `SPEEDUP` declaration is described in Section 4.2.11.)

3.2 Log Files

GIL provides two log files for the application: an *error* log file (`error.log`) and an *output* log file (`output.log`). Both **GIL** and the application may log errors to the *error* log. The application alone writes to the output log. `error.log` is conventionally used for debugging purposes, and **GIL**ś own messages are written there. `output.log` is available for the application's needs.

3.3 Backing Store

Backing store is memory used to save a screen area when it is overdrawn by a **GIL** window or menu. When the window or menu is later removed, the image saved in backing store is restored to the screen. Restoring the screen from backing store is quicker and smoother in appearance than redrawing it from scratch. However, storing screen images requires additional memory, which may be scarce on some systems.

Popup menus automatically use backing store. An application decides at runtime whether to use backing store for its windows.

GIL provides the programmer with five backing store areas. That is, up to five windows and/or popup menus at a time may use backing store memory. Each backing store has an integer identifier in the range 1 to 5. Popup menus automatically use level 1. Windows can be assigned to this or other backing stores as desired.

To use backing store to save the portion of the screen overdrawn by a window, an application programmer must do three things:

1. Call `GSinterfaceinit` with `bstore = BSTORE`. This enables backing store for the application. See page 40 for more information on `GSinterfaceinit`.
2. In the window's interface file declaration, set *bstore* equal to the identifier of the backing store that the window will use. See page 4.2.2 regarding interface file declarations for windows. Note that two windows that need to use backing store simultaneously must use different backing stores.
3. When the window is drawn with `GSdrawnamedwindow`, the `bstore` argument must equal `BSTORE`. See 8.2.1 for more information about `GSdrawnamedwindow`.

Care should be taken to avoid backing store"collisions". A collision is a runtime error that occurs when a window or menu tries to use a backing store level that is already in use. A collision will cause the application to shut down.

3.4 Redraw Function and Multi-Window Environments

When a **GIL** application runs in a multi-window environment (such as Macintosh or X Window), **GIL** graphical output is sent to a "native" window, one which is created by the environment's window manager. It is possible for one window to cover the **GIL** application's window; when the **GIL** window is uncovered, its contents will need to be redrawn.

GIL accepts expose messages from the host environment's window manager. **GIL** responds to these messages by calling the application-defined redraw function. This redraw function should call `GSredrawnamedwindow` for all windows which are currently visible, and then redraw anything that appears in active **GIL** windows but is not an interface element. For example, an application which draws a figure into a window would need to redraw the figure from its redraw function.

Note that in order to reproduce graphical output, an application must preserve information about the output. It is not sufficient simply to draw output and then forget about it. See Section 9 for an example of an application's redraw function.

To activate a redraw function, an application programmer must register the function in the `FuncNames` array, and declare the function in the application's interface file. See Section 4.2.10 for the syntax of the redraw function declaration.

Declaring a redraw function is optional; if no redraw function is declared, **GIL** automatically redraws active windows and their interface elements. An application which only displays **GIL** interface elements does not need a redraw function. Also, a **GIL** application running under DOS does not need a redraw function, since there are no competing applications that might cover the **GIL** application. However, it is a good idea to write a redraw function for every **GIL** application. Including a redraw function makes the application's code more portable.

3.5 Drag Functions

A drag function is associated with a drag area by a declaration in the interface file. A drag function takes the integer parameters x and y, and the parameter *status*, of type `DragStatusType`. The screen coordinates (relative to the current window) of the mouse cursor are passed in the parameters x and y each time the event loop is executed. The type of mouse event which caused the drag function to be called is passed in *status*. The possible values for status — along with the respective events — are:

`DRAG_INIT` is passed when the user initiates a mouse drag. A mouse drag is initiated by pressing and holding the mouse button down and moving the mouse.

`DRAG_PROCESS` is passed whenever the mouse moves during a drag. A mouse drag continues as long as the mouse button is held down.

`DRAG_FINAL` is passed when the user releases the mouse button after a drag.

`MOUSE_INSIDE` is passed when the mouse cursor moves to a point inside the drag area from a point either inside or outside the drag area while the mouse button is up.

`MOUSE_CLICK` is passed when the user releases the mouse button without having moved the mouse while the button was down.

`MOUSE_OUTSIDE` is passed when the mouse cursor moves to a point outside of the drag area from a point either inside or outside the drag area while the mouse button is up.

3.6 Window Relative vs. Absolute Coordinates

Generally, an application directs output (strings, graphics) to a named window. The location of such output is meant to be relative to the window, so that moving the position of the window will not affect the relative placement of graphics within the window. The **GIL** drawing functions, therefore, take window relative coordinates as opposed to absolute screen coordinates. However, the **GIL** event handler sends drag area relative coordinates to a drag area's function, because these events are typically processed relative to the drag area's position. If the application needs to find the window relative coordinates of such an event, it can retrieve the window relative origin of the drag area or button. (See `GSgetbuttonspecs` and `GSgetcursorxy` in Section 8.3.6 for details.)

The Current Window. In order to send output to a named window, it must be the *current* window. Only one window at a time can be current. The current window can be set explicitly by the function `GSsetcurrentnamedwindow`. Several other **GIL** functions set the current window implicitly.

3.7 Popup Windows

A popup window is one that "pops" up in front of other windows. Popup windows are typically meant to be on the screen for short periods of time. A **GIL** popup window is *preemptive*, meaning that other windows (and their buttons and drag areas) are made temporarily inactive until the popup window is removed, usually by some user action. The **GIL** function `GSsetactivenamedwindow` can be used to reactivate a window before the popup window is removed.

The interface file declaration of a **GIL** window says nothing about whether or not it is a popup. Windows only become popups or non-popups when they are drawn. The **GIL** function `GSdrawnamedwindow` is for drawing windows on the screen; it takes the parameter `popup`. The value passed to `popup` determines whether or not a window is drawn as a popup. The legal values for `GSdrawnamedwindow` are `POPUP` (to draw the window as a popup) and `NO_POPUP` (to draw the window as a non-popup).

3.8 Active vs. Inactive Windows

A user may only manipulate the controls of *active* windows. For example, a button may be displayed on screen, but it will not respond to mouse presses unless the window it belongs to is active. The most recently drawn window is considered active by default. Additionally, the application developer may set any number of windows active or inactive as desired with `GSsetactivenamedwindow` and `GSsetdeactivenamedwindow` . The application developer is responsible for guarding against overlapping active windows or related problems.

3.9 Enabled vs. Disabled vs. Invisible Buttons, Drag Areas, and Menu Items

Buttons, drag areas, and menu items may be enabled or disabled. In its disabled state, the button label or menu item is *dimmed* (i.e., it uses the disabled text color). The user can see a disabled button or menu item, but the color of disabled text should make its inaccessibility clear. Disabled buttons and menu items may also be made invisible, if the application programmer does not want them to be seen at all.

3.10 Checklist Menus

If a menu is declared in the interface file to be a checklist, then **GIL** will associate a check mark with each item, which is used as a bool indicator. Selecting an item with an invisible check mark makes the check mark visible, and vice versa. Other than this, **GIL** treats a checklist menu just like any other menu: each item on any menu is associated with an application program function, which is executed when the item is selected.

Semantics of Checklist Menus. It is up to the application programmer to establish the semantics of any menu. The semantics of a menu are implemented in the application program itself, via the functions associated with the menu's items. Checklist menus are typically used to set application program parameters which will affect the subsequent behavior of the program. Some checklists represent a list of bool parameters. In this case, the check mark for each parameter is generally visible when the parameter is true, or on, and invisible when the parameter is false, or off. Other checklists represent a list of legal values for a single parameter. In this case, only one value can have a check mark next to it at a time (the application programmer must remove old check marks when a new value is selected.)

The application *giltest* is a simple example of **GIL**. *giltest* has both types of checklist menus mentioned above. In the "box style" menu, the options "Draw Black Border" and "Fill With Color" are independent of each other; both can be checked or unchecked at the same time, or exactly one can be checked.

The "fill color" menu in *giltest* allows the user to select a color. Exactly one color may be checked at a single time. Note that *giltest* is responsible for unchecking colors when a different color was selected.

3.11 Picklists

An application which needs to display a large number of items (more than will fit in a window), or a number of items which can change, can use a *picklist* to display the items. Picklists are a common interface component in many graphical user interfaces.

Picklists can contain any number of items. The picklist displays as many items as will fit in its display area. Also, the picklist tracks mouse activity inside its display area, reporting which item is currently under the mouse, and reporting when the mouse is clicked on an item.

A picklist is almost always used in conjunction with a scroll bar and scroll buttons. A scroll bar moves the picklist display proportionally through the picklist's items. Scroll buttons move the picklist display either "down" or "up" by one item, each time the button's action executes. Together, the picklist/scroll bar/scroll button system is called a *scrolling list*.

In **GIL**, a scrolling list is a *composite* interface element. Composite interface elements are not declared in a **GIL** interface file. They are made of several basic **GIL** interface elements. A scrolling list requires these **GIL** interface elements: two drag areas, one for the picklist and one for the scroll bar; and two buttons, one for scrolling up and one for scrolling down.

GIL handles most scrolling list tasks, including drawing and responding to user scrolling. **GIL** references list components through *handles*. A handle is simply a unique identifier given to each list component. **GIL** creates handles every time a scrolling list is created. Most **GIL** scrolling list functions require a handle as a parameter. Specificly, **GIL** uses two types of list handles: `GSlistHandle` and `GSsclistHandle`.

In order to support scrolling lists, the application programmer must do the following:

1. Declare in the application's interface file a drag area for the picklist, another drag area for the scroll bar, and two buttons for scrolling.

2. As soon as the window containing the scrolling list is drawn, call `GSsclistsetup` with appropriate parameters. In particular, store the `GSlistHandle` and `GSsclistHandle` returned from `GSsclistsetup`.

3. In the picklist drag area's function, call `GShandlelist`, passing the `GSlistHandle` returned from `GSsclistsetup` as a parameter. Call `GShandlesclist` in the scroll bar drag area's function, with the `GSsclistHandle` returned from `GSsclistsetup` as a parameter. In the up and down buttons' functions, call `GShandleupbutton` and `GShandledownbutton`, respectively, passing the `GSsclistHandle` as a parameter.

4. In the application's redraw function, call `GSdrawsclist` for every visible scrolling list. As the parameter to `GSdrawsclist`, pass the `GSsclistHandle` reutrned fron `GSsclistsetup`.

5. When the window containing the scrolling list is removed, call `GSdismantlesclist`, with the scrolling list's handle as the parameter.

The **GIL** functions mentioned above are documented in Section 8.2.6.

There is only one restriction on the drag areas and buttons used for a scrolling list: they all must be in the same window. However, a scrolling list looks better if its scroll bar is immediately to the right of its picklist, with the up and down scroll buttons immediately above and below the scroll bar. Using the `|\^|` and `|\v|` arrow symbols for the text of the up and down arrow buttons, respectively, gives these buttons an appearance which suggests their purpose. See Section 4.2.3 for more information about button arrow symbols.

Among `GSsclistsetup`'s parameters are five function pointers. These functions are supplied by the application programmer to implement various aspects of the scrolling list's features. They are:

`label_func` - returns a pointer to the text of a list item.

`settext_func` - sets the text attributes (font and color) for a list item.

`in_func` - called when the mouse is over a list item. The item number is passed as a parameter to this function.

`out_func` - called when the mouse moves out of the picklist area.

`click_func` - called when the mouse is clicked on a list item. The number of the selected item is passed as a parameter to this function.

3.12 Fonts

GIL provides two simple fonts: `SMALL` and `LARGE`. `LARGE` is a boldface version of `SMALL`, a sans serif typeface. The exact typeface depends on the computer platform on which the program is compiled.

3.13 Bitmap Images

GIL uses its own bitmap image file format for raster graphics. This file format is based on Run Length Encoding (RLE) to keep images small. Several pixel resolutions are supported to provide optimal compression and flexibility. The image file format is discussed in Section 5.

GIL allows an image to be drawn either directly from a file, or from a `GSPicture` structure in memory. Drawing a picture stored in a `GSPicture` is faster than drawing one stored in a file, but uses more memory. See Section 8.3.3 for documentation on **GIL** picture support routines.

3.14 Linking Function Names to Function Pointers

A GUI element such as a button, drag area or menu item is associated with an application program function that performs some action when the element is manipulated by the user. The function name is specified when the element is declared in the interface file. However, there must be some mechanism for attaching the name of the function as specified in the interface file to a function pointer (address) in the program. This is done using an array of structures — called `FuncNames` — initialized within the application program source code. Each element of the array maps a name to its associated function pointer. Note that independent functions, which are not associated with a particular interface element, (see Section 4.2.9) must also be included in the `FuncNames` array. This approach requires recompilation if either the logical or physical name of the function changes, as well as some coordination between the interface file and the source code. Fortunately, these names rarely change in practice. Figure 2 shows the `FuncNames` array for *giltest*, a simple example of a **GIL** application.

Initialization of `NumFuncs`. The application programmer must declare and initialize a global integer variable named `NumFuncs`. `NumFuncs` tells **GIL** the number of functions in the `FuncNames` array. **GIL** supplies a macro `GSnumifuncs` to make initialization of `NumFuncs` simple and convenient for the application programmer. Initialization of `NumFuncs` via `GSnumifuncs` is shown at the bottom of Figure 2.

3.15 Generic Database Reader

GIL was originally developed to support **Project GeoSim**, whose simulations typically require extensive databases. Thus, various database support functions were developed early on. The design philosophy was that data files should be human as well as machine readable. Therefore, the **GIL** database support functions use an ASCII-based data formatting scheme. It quickly became the convention to use this same file structure and these same support utilities for other **GIL** application needs such as application configuration files. Figure 3 shows a database file for the **Project GeoSim** application **Mental Maps**. Section 8.4.3 describes the database reader functions.

```
 IntrFunction FuncNames[] = {
 /*  name in .inf file     function pointer
     -------------------   --------------------- */
   { "again_func",         do_again              },
   { "do_nothing",         do_nothing            },
   { "intro",              do_intro              },
   { "color_menu",         show_colors           },
   { "clear_draw_func",    clear_draw            },
   { "clear_text_func",    clear_text            },
   { "quit_prog_func",     do_quit               },
   { "done_func",          alert_done            },
   { "box_menu",           show_box_styles       },
   { "funcs_menu",         show_funcs_menu       },
   { "kbd_hndlr",          (bool(*)())do_text },
   { "draw_func",          (bool(*)())do_draw },
   { "set_color_func",     set_color             },
   { "toggle_fill_func",   toggle_fill           },
   { "toggle_border_func", toggle_border         },
} ;

int NumFuncs = GSnumifuncs(FuncNames);
```

Figure 2: The FuncNames array for *giltest*.

```
#keyword   value
#-------   --------
database=  MM_cdata  # ID tag for database; passed to GSgenreader
mapscale=  1         # map scale factor (x's, y's multiplied by this)
mapoffx=   1         # map horizontal offset (added to x's)
mapoffy=   15        # map vertical offset (added to y's)
numcities= 24        # number of city records to follow
format=              # signals that format list follows
 x     y        pop     low    hi  name           labx   laby
tamrof               # signals end of format list to GSrdformat
225   207   12596243    50   105  Bombay          184    208
399   177   11021915    57    98  Calcutta        402    180
280   107    8419084    43   105  Delhi           249    108
302   290    5421985    67   101  Madras          305    293
279   248    4253759    59   101  Hyderabad       282    251
269   292    4130288    57    93  Bangalore       211    294
237   217    2493947    53   101  Poona           203    219
312   132    2029889    47   105  Kanpur          302    140
321   127    1669204    47   105  Lucknow         301    124
301   186    1664006    57   109  Nagpur          304    188
260   169    1109056    50   103  Indore          235    165
367   150    1099647    47   105  Patna           370    153
275   326    1085914    75    92  Madurai         279    329
283   163    1062771    51   106  Bhopal          275    173
230   172    1061598    50   105  Baroda          215    179
289   127     948063    43   107  Agra            259    129
331   151     844546    58   107  Allahabad       305    162
293   141     717780    45   109  Gwalior         249    144
263    65     708835    40   106  Amritsar        212     67
236   134     666279    49   105  Jodhpur         191    136
305   110     617350    46   103  Bareilly        307    112
206   168     612458    51   105  Rajkot          174    177
279    74     575829    43   104  Chandigarh      281     77
281   112     301297    43   105  New Delhi       263    118
endformat            # end of formatted list
```

Figure 3: The India city data file for **Mental Maps**.

4 Interface File: *An Example*

The easiest way to introduce the parts of an interface file is by means of a simple example. The excerpts used here are from an interface file for a simple program called *giltest*. The purpose of *giltest* is to provide exposition of the basic types of interface elements available with **GIL**.

Interface Files and the *Graphical Builder.* All **GIL** developers should have some familiarity with **GIL** interface files. However, we strongly encourage developers to use the *Graphical Builder* to create interface files, instead of hand-coding them. With *Graphical Builder* a developer can generate an interface quickly, and can study its "look and feel" while creating it. Also, the interface files created with *Graphical Builder* are free from syntactical errors which inevitably occur in hand-coded interface files.

Comments in the Interface File. Comments in interface files begin with a pound sign (`#`). All text to the right of the pound sign is ignored. Comments can begin in any column.

4.1 Color Declarations

4.1.1 Color Palette Declaration

An interface file typically begins with the declaration of a color palette. The color palette defines the specific colors available for use in the interface. A palette consists of up to 256 colors. The number of colors in the palette declaration should correspond to the number of colors specified in the **GIL** initialization. (See Section 8.1.1). Each color in the palette is specified by a set of Red-Green-Blue (RGB) values. Each RGB value must be in the range 0-63. A color declaration has the following syntax:

(*color-name* *red-value* *green-value* *blue-value*)

All of the parameters are mandatory. The parameters are:

colorname : **name** - the name of the color.

red-value, green-value, blue-value : **integer** - the red, green, and blue components of the color.

The palette declaration must begin with the word `PALETTE`. The color declarations follow, one color per line. The word `END` must appear after the last color declaration. The color palette declaration for *giltest* appears in figure 4.

```
PALETTE
#           R   G   B
#          ------------
(black      0   0   0)
(dgray     50  45  45)
(mgray     30  30  55)
(lgray     53  53  53)
(aqua       0  50  50)
(lblue     10  10  55)
(peach     63  47  50)
(blue       0   0  36)
(green      0  36   0)
(lpurple   63  50  63)
(red       55   0   0)
(yellow    63  63  21)
(lcyan     50  59  63)
(magenta   44   6  44)
(sandy     63  51  51)
(white     63  63  63)
END #PALETTE
```

Figure 4: The 16-color palette for *giltest*.

4.1.2 Color Alias Declarations

Note that the color names used in the palette declaration for *giltest* are general in nature. These names attempt to describe the appearance of the colors, not the ways in which these colors are used in the application. It is better to indicate the use of a color with an *aliased* name. Use of color aliases in the interface file makes it easier to modify the colors of interface elements, just as using named constants makes your code easier to change. Figure 5 shows the color alias declarations for *giltest*.

For an example of how aliases can make it easier to modify an interface, note that altering the alias `ALIAS ( bbg lblue )` to `ALIAS ( bbg yellow )` would change the background color of *all* buttons in the interface from blue to yellow. Likewise, the appearance of menus, windows, etc. can be easily and consistently modified by changing the appropriate alias declarations. The power inherent in color aliases is especially helpful in applications with large interfaces.

The syntax for a color alias declaration is as follows:

`ALIAS (` *color-name* *alias-name* `)`

All of the parameters in color alias declarations are mandantory. The parameters for color alias declarations are:

color-name **: name** - the name of the color referenced by *alias-name*.

```
#       alias       color
#       ----------  ------
                              # Window colors.
ALIAS (rootbg       aqua  )     # background color for root window
ALIAS (rootfg       black )     # foreground color for root window
ALIAS (wbdr         black )     # border color for windows
                              # Button colors.
ALIAS (bbg          lblue )     # background color for buttons
ALIAS (befg         white )     # text color for enabled buttons
ALIAS (bdfg         mgray )     # text color for disabled buttons
                              # Menu colors.
ALIAS (popefg       black )     # text color for enabled popup menu items
ALIAS (popdfg       dgray )     # text color for disabled popup menu items
ALIAS (popbg        peach )     # background color for popup menus
ALIAS (popbdr       black )     # border color for popup menus
                              # Color List colors.
ALIAS (fillcolor0   black )     # first color in menu
ALIAS (fillcolor1   yellow)     # second color in menu
ALIAS (fillcolor2   white )     # third color in menu
ALIAS (fillcolor3   lblue )     # fourth color in menu
ALIAS (fillcolor4   red   )     # fifth color in menu
                              # Other colors.
ALIAS (text         black )     # color of text in text entry field
ALIAS (dragbg       white )     # background color of draw drag area.
```

Figure 5: Color Aliases for *giltest*.

alias-name **: name** - the alias which references *color-name*.

4.1.3 Color List Declarations

Color lists are used in **GIL** to establish logical orderings of color. These orderings are typically independent of the order of the colors in the palette declaration. Uses for color lists include graph coloring and support for color selection menus. *Giltest* uses a color list to support a menu of fill colors. The format for a color list declaration is as follows:

`COLORLIST` (*color0 color1 color2 color3 color4*)

All of the parameters in a color list declaration are mandatory. The parameters for color list declarations are:

color0, color1, color2, color3, color4 **: name** - five color names (either palette names or aliases).

There is one color list declared in the interface file for *giltest*:

```
COLORLIST (fillcolor0 fillcolor1 fillcolor2 fillcolor3 fillcolor4)
```

4.2 Interface Element Declarations

Once the colors are set, interface elements can be declared. Note that the element declarations all contain either color palette names or their aliases. This means that the color declarations *must* precede the element declarations in an interface file.

4.2.1 Menu Declarations

Menus are lists of functions from which a user may select. Menu items can be disabled or made invisible. Check-list menus, which allow a user to toggle program parameters, are also available. A menu is declared as a `POPUP` in the interface file. Menus do not belong to any particular window. A menu declaration has the following syntax:

`POPUP` (*name x y efgcolor dfgcolor bgcolor bdrcolor checklist*? [*func*])

Except for *func*, all parameters in menu decarations are mandatory. The menu declaration parameters are:

name : **name** - the name of the menu.

x : **integer** - location of the left edge of the menu.

y : **integer** - location of the top of the menu.

efgcolor : **name** - the text (foreground) color for enabled menu items.

dfgcolor : **name** - the text (foreground) color for disabled menu items.

bgcolor : **name** - the background color of the menu.

bdrcolor : **name** - the color of the menu's border.

checklist? : **integer** - 1 if the menu is a checklist; 0 otherwise.

func : **name** - an optional function for the event handler to call whenever the menu is closed.

Each item of a menu is declared as a `PLABEL` (*P*opup *LABEL*). A `PLABEL` declaration is associated with the nearest `POPUP` declaration above it in the interface file. The syntax for a `PLABEL` declaration is as follows:

`PLABEL` (*name enable*? *func text*)

All parameters in a `PLABEL` declaration are mandantory. The `PLABEL` parameters are:

name : **name** - the name of the menu item. The item name is passed as a parameter to *func*, the item's function.

enable? : **integer** - 1 if the menu item should be enabled at program startup; 0 otherwise.

func : **name** - the function which is executed when this menu item is selected.

text : **string** - the label text to show for this menu item. Label text may contain spaces. The label text must be delimited by the '`|`' character. All characters between the '`|`' characters will be part of the label text.

There are three popup menus used in *giltest*. One of them is a regular menu (as opposed to a checklist menu):

```
POPUP (funcs_menu 9 43 popefg popdfg popbg popbdr 0)
  PLABEL (ClearText 0 clear_text_func |Clear Text Field|)
  PLABEL (ClearDraw 0 clear_draw_func |Clear Draw Area|)
  PLABEL (QuitProg 1 quit_prog_func |Quit|)
```

These declarations declare the *Functions* menu, which contains three items, and pops up at position (9, 43) on the screen when the button labeled *Functions* is pressed. The items are labeled `Clear Text Field`, `Clear Draw Area`, and `Quit`. When selected, these items cause the application program functions linked with the names `clear_text`, `clear_draw`, and `doquit` to be executed, respectively. (See Section 3.14 concerning function name mapping.) The color characteristics of the menu are defined by the color aliases `popefg`, `popdfg`, `popbg`, and `popbdr`.

4.2.2 Window Declarations

Windows are named, rectangular regions of the screen within which other elements may be grouped. The syntax of a window declaration is as follows:

`WINDOW` (*name x y wd ht fgcolor bgcolor bdrcolor bdrsize active? bstore*)

All of the parameters in a window declaration are mandatory. The parameters for window declarations are:

name : **name** - the name of the window.

x : **integer** - location of the left edge of the window.

y : **integer** - location of the top of the window.

wd : **integer** - the width — in pixels — of the window.

ht : **integer** - the height — in pixels — of the window.

fgcolor : **name** - the text color of the window. This is used only for special help windows (see Section 4.2.2) and the login window (see Section 4.2.2).

bgcolor : **name** - the background color of the window.

bdrcolor : **name** - the color of the window's border.

bdrsize : **integer** - the width – in pixels – of the window's border.

active? : **integer** - 1 if the window should be active at program startup; 0 otherwise. The buttons, drag areas, etc. in a window can only be manipulated when the window is active.

bstore : **integer** - the (integer) identifier of the backing store that the window will use to save the portion of the screen that it covers when it is drawn (see Section 3.3). 1, 2, 3, 4, and 5 are the legal backing store identifiers. Use 0 if the window will not use backing store. 0 should be used for windows that will never be removed from the screen during program execution. Note that this parameter only determines which backing store *can* be used when the window is drawn, not whether it *will* be used.

Note that while the parameter *fgcolor* is not used on most windows, it must have a corresponding argument in every window declaration. For windows which do not use *fgcolor*, any legal color name or alias will suffice as an argument.

The *giltest* interface contains four windows. Below is an example of window declaration. These windows in turn contain other types of elements, which will be described below. For now, it is only important to note that the declarations of these other elements appear grouped together below the declaration of the window which contains them.

```
WINDOW (root 0 0 640 480 white rootbg wbdr 2 1 0)
  BUTTON (funcs |Functions| 9 23 105 25 befg bdfg bbg @funcs_menu 1 1 0 C)
  BUTTON (box |Box Style| 9 98 105 25 befg bdfg bbg @box_menu 1 1 0 C)
  BUTTON (color |Fill Color| 9 173 105 25 befg bdfg bbg @col_menu 1 1 0 L)
  LABEL (235 15 white |GeoSim Interface Library (GIL) Test| black)
  LABEL (550 15 rootfg |GeoSim|)
  FIELD (version 450 5 60 19 rootfg)
  FIELD (fillcolor 99 178 10 10 rootfg)
```

The declaration above is for the `root` window, which defines the screen area of a **GIL** application. Its text color argument is white, although this parameter is not used for this window. Its background color is defined by the color alias `rootbg`, which is associated with the color `aqua` by an earlier `ALIAS` declaration. It has a two-pixel wide border, the color of which is defined by the alias `wbdr`. It is active at the start of the program. It cannot use backing store, since its *bstore* argument is 0. (It does not need backing store because it is never removed from the screen.) It contains three buttons, two labels, and two fields.

Root Window Every application that uses **GIL** must have a window named `root`. It must be the first window declared in the interface file. The location of the left edge and top of the `root` window must be 0. The width and height of the `root` window define the available screen real estate for a **GIL** application. Currently, the root window *must* be 640 pixels wide and 480 pixels high.

Help Messages and Help Windows **GIL** uses specific window names for its help, message, and alert functions. The window named `help` is used by the function `GSdohelpscreens`, which loads help text from a file. The text can be of arbitrary length; `GSdohelpscreens` will break it into pages.

The `message` window is used by `GSdisplayhelpmessage` to display a short message (up to three lines). The `message` window should remain visible anytime a help message can be displayed. `GSdohelpscreens` also calls `GSdisplayhelpmessage` , so it also needs the `message` window.

Messages for the message window are declared in the interface file. Each declaration consists of three lines of text; if the message has fewer than three lines, make the declaration as shown below, but leave the extra lines blank.

The syntax of a message declaration is as follows:

`MSG` (*hmX0* *messagetextline1*)
`MSG` (*hmX1* *messagetextline2*)
`MSG` (*hmX2* *messagetextline3*)

The *X* in `hmX0`, `hmX1`, and `hmX2` is the number of the message. This number can be any unique positive integer; it is used as the argument to `GSdisplayhelpmessage`.

All parameters in message declarations are mandantory. The message declaration parameters are:

hmXX : **name** - the message identifier.

messagetextlineX : **string** - the message text line. Message text may contain spaces. The label text must be delimited by the '`|`' character. All characters between the '`|`' characters will be part of the label text.

Here is an example of a message from *giltest*:

```
MSG (hm10 |Look here for help messages as you go through the program.|)
MSG (hm11 |Press "Again", or type a message, or press "Box Style" to|)
MSG (hm12 |set parameters for drawing boxes in the Drawing Area.|)
```

The `alert` window is used by `GSalert` to display warning or error messages. This window is normally out of sight; it pops up only when a message needs to be displayed, and disappears again when the user acknowledges the message. An alert message declaration is similar to the declarations shown above; however, they contain only one line, and may be given any legal identifier name (See Section 2.3 regarding legal identifier names):

`MSG` (*messagename* |*messagetext*|)

giltest has one alert message, which is used to signal a user that he or she has exceeded the maximum number of characters in an input string:

```
MSG (typedtoofar |You have reached the end of the text box.|)
```

Note that the application programmer *must* declare these windows in the interface file in order to use their corresponding functions. **GIL** knows the names of the windows, but does not automatically create them.

Login Window Some application programmers may want users to "log in" to an application. **GIL** provides a skeletal mechanism for allowing a user to log in. The **GIL** function `GSdologinscreen` initiates this mechanism. **GIL** requires the application programmer to declare a window named `login` in the interface file for the login mechanism to work. The application programmer must also declare a field named `login`; this field is used to echo user keyboard input.

4.2.3 Button Declarations

Buttons are graphical elements to be "pressed" using the mouse. "Pressing" a button causes some function in the application program to be called. Each button belongs to a particular window. When **GIL** reads a button declaration in the interface file, it associates the button with the most recently declared window. A button can be disabled — in which case it is visible, but cannot be pressed — or made invisible. When a button is disabled, its label is printed using *dfgcolor* instead of *efgcolor*.

The syntax for a button declaration is as follows:

`BUTTON` (*name* |*lab*| *x* *y* *wd* *ht* *efgcol* *dfgcol* *bgcol* *func* *bdr*? *enab*? *repeat*? *labpos*)

All of the parameters for a button declaration are mandatory. The parameters are:

name : **name** - the name of the button.

lab : **string** - the label to show on the button. The label text may contain spaces. The label text must be delimited by the '`|`' character. The label can contain multiple lines. Use the '`@`' character to signal the start of a new line (e.g., `|line1@line2|`). An arrow can be placed on a button by including the appropriate escape sequence in the label argument. See below for more details.

x : **integer** - location of the left edge of the button, relative to the left edge of the window which contains it.

y : **integer** - location of the top of the button, relative to the top of the window which contains it.

wd : **integer** - the width — in pixels — of the button.

ht : **integer** - the height — in pixels — of the button.

efgcol : **name** - the color of the button's label when the button is enabled.

dfgcol : **name** - the color of the button's label when the button is disabled.

bgcol : **name** - the background color of the button.

func : **name** - the function which the button causes to execute. If preceded by the `@` character, the popup menu `func` is displayed when the button is pressed.

bdr? : **integer** - 1 if the button should have a (black) border; 0 if the button should have no border.

enab? : **integer** - 1 if the button should be enabled at program startup; otherwise, 0. See Section 3.9 regarding enabled vs. disabled buttons.

repeat? : **integer** - 1 if the function associated with the button should be repeated when the button is held down; otherwise, 0. See Section 3.1 about repeatable buttons.

labpos : **name** - `L` to position the first character of the label near the left edge of the button; `C` to center the label between the left and right edges of the button; `R` to position the last character of the label near the right edge of the button.

There are five buttons in the *giltest* interface. The `io` window contains the following button declaration:

```
BUTTON (again |Hello Again| 220 75 80 25 befg bdfg bbg again_func 1 1 0 C)
```

The name of this button is `again`; this is the name used within the application program to refer to the button. The label on this button — which tells the application user what the button does — is `Hello Again`. The upper left corner of the button is located at pixel position (220, 75); this position is relative to the upper left hand corner of the `io` window. The color characteristics of this button are defined by a series of color aliases. This button causes the application program function linked to the name `again_func` to be executed. It has a one-pixel-wide border, is enabled at program startup, and is not repeatable.

The root window contains three buttons, including the `functions` button, declared as follows:

```
BUTTON (funcs |Functions| 9 23 105 25 befg bdfg bbg @funcs_menu 1 1 0 C)
```

The main difference between this declaration and the one for `again` is the '`@`' symbol before the name `funcs_menu`. This at sign indicates that the button is associated with the popup menu named `funcs_menu`. This means that when the `funcs` buttons is pressed, the application program function linked to the name `funcs_menu` is called, and the `funcs_menu` menu is displayed. Note that the name of the menu must match the name of the function as declared in the interface file.

The other two button declarations in the `root` window are also for popup menus, and are similar to the `funcs` button.

Small Font Buttons. The `BUTTON` declaration is used for buttons which have labels written in the `LARGE` font. Alternatively, you can use *small font* buttons. Small font buttons use the `SMALL` font. To declare a small font button, use `BUTTONS` in place of `BUTTON` in your declaration.

Arrows on Buttons You may want to put an arrow symbol on a button in addition to — or in place of — text. This can be done by using an escape sequence in the button label argument. The escape sequences for arrow symbols are given in the following table:

Escape Sequence	*Arrow Direction*
`\^`	Up
`\v`	Down
`\<`	Left
`\>`	Right

4.2.4 Field Declarations

Fields are rectangular regions. Fields typically specify a position where output is displayed. They allow the location of graphical elements (such as variable labels or pictures) to be defined in the interface file rather than hard-coding these locations within the program. A field does not belong to a particular window; however, the coordinates of a field are relative to the current window at run-time. In this way, the same field definition may be used to locate output within more than one window.

The syntax for a field declaration is as follows:

`FIELD` (*name x y wd ht color*)

All of the parameters for a field declaration are mandatory. The parameters are:

name : **name** - the name of the field.

x : **integer** - location of the left edge of the field, relative to the left edge of the current window at run time.

y : **integer** - location of the top of the field, relative to the top of the current window at run time.

wd : **integer** - the width — in pixels — of the field.

ht : **integer** - the height — in pixels — of the field.

color : **name** - a color associated with the field. A field is defined by its location and dimensions; it has no color per se. The color parameter can be used at runtime to set the color of output (text, lines, solid fill, etc.) which appears in the field.

There are eleven fields in the *giltest* interface. The field `textfg` in the `io` window defines the color and location for echoing a user's input string, `textbg` defines a background fill area. The important thing to notice is that the syntax for these two declarations is the same; the semantic characteristics of a field are determined entirely by the application code.

```
FIELD (textbg 220 18 126 16 dgray)
FIELD (textfg 222 30 120 370 text)
```

4.2.5 Drag Area Declarations

Drag areas are rectangular regions of the screen within which a user may perform mouse operations such as pointing, dragging, and clicking. A user performs a mouse drag by moving the mouse while holding the mouse button down. Each declared drag area is associated with a drag function in the application program (see Section 3.5). A drag area belongs to the most recently declared window.

A drag area declaration has the following syntax:

`DRAGAREA` (*name x y wd ht bgcolor func enable?*)

All of the parameters for a drag area declaration are mandatory. The parameters for are:

name : **name** - the name of the drag area.

x : **integer** - location of the left edge of the drag area, relative to the left edge of the window which contains it.

y : **integer** - location of the top of the drag area. relative to the top of the window which contains it.

wd : **integer** - the width — in pixels — of the drag area.

ht : **integer** - the height — in pixels — of the drag area.

bgcolor : **name** - the background color of the drag area.

func : **name** - the function which the drag area causes to execute.

enable? : **integer** - 1 if and only if the drag area should be enabled at program start-up; 0 otherwise.

giltest has one drag area, which is part of the `io` window:

```
DRAGAREA (drawarea 2 191 376 177 dragbg draw_func 1)
```

This drag area is named `drawarea`, and its upper left corner lies at (`2, 191`) in the `io` window. It is 376 pixels wide and 177 pixels high. Its background color is defined by the alias `dragbg`. It causes the application program function linked with the name `draw_func` to be called when it is manipulated. (See Section 3.5 regarding drag area manipulations.) It is enabled at program start-up.

4.2.6 Label Declarations

Labels are static text phrases which are fixed in a particular position within a window. They are useful for presenting text which should appear every time the window is drawn. Examples are the name or version number of the program, the name of the individual or organization responsible for creating the program, the title of a graph, etc. The syntax of a label declaration is as follows:

`LABEL` (*x* *y* *color* *text* [*shadowcolor*])

All of the parameters in label declarations except *shadowcolor* are mandatory. The parameters are:

- *x* : **integer** - location of the left edge of the first letter in the label, relative to the left edge of the window which contains it.
- *y* : **integer** - location of the bottom of first letter of the label, relative to the top of the window which contains it.
- *color* : **name** - the text color of the label.
- *text* : **string** - the text of the label. Label text may contain spaces. The label text must be delimited by the '`|`' character.
- *shadowcolor* : **name** - the color of the label's shadow. Shadow text appears one pixel below and to the right of the label. No shadow is displayed if this argument is omitted.

There are three labels in the root window. The first is given by the declaration:

```
LABEL (235 15 white |GIL Application Test| black)
```

This label reads "GIL Application Test", and appears at position (235, 15) in the root window. It it white with a black shadow.

The second label declaration in the root window reads:

```
LABEL (550 15 rootfg |GeoSim|)
```

This label reads "GeoSim", and appears at position (550, 15) in the root window. It has no shadow, since there is no argument provided for *shadowcolor*. There is also an unshadowed label in the `io` window.

Small Labels As with buttons, `LARGE` is the default font for labels. To use the `SMALL` font for a label, replace `LABEL` with `LABELS`.

4.2.7 Line and Rectangle Declarations

Lines and rectangles which are declared in the interface file are drawn automatically by **GIL** whenever the window which contains them is drawn. Thus, rectangles and lines which are permanent fixtures in a window can be conveniently managed by declaring them in the interface file. Rectangles and lines which appear in a window temporarily are best managed using the **GIL** drawing functions described in Section 8.3.2. The syntax for a line declaration is:

`LINE` (*x0 y0 x1 y1 width color*)

All of the parameters in line declarations are mandatory. The parameters are:

x0 : **integer** - the x-coordinate of endpoint 1 of the line, relative to the left edge of the window which contains it. (Arbitrarily pick one endpoint to be endpoint 1.)

y0 : **integer** - the y-coordinate of endpoint 1 of the line, relative to the top of the window which contains it.

x1 : **integer** - the x-coordinate of endpoint 2 of the line, relative to the left edge of the window which contains it.

y1 : **integer** - the y-coordinate of endpoint 2 of the line, relative to the top of the window which contains it.

width : **integer** - the width — in pixels — of the line. Legal values are 1 and 2.

color : **name** - the color of the line.

There are ten lines declared in the interface file for *giltest*. We show two of these declarations here as examples. There is a two-pixel wide horizontal line which runs between x-coordinates 0 and 380 at y-coordinate 368 in the `io` window:

```
LINE ( 0 368 380 368 2 black )
```

There is also a one-pixel wide vertical line which runs between y-coordinates 35 and 16 at x-coordinate 347 in the `io` window:

```
LINE ( 347 35 347 16 1 white )
```

The syntax for a rectangle declaration is as follows:

`RECT` (*x y wd ht color bdrsize style*)

All of the parameters for rectangle declarations are mandatory. The parameters are:

x : **integer** - location of the left edge of the rectangle, relative to the left edge of the window which contains it.

y : **integer** - location of the top of the rectangle, relative to the top of the window which contains it.

wd : **integer** - the width — in pixels — of the rectangle.

ht : **integer** - the height — in pixels — of the rectangle.

color : **name** - the color of the rectangle's border.

bdrsize : **integer** - the width — in pixels — of the rectangle's border. Legal values are 1 and 2. Not used for solid rectangles (but argument nonetheless required.)

style : **name** - "fill" for a solid rectangle, "hollow" for hollow frame rectangle.

There are three rectangles declared in the interface file for *giltest*. We show two examples here. The first is a solid rectangle; the second is a hollow frame rectangle with a thick border:

```
RECT (218 16 130 20 dgray 2 fill)
RECT (218 16 130 20 wbdr 2 hollow)
```

4.2.8 Draw Order of Labels, Lines, and Rectangles

A window's labels, lines, and rectangles are all *static* interface elements. This means that they are not changed by the application program code, and that they always are drawn automatically when the window is drawn. They are drawn in the order in which they are declared in the interface file. If two static elements occupy the same screen space, the element which is declared later in the interface file will be drawn "on top".

4.2.9 Independent Function Declarations

These are functions that are not part of any specific interface element. The application programmer may declare an independent function to be called each time **GIL** iterates its event loop. Independent functions may be activated at program startup with the *active?* parameter in the interface file. They can also be activated (with `GSactivatefunction`) and deactivated (with `GSdeactivatefunction`) by the program as needed. Note that independent functions must also be included in the `FuncNames` array. The purpose of the `FUNCTION` declaration is to make the function eligible to be called by the event loop. This allows an application to provide functionality not tied to a user action, such as an animation or time-based simulation. The syntax of a function declaration is as follows:

`FUNCTION` (*funcname* *dtime* *active*? [*mouseoff*?])

The first three parameters are mandatory; the last parameter is optional. The parameters for function declarations are:

funcname : **name** - the name string of the function as declared in the `FuncNames` array.

dtime : **integer** - how often to execute the function. Not implemented.

active? : **integer** - 1 if the function should be active at program startup; 0 otherwise.

mouseoff? : **integer** - to hide the mouse cursor during execution of the function, use 1, or omit the argument. If the cursor should remain visible, use 0.

There are two independent functions declared in the *giltest* interface file:

```
FUNCTION (intro 0 1)
FUNCTION (kbd_hndlr 0 0)
```

4.2.10 Redraw Function Declaration

Section 3.4 described the need for a redraw function in the application program code. An application's redraw function must be declared in the interface file, so that **GIL** knows to call it when a redraw is necessary. The syntax of a redraw function declaration is as follows:

`REDRAWFUNC` (*funcname*)

The following parameter is mandatory:

funcname : **name** - the name string of the function as declared in the `FuncNames` array.

4.2.11 Miscellaneous Parameter Declarations

The following are declarations which are not associated with a particular interface element. The `HIGHLIGHT`, `SPEEDUP`, and `BUTTONSTUFF` declarations are instead generally associated with multiple interface elements.

The `HIGHLIGHT` declaration determines the color used to highlight the current selection on a popup menu. Its syntax is:

`HIGHLIGHT` (*highlightcolor*)

Its parameter is mandantory:

highlightcolor : **name** - a color name or alias.

The highlight color in *giltest* is set to "aqua":

```
HIGHLIGHT (aqua)
```

The `SPEEDUP` declaration is used for repeatable buttons (See Section 3.1). It specifies how quickly the repetition rate should accelerate. The repetition rate is made deliberately slow to start off with, to minimize the chance of an accidental repetition. As the button is held down, this rate increases. This keeps the user from having to wait too long for repetitions to occur.

The syntax for a `SPEEDUP` declaration is as follows:

`SPEEDUP` (*speeduprate*)

Its parameter is:

speeduprate : **integer** - how quickly the repetition rate for a repeatable button should increase. Ususally, 100 is used for this value.

The `SPEEDUP` declaration for *giltest* is:

```
SPEEDUP (100)
```

The `BUTTONSTUFF` declaration sets certain global button characteristics. Its syntax is:

`BUTTONSTUFF` (*bordercolor diagonals? highlight_TL highlight_BR*)

All of the parameters for `BUTTONSTUFF` declarations are mandatory. The parameters are:

bordercolor : **name** - the color of button borders.

diagonals? : **integer** - non-zero if and only if each disabled button should have a diagonal line drawn across it.

highlight_TL : **name** - the color of the highlight on the top and left edges of each button. See Section 3.1 regarding button depressing visuals.

highlight_BR : **name** - the color of the highlight on the bottom and right edges of each button.

The `BUTTONSTUFF` declaration for *giltest* is:

```
BUTTONSTUFF (black 0 white black)
```

5 GIL Image Format

GIL picture functions operate on *runlength encoded* image files. Runlength encoding is a form of image compression. Instead of representing an image as a two-dimensional array of pixel values, runlength encoding represents each row of the image as a series of *runs*. A run consists of several adjacent pixels with the same value. A run is represented in the image file as a record with two fields:

run length	*pixel value*

The *run length* field contains the number of pixels in the run. The *pixel value* field contains the common value of the pixels in the run.

All runlength encoded image files have the following format:

tag	*row count*	*column count*	*row vector*	*runs*

The 4 byte *tag* field identifies the image type. **GIL** supports four types of run length encoding, differentiated by the number of bytes per run, and the number of bits per pixel value field:

1. 1 byte per run. The high order 4 bits are the run length, and the low order 4 bits are the pixel value. Typically the pixel value is the color value for a 16-color palette. A zero (0) in the runlength field represents a runlength of 16.

2. 2 bytes per run. The first byte is the run length, and the second byte is an 8 bit pixel value. The pixel value can be an 8 bit palette index. Alternatively, it can be a data value which is converted to a color index by an application program function that is passed to `GSwdrawpict` or `GSwdrawfilepict` as a parameter. A zero (0) in the runlength field represents a runlength of 256.

3. 2 bytes per run. The high order 4 bits are the run length, and the low order 12 bits are the pixel value. The pixel value is always a data value, and must be converted to a color by the application program. A zero (0) in the runlength field represents a runlength of 16.

4. 3 bytes per run. The first byte is the run length, and the next two bytes are a 16 bit pixel value. The pixel value is always a data value, and must be converted to a color by the application program. A zero (0) in the runlength field represents a runlength of 256.

The *row count* and *column count* fields contain the number of pixel rows and pixel columns, respectively.

The *row vector* indicates the position in the file for the beginning of each row. This allows direct access to each row of the image (to get to a pixel within a row, the row must be processed in order). *rowvector*[0] stores the actual byte location within the file of the first run of row 0. Each item of *rowvector* thereafter stores the offset from the previous row. This allows the row vector values to be only 2 bytes long, without limiting the entire image file size.

The *runs* section of the file contains the pixel runs for the image.

5.1 Runlength Encoder

GIL includes a utility program called `rencode` which converts a raster image file to **GIL**'s runlength encoded format. Currently, `rencode` can only convert (uncompressed) *TIFF* files and raw raster files, but we may add other image formats in the future. Image files created with `rencode` on any **GIL**-supported platform can be ported to any other **GIL**-supported platform without modification. Use `rencode` as follows:

`rencode` *bits-per-pixel* *infile* *outfile*

bits-per-pixel indicates which of the four runlength encodings will be used. The acceptable values for *bits-per-pixel* and the corresponding sizes for the run length and pixel value fields are as follows:

bits-per-pixel	*run length field*	*pixel value field*
4	4	4
8	8	8
12	4	12
16	8	16

infile is the input file in *TIFF* or raw raster format. It should contain a series of pixel values of the appropriate format. If *bits-per-pixel* is 4, then input pixels should be one byte per pixel with only the lower 4 bits significant. If *bits-per-pixel* is 8, then input pixels should be one byte per pixel, and all 8 bits will be treated as significant. If *bits-per-pixel* is 12, then input pixels should be two bytes per pixel, with only the lower 12 bits significant. If *bits-per-pixel* is 16, then input pixels should be two bytes per pixel, and all 16 bits will be treated as significant.

outfile is the name of the resulting runlength encoded image. The *outfile* argument can be omitted, in which case the name of the runlength encoded image file will be derived from the name of the raster image file by replacing the extension of the raster image file name with the extension ".rl$X$", where X is the least significant decimal digit of *bits-per-pixel.* ("rl$X$" is simply appended to the end of the raster image file name if it has no extension.)

For certain pixel configurations, the application programmer may have a choice in which runlength encoding format to use. For example, raster images with 4 significant bits per pixel can be encoded with *bits-per-pixel* as either 4 or 8. If *bits-per-pixel* is set to 4, then the runlength codes will be shorter (only one byte), but the maximum runlength will be 16. Alternatively, if *bits-per-pixel* is set to 8, then the runlength codes will be longer (two bytes), but the maximum runlength can now be 256. Runlength encoded images that yield long runlengths may be smaller with *bits-per-pixel* set to 8; programmers may wish to experiment. Likewise, images with 12 significant bits per pixel can be encoded with 12 or 16 bits per pixel.

6 Portability Issues

The concern for portability has driven several design decisions. Many portability problems are solved by masking platform dependencies with **GIL** API functions. Other portability problems are not so easily solved.

Graphics Resolutions The **GIL** API uses up to a 640x480 pixel portion of the screen, which is the entire screen on MS-DOS (VGA) and some Macintosh machines. Whereas MS-DOS applications control the entire screen, on the Macintosh the top of the screen is normally taken by a standard menu bar. To obtain 640x480 pixels we eliminate this bar from the Macintosh screen on 640x480 displays. On larger monitors, the **GIL** application works properly within a Macintosh OS window, with the Macintosh menu in its usual location at the top of the screen. We make little pretense of following Macintosh (or any other) GUI standards.

Colors We only require 16 colors for existing **GeoSim** modules. However, we anticipate future need for more than 16 but no more than 256 colors. Although this is not a problem on the Macintosh or X-Windows platforms, there is no standard among the many manufacturers of MS-DOS video components that provides 640x480 pixels with 256 colors. Despite this, we are able to use most of the major video hardware that does support this resolution with public domain graphics drivers.

File and Path Names. File names follow the MS-DOS convention (eight characters plus a three character extension), since the other platforms allow this format. Full and partial pathnames can be used, but pathnames should always use the Unix path separator: `'/'`. **GIL** translates this path separator to the platform's native format.

Memory Issues. MS-DOS uses a segmented memory scheme which requires that memory blocks be confined to 64 Kilobytes. Additionally, MS-DOS does not provide virtual memory. Programmers who expect their **GIL**-based applications to run under MS-DOS should be aware of these facts, and should also restrict their total run-time memory requirements to less than 640 Kilobytes.

Constant	*Semantics*	*Function*	*Parameter*
`DRAW`	Draw button immediately after enabling it.	`GSenablebutton`	`draw`
	Draw button immediately after disabling it.	`GSdisablebutton`	
	Immediately draw button on screen.	`GSvisiblebutton`	
	Immediately erase button from screen.	`GSinvisiblebutton`	
`NO_DRAW`	Wait until window that contains button is (re)drawn to (re)draw button.	`GSenablebutton`	`draw`
		`GSdisablebutton`	
		`GSvisiblebutton`	
	Wait until window which contains button is (re)drawn to erase button.	`GSinvisiblebutton`	
`BSTORE`	Enable backing store for the application.	`GSinterfaceinit`	`bstore`
	Save screen when named window is drawn.	`GSdrawnamedwindow`	
	Save screen when Alert window is drawn.	`GSalert`	
	Save screen when Help window is drawn.	`GSdohelpscreens`	
`NO_BSTORE`	Disable backing store for the application.	`GSinterfaceinit`	`bstore`
	Don't save screen when named window is drawn.	`GSdrawnamedwindow`	
	Don't save screen when Alert window is drawn.	`GSalert`	
	Don't save screen when Help window is drawn.	`GSdohelpscreens`	
`POPUP`	Deactivate all other active windows when named window is drawn.	`GSdrawnamedwindow`	`popup`
`NO_POPUP`	Keep all other active windows active when named window is drawn.	`GSdrawnamedwindow`	`popup`
`SMALL`	Use small font for text.	`GSsetfont`	`size`
`LARGE`	Use large font for text.		
`THIN`	Use thin line width.	`GSsetlinesize`	`size`
`THICK`	Use thick line width.		
`CURR_MSG`	Show current help message.	`GSdisplayhelpmessage`	`messnum`
`PREV_MSG`	Show previous help message.		

Table 1: Named Constants used as Arguments to **GIL** Functions.

7 GIL Constants and Data Types

7.1 Constants

Some **GIL** functions expect named constants (or variables which evaluate to these constants) as arguments. These constants are shown in Table 1. Each constant name is listed in the column labeled *Constant*. The semantic significance of using a particular constant as an argument to a particular function can be found in the column labeled *Semantics* by looking across the row which contains the desired constant and function. The functions which use each constant are listed in the column labeled *Function*. For each function, the parameter for which the constant is a legal value is listed in the column labeled *Parameter*.

Key Constants Some keys generate different codes on different platforms. **GIL** converts each of these codes to a universal value which is consistent across all platforms, and returns this value to the application's keyboard handler function. Each such value is represented by a defined constant

Constant Name	*Key*
`KeyRubout`	Backspace Key
`KeyTab`	Tab Key
`KeyEnter`	Return Key
`KeyEscape`	Escape Key
`KeyUp`	Up Arrow Key
`KeyLeft`	Left Arrow Key
`KeyDown`	Down Arrow Key
`KeyRight`	Right Arrow Key

Table 2: **GIL** Key Constants.

name. Each of these constants is shown in Table 2 alongside the key which produces it.

7.2 Data Types

7.2.1 Enumerated Types

Some **GIL** functions expect enumerated type values (or variables which evaluate to these values) as arguments. In some cases, **GIL** passes enumerated type values to application-defined functions. The **GIL** enumerated types and their values are shown in Tables 3 and 4. Each enumerated type name is listed in the column labeled *Type*. The legal values for each enumerated type are list in the column labeled *Values*. The semantic significance of using a particular value as an argument to a particular function is can be found in the column labeled *Semantics* by looking across the row which contains the desired value and function. The functions which use each enumerate type are listed in the column labeled *Function*. For each function, the parameter for which the enumerated type is a legal value is listed in the column labeled *Parameter*.

7.2.2 Handles

A *handle* is a unique, system-assigned identifier for items which are managed jointly by the system and the application program. **GIL** uses two types of handles: `GSlistHandle` and `GSsclistHandle`. Handles of these types are returned to the application program by the function `GSsclistsetup`. Other scrolling list functions expect parameters of type `GSlistHandle` or `GSsclistHandle`.

7.2.3 Character Strings

GIL defines several character string types, each of a different size. The size of each string type is defined as a **GIL** constant. These types and their sizes are shown in Table 5. `BigString` is used for parameters in a number of **GIL** functions. The sizes shown represent the number of actual

Type	*Values*	*Semantics*	*Function*	*Parameter*
`HelpScreenPage`	`FirstPage`	Show the first page of the help file.	`GSdohelpscreens`	`pagecommand`
	`NextPage`	Go forward one page.		
	`PrevPage`	Go back one page.		
	`CurrPage`	Redisplay current page.		
`GraphicsModeType`	`G640x480x16`	16 color graphics mode.	`GSinterfaceinit`	`graphmode`
	`G640x480x256`	256 color graphics mode.		
`GraphicsFileType`	`NO_FILE`	Don't dump screen.	`GSdumpscreen`	`filetype`
	`BMP_16`	16 color Windows 3.1 bitmap format.		
	`PS_GRAY`	PostScript Level 2.0 greyscale format.		
	`PS_COLOR`	PostScript Level 2.0 color format.		
	`GIF_16`	16 color GIF87a format.		
`DispType`	`Highlight`	Highlight pick list item.	`GSdrawlistitem`	`displaytype`
	`Unhighlight`	Remove highlight from pick list item.		
`ButtonStatusType`	`ENABLED`	Button is enabled.	`GSgetbuttonspecs`	`status`
	`DISABLED`	Button is disabled.		
	`INVISIBLE`	Button is invisible.		
	`TMP_DISABLED`	Button is disabled for a popup window.		
`DragAreaStatusType`	`ENABLED`	Drag area is enabled.	`GSgetdragareaspecs`	`status`
	`DISABLED`	Drag area is disabled.		
`ControlGroupType`	`WINDOW`	Last control element was button or drag area.	`GSgetlastcontrol`	`control.type`
	`MENU`	Last control element was menu item.		
	`NONE`	Last mouse click did not access control element.		
`GSjustType`	`JUST_LEFT`	Left-justify.	`GSsclistsetup`	`just`
	`JUST_CENTER`	Center list items.		
	`JUST_RIGHT`	Right-justify.		

Table 3: Enumerated types used as arguments to **GIL** functions.

Type	*Values*	*Semantics*	*Function*	*Parameter*
`ReaderStatusType`	`READ_INIT`	Signals `reader_func` to do initialization.	`reader_func` in `GSgenreader`	`status`
	`READ_PROCESS`	Signals `reader_func` to process a record.		
	`READ_FINAL`	Signals `reader_func` to do post-processing.		
`DragStatusType`	`DRAG_INIT`	mouse drag started.	`func` associated with a dragarea	`status`
	`DRAG_PROCESS`	mouse drag in progress.		
	`DRAG_FINAL`	mouse drag ended.		
	`MOUSE_INSIDE`	mouse inside drag area.		
	`MOUSE_OUTSIDE`	mouse out of drag area.		
	`MOUSE_CLICK`	mouse clicked in drag area.		

Table 4: Enumerated types used as arguments to application-defined functions.

String Type	*Size*	*Size Constant*
`FileName`	13	`FILENAMELEN`
`GSString`	40	`GSSTRINGLEN`
`BigString`	80	`BIGSTRINGLEN`
`HugeString`	255	`HUGESTRINGLEN`

Table 5: **GIL** String Types.

characters; an extra position is reserved for the NULL character.

7.2.4 Boolean Values

GIL defines a type named `bool`. The legal values for the `bool` data type are `TRUE` and `FALSE`. These values have the usual Boolean significance.

7.2.5 `GSColor`

An application's colors are set in the interface file. These colors can be referenced in the application code using variables of the **GIL** data type `GSColor`. The **GIL** functions `GSgetfieldrect`, `GSgetlistcolor`, `GSwgetpoint`, `GSgetcolor`, `GSgetdragareaspecs`, and `GSconvertcolor` can be used to assign values to variables of type `GSColor`; these variables can then be used as arguments to `GSsetcolor`, which sets the global draw color.

7.2.6 `FormatList`

The **GIL** type `FormatList` is an array of character strings. It is used by `GSrdformat` to return a list of format strings from a **GIL** ASCII tagged database. Figure 3 shows a database file which includes the following format strings:

```
format=
 x     y         pop      low     hi  name            labx    laby
tamrof
```

`GSrdformat` reads the format strings and inserts them into a variable of type `FormatList` declared by the application programmer. See the description of `GSrdformat` in Section 8.4.3 for more information.

7.2.7 `GSPicture`

`GSPicture` is a structure which represents a runlength encoded picture. The application code does not set any of the fields in a variable of type `GSPicture`. Instead, a call to `GSinitpic` is used to initialize a `GSPicture` variable from a file. A picture represented by a variable of type `GSPicture` can be drawn by passing the variable to `GSwdrawpict`. The `GSPicture` data type is also used by `GSgetpixel`, which returns specific pixel values from a runlength encoded picture.

7.2.8 `IntrFunction`

The **GIL** type `IntrFunction` is used to link a function name declared in an interface file to a function pointer declared in the source code. (See Section 3.14 for a description of function name-pointer linkage.) It is declared as follows:

```
typedef struct {
  char    *name;
  bool (*funcptr)();
} IntrFunction;
```

Initialize the `name` field to the name declared in the interface file; set the `funcptr` field to the address of the function. Figure 2 shows an example of an `IntrFunction` initialization.

The library routines refer to a global array of type `IntrFunction` called `FuncNames`. The `FuncNames` array must be declared by the application programmer. Ususally, the `FuncNames` array is the only data item of type `IntrFunction`.

7.2.9 `ControlType`

The `ControlType` structure is used to pass information regarding the last (i.e., most recent) control element accessed by the user. A control element is an interface element which can be used to control the behavior of the application at runtime. Examples of control elements are buttons, menu items, and drag areas. A label is an example of an interface element which is not a control element.

This information can be useful in altering the functionality of a program. A walk-through tutorial is an example of a situation where an application programmer might want to do this. For a walk-through tutorial, an independent function is written that controls the tutorial. This function is activated and called each time through the event loop (i.e., each time there is user input). The tutorial function might turn off buttons that are usually on, for example, to prevent a user from pressing it until the tutorial instructs the user to do so.

The **GIL** function `GSgetlastcontrol` returns the `ControlType` structure for the most recently accessed control element. The parameter `control` is a pointer to a variable of type `ControlType`; it must be passed the address of a `ControlType` variable that is declared in the application source code. The type declaration for `ControlType` is:

```
typedef struct {
  ControlGroupType type;
  BigString gname;
  BigString time;
  union {
    BigString name;
    int number;
  } control;
} ControlType;
```

The `type` field describes the type of control last accessed: a control located in a window, a control located in a menu (a menu item), or none. The `gname` field contains the name of the particular window or menu where the most recently accessed control resides. The `time` field gives the time that the control was accessed. Finally, the `control` union describes the name of the control if it is part of a window, or the number if it is a menu item.

8 GIL Function Library

This section contains descriptions for every function in **GIL**. Note that **GIL** functions which draw interface elements (those in Section 8.2) and pictures (those in Section 8.3.3) may change the state of graphics attributes. That is, the current window, color, font size of line thichness may have changed. Therefore, the application program should explicitly set such attributes *before* it uses text and graphics drawing functions (those in Section 8.3).

8.1 Initialization, Start-Up and Shutdown

8.1.1 Interface Initialization

Any program which uses **GIL** will need to call `GSinterfaceinit` to initialize the user interface. `GSinterfaceinit` creates the interface elements and opens the error log file. Functions for interface handling, manipulating interface elements, and text and graphics output, should not be called before `GSinterfaceinit` is called. It is best to call `GSinterfaceinit` from `main`, since `GSinterfaceinit` requires the arguments passed into `main`.

```
void GSinterfaceinit (BigString appl_name, BigString ifile, int bstore,
                      char *elog_file_mode, GraphicsModeType graphmode,
                      int argc, char **argv);
```

Initializes the user interface.

`appl_name` - the name of the application. This name is used to label the application's window and icon in **GIL** versions that use them.

`ifile` - the name of the interface file.

`bstore` - `BSTORE` if backing store is to be used; `NO_BSTORE` otherwise.

`elog_file_mode` - "w" if `error.log` should be overwritten each time the program is started; "a" if error messages should be appended to the end of the file.

`graphmode` - constant `G640x480x16` for 16 colors or constant `G640x480x256` for 256 colors.

`argc` - the value passed into `main` giving the number of command-line arguments in the command to start the application.

`argv` - the value passed into `main` giving the command-line arguments used in the command to start the application.

8.1.2 Event Processing

GIL is responsible for processing the events associated with its interface elements. For example, a button labeled "Help" might cause a pop-up help window to appear. **GIL** links the user's action to the program's response, which may be defined in **GIL**, or may be defined by the application programmer.

`void GSinterface(void);`

Starts the interface handler (i.e., the event loop) and initializes the mouse. The interface handler then runs until stopped by `GSquit` or the application program exits. `GSinterface` does not return to its caller.

`void GSdoeventsandreturn(void);`

Starts the interface handler (i.e., the event loop). The interface handler then runs until there are no events to process, at which point control is returned to the calling function. Mouse initialization is not done in `GSdoeventsandreturn`, since it is generally called multiple times. Use `GSmouseinit` to initialize the mouse prior to the first call to `GSdoeventsandreturn`.

`void GSmouseinit(void);`

Initializes the mouse.

8.1.3 Shutdown

The function `GSquit` is called to shutdown **GIL**. The **GIL** event loop runs until `GSquit` is called. `GSquit` performs platform-specific clean-up, such as closing windows, or exiting graphics mode in MS-DOS. `GSquit` does not return to its caller.

`void GSquit (char *format, ...);`

Quit the program and write a message to `stdout` and `error.log`. The arguments of this function are like those of `printf`.

8.2 Functions for Manipulating Interface Elements

8.2.1 Functions for Window Support

Windows are declared in the interface file, as described in Section 4.2.2. The following functions are for manipulating windows.

`void GSdrawnamedwindow (char *name, int bstore, int popup);`

Draws the named window on the screen, and makes it the current window. Do not use `GSdrawnamedwindow` to redraw a displayed window (use `GSredrawnamedwindow` instead).

`name` - the name of the window, as specified in the interface file.

`bstore` - `BSTORE` if backing store is to be used to save the screen area overdrawn by the window; `NO_BSTORE` otherwise. An error will result — causing the program to exit — if this window's backing store is currently being used for another window.

`popup` - `POPUP` if this is to be treated as a popup window; `NO_POPUP` otherwise. A popup window deactivates other active windows when it is drawn. The other windows remain disabled until either the popup window is removed, or they are explicitly enabled by a call to `GSsetactivenamedwindow` in the application.

`void GSremovenamedwindow (char *name);`

Removes the named window from the screen, and makes "root" the current window.

`name` - the name of the window, as specified in the interface file.

`void GSsetcurrentnamedwindow (char *name);`

Makes the named window the current window. **GIL** drawing functions send output to coordinates which are relative to the coordinates of the current window.

`name` - the name of the window, as specified in the interface file.

`void GSsetactivenamedwindow (char *name);`

Activates the named window (without drawing it). A window must be active in order for users to use the interface elements (buttons, drag areas, etc.) which it contains.

`name` - the name of the window, as specified in the interface file.

`void GSsetdeactivenamedwindow (char *name);`

Deactivates the named window (without removing it from the screen). Deactivating a window makes its buttons and drag areas unavailable to the user.

`name` - the name of the window, as specified in the interface file.

`void GSremovetopwindow (void);`

Removes the top (i.e., the current) window from the screen, and makes "root" the current window.

`void GSredrawnamedwindow (char *name);`

Redraws the named window, and makes it the current window.

`name` - the name of the window, as specified in the interface file.

`void GSredrawactivewindows (void);`

Redraws all active windows.

`char *GSgetcurrentwindowname (char *name);`

Returns in `name` the name of the current (top) window. The return value is also `name`. Application programmers must make sure that `name` points to sufficient memory to store the window's name string.

`name` - the name of the window, as specified in the interface file.

```
void GSgetwindowspecs (char *windowname, int *x, int  *y, int *wd, int *ht,
                       int *active);
```

Returns the position and dimensions of a named window.

`windowname` - the name of the window.

`x` - returns the x-coordinate of the left edge of the window, relative to the root window. If x-coordinate is not required, you may pass `NULL`.

`y` - returns the y-coordinate of the top of the button, relative to the root window. If y-coordinate is not required, you may pass `NULL`.

`wd` - returns the width (in pixels) of the window. If width is not required, you may pass `NULL`.

`ht` - returns the height (in pixels) of the window. If height is not required, you may pass `NULL`.

`active` - returns TRUE if window is active, and FALSE if window is inactive. If active status is not required, you may pass `NULL`.

```
void GSsetwindowspecs (char *wname, int *x, int *y, int *wd, int *ht);
```

Sets the origin (absolute) and dimensions of a window. The origin of a window is its top left corner. To leave a window dimension unchanged, pass `NULL` as the dimension's parameter.

`wname` - the name of the window, as specified in the interface file.

`x` - the x-coordinate of the desired origin.

`y` - the y-coordinate of the desired origin.

`wd` - the new width of the window.

`ht` - the new height of the window.

8.2.2 Functions for Button Support

```
void GSenablebutton (char *windowname, char *buttonname, int draw);
```

Enables a named button. A button must be enabled for a mouse click to affect it. Makes `windowname` the current window. If `draw` == `DRAW`, then the button is (re)drawn (with the enabled button text color).

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button to enable.

`draw` - `DRAW` to (re)draw, `NO_DRAW` otherwise.

```
void GSdisablebutton (char *windowname, char *buttonname, int draw);
```

Disables a named button. Users can see, but cannot press disabled buttons. Makes `windowname` the current window. If `draw == DRAW`, then the button is (re)drawn (with the disabled button text color).

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button to disable.

`draw` - `DRAW` to (re)draw, `NO_DRAW` otherwise.

```
void GSinvisiblebutton (char *windowname, char *buttonname, int draw);
```

Makes a named button invisible (removes it from the screen). Previous state (enabled vs. disabled) is not remembered. Makes `windowname` the current window. If `draw` == `DRAW`, then the button is erased from the screen.

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button to make invisible.

`draw` - `DRAW` to (re)draw, `NO_DRAW` otherwise.

```
void GSvisiblebutton (char *windowname, char *buttonname, int draw);
```

Makes a named button visible and enabled. Makes `windowname` the current window. If draw == `DRAW`, then the button is (re)drawn.

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button to make invisible.

`draw` - `DRAW` to (re)draw, `NO_DRAW` otherwise.

```
void GSgetbuttonspecs (char *windowname, char *buttonname, int *x, int  *y,
                       int *wd, int *ht, ButtonStatusType *status);
```

Returns the position, dimensions, and status of a named button.

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button.

`x` - returns the x-coordinate of the left edge of the button. If x-coordinate is not required, you may pass `NULL`.

`y` - returns the y-coordinate of the top of the button. If y-coordinate is not required, you may pass `NULL`.

`wd` - returns the width (in pixels) of the button. If width is not required, you may pass `NULL`.

`ht` - returns the height (in pixels) of the button. If height is not required, you may pass `NULL`.

`status` - returns the status (enabled, disabled, invisible) of the button. If status is not required, you may pass `NULL`.

```
void GSsetbuttonspecs (char *windowname, char *buttonname, int *x, int  *y,
                       int *wd, int *ht, ButtonStatusType *status);
```

Sets the position, dimensions, and status of a named button. If a button characteristic should not change, pass `NULL` as the characteristic's parameter.

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button.

`x` - sets the x-coordinate of the left edge of the button. If x-coordinate should not change, pass `NULL`.

`y` - sets the y-coordinate of the top of the button. If y-coordinate pass `NULL`.

`wd` - sets the width (in pixels) of the button. If width should not change, pass `NULL`.

`ht` - sets the height (in pixels) of the button. If height should not change, pass `NULL`.

`status` - sets the status (`ENABLED, DISABLED, INVISIBLE`) of the button. If status should not change, pass `NULL`.

```
void GSsetbuttontext (char *windowname, char *buttonname, char *text);
```

Sets the text displayed in a button. This function does not cause the button to be redrawn.

`windowname` - the name of the window that contains the button.

`buttonname` - the name of the button.

`text` - a pointer to the new button text. **GIL** makes its own copy of the text.

8.2.3 Functions for Menu Support

```
void GScreatenamedpopup (char *name);
```

Draws a named popup menu, and temporarily makes "root" the current window. The former current window is restored as the current window when the menu is removed. Ordinarily, an application program does not call this function. Popup menus are associated with buttons in the interface file (see Section 4.2.3). When a button is pressed, **GIL** displays the appropriate popup menu.

`name` - the name of the popup menu, as specified in the interface file.

```
void GSinvisiblemenuitem (char *menuname, char *itemname);
```

Flags a popup menu item to be hidden. The item will not appear the next time the menu is drawn (remaining items "move up" to fill the gap.) Note that although the position of remaining items will appear different on the screen, the item names do not change.

`menuname` - the name of the menu that contains the item.

`itemname` - the name of the item.

```
void GSvisiblemenuitem (char *menuname, char *itemname);
```

Flags a hidden popup menu to be restored to visibility. The item will reappear the next time the menu is drawn. Note that although the position of remaining items will appear different on the screen, the item names do not change.

`menuname` - the name of the menu that contains the item.

`itemnname` - the name of the item.

```
void GSenablemenuitem (char *menuname, char *itemname);
```

Enables a popup menu item. The enabled menu text color declared in the interface file is used for the item when the menu is subsequently displayed. A menu item must be enabled for a user to select it.

`menuname` - the name of the menu that contains the item.

`itemname` - the name of the item.

```
void GSdisablemenuitem (char *menuname, char *itemname);
```

Disables a popup menu item. The disabled menu text color declared in the interface file is used for the item when the menu is subsequently displayed. Users can see, but cannot select disabled menu items.

`menuname` - the name of the menu that contains the item.

`itemname` - the name of the item.

```
void GStogglecheck (char *menuname, char *itemname);
```

Toggles a check mark on a checklist menu item. Check marks are bool indicators; toggling a visible check mark makes it invisible and vice versa. Note that the application programmer is responsible for keeping track of the current state of check marks and their semantics — this function only affects the appearance of a menu item on screen.

`menuname` - the name of the menu that contains the item.

`itemnname` - the name of the item.

```
void GSsetmenuorigin (char *menuname, int x, int y);
```

Sets the origin (absolute) of a menu. The origin of a menu is its top left corner.

`itemname` - the name of the menu, as specified in the interface file.

`x` - the x-coordinate of the desired origin.

`y` - the y-coordinate of the desired origin.

```
int GSgetmenuitemnum (char *menuname, char *itemname);
```

Returns the position of item `itemname` in menu `menuname`. The first item in a menu has position 0.

`menuname` - the name of the menu.

`itemname` - the name of the item.

```
char *GSgetmenuitemname (char *menuname, int itemnum);
```

Returns the name of the `itemnum`-th item in menu `menuname`. The first item in the menu is item number 0.

`menuname` - the name of the menu.

`itemnum` - the position of the item in the menu.

8.2.4 Functions for Drag Area Support

```
void GSenabledragarea (char *windowname, char *dragareaname);
```

Enables a named drag area. A drag area must be enabled for its function to be called. Makes `windowname` the current window.

`windowname` - the name of the window that contains the drag area.

`dragareaname` - the name of the drag area to enable.

```
void GSdisabledragarea (char *windowname, char *dragareaname);
```

Disables a named drag area. The function associated with a disabled drag area is not called. Makes `windowname` the current window.

`windowname` - the name of the window that contains the drag area.

`dragareaname` - the name of the drag area to disable.

```
void GSgetdragareaspecs (char *windowname, char *dragareaname,
                         int *x, int *y, int *wd, int *ht,
                         DragAreaStatusType *status,
                         GSColor *color);
```

Returns the position, dimensions, and status of a named drag area.

`windowname` - the name of the window that contains the drag area.

`dragareaname` - the name of the drag area.

`x` -returns the x-coordinate of the left edge of the drag area. If x-coordinate is not required, you may pass `NULL`.

`y` - returns the y-coordinate of the top of the drag area. If y-coordinate is not required, you may pass `NULL`.

`wd` - returns the width (in pixels) of the drag area. If width is not required, you may pass `NULL`.

`ht` - returns the height (in pixels) of the drag area. If height is not required, you may pass `NULL`.

`status` - returns the status (`ENABLED`, `DISABLED`) of the drag area. If status is not required, you may pass `NULL`.

`color` - returns the color of the dragarea. If color is not required, you may pass NULL.

```
void GSsetdragareaspecs (char *windowname, char *dragareaname,
                         int *x, int *y, int *wd, int *ht,
                         DragAreaStatusType *status,
                         GSColor *color);
```

Sets the position, dimensions, and status of a named drag area. If a drag area characteristic should remain unchanged, pass `NULL` as that characteristic's parameter.

`windowname` - the name of the window that contains the drag area.

`dragareaname` - the name of the drag area.

`x` - sets the x-coordinate of the left edge of the drag area. If x-coordinate should not change, pass `NULL`.

`y` - sets the y-coordinate of the top of the drag area. If y-coordinate should not change, pass `NULL`.

`wd` - sets the width (in pixels) of the drag area. If width should not change, pass `NULL`.

`ht` - sets the height (in pixels) of the drag area. If height should not change, pass `NULL`.

`status` - sets the status (`ENABLED`, `DISABLED`) of the drag area. If status should not change, pass `NULL`.

`color` - sets the color of the dragarea. If color should not change, pass NULL.

8.2.5 Functions for Field Support

```
void GSgetfieldrect (char *fieldname, int *x, int *y, int *wd, int *ht,
                     GSColor *color);
```

Returns the enclosing box and color for a named field. Except `fieldname`, all parameters may be `NULL`. A `NULL` parameter returns nothing.

`fieldname` - the name of the field.

`x, y` - returns the pixel coordinates of the upper left corner of the field.

`wd` - returns the width of the field in pixels.

`ht` - returns the height of the field in pixels.

`color` - returns the color associated with the field.

```
void GSsetfieldrect (char *fieldname, int *x, int *y, int *wd, int *ht,
                     GSColor *color);
```

Sets the enclosing box and color for a named field. If a characteristic should remain unchanged, pass `NULL` as the parameter for that characteristic.

`fieldname` - the name of the field.

`x, y` - sets the pixel coordinates of the upper left corner of the field.

`wd` - sets the width of the field in pixels.

`ht` - sets the height of the field in pixels.

`color` - sets the color associated with the field.

```
void GSwclearrect (int x, int y, int wd, int ht);
```

Clears a rectangle in the current window with window relative dimensions (`x, y, wd, ht`) (i.e., sets rectangle to background color). `x, y` are relative to the current window.

`x, y` - the pixel coordinates of the upper left corner of the field.

`wd` - the width of the field in pixels.

`ht` - the height of the field in pixels.

```
void GSframefield (char *windowname, char *fieldname,
                   GSColor tlcolor, GSColor brcolor);
```

Draws a "shadowed" box around the field `fieldname`. The frame is drawn in `windowname`. If `windowname` is `NULL`, the field is drawn in the current window. `tlcolor` specifies the color of the top and left sides of the frame; `brcolor` specifies the color of the bottom and right sides of the frame.

`windowname` - the name of the window in which to draw. If `NULL`, the current window is used.

`fieldname` - the name of the field to frame.

`tlcolor` - the color of the top and left sides of the frame.

`brcolor` - the color of the bottom and right sided of the frame.

```
void GSframedragarea (char *windowname, char *dragareaname,
                      GSColor tlcolor, GSColor brcolor);
```

Draws a "shadowed" box around the drag area `dragareaname` in window `windowname`. `tlcolor` specifies the color of the top and left sides of the frame; `brcolor` specifies the color of the bottom and right sides of the frame.

`windowname` - the window containing the drag area.

`dragareaname` - the name of the drag area.

`tlcolor` - the color of the top and left sides of the frame.

`brcolor` - the color of the bottom and right sided of the frame.

8.2.6 Scrolling List Functions

Slot Numbers Items in scrolling lists are referenced by *slot numbers*. An item's slot number is simply its position in the scrolling list. The first item in a scrolling list has slot number 0.

Handles Two types of handles are used to refer to scrolling lists: `GSsclistHandle` and `GSlistHandle`. Passing the wrong handle to a function is a common programming error. Be sure to pass the correct handle to **GIL** scrolling list functions.

```
void GSsclistsetup (char *windowname, char *listdaname,
                    int cols, char *fieldname,
                    int colgap, int rowgap,
                    GSjustType just,
                    char *(*label_func)(int slotnum),
                    void (*settext_func)(GSlistHandle list, int slotnum),
                    void (*in_func)(int slotnum),
                    void (*out_func)(void),
                    void (*click_func)(int slotnum),
                    char *thDaname,
                    GSColor sbarcol,
                    GSColor topleftcol, GSColor botrightcol,
                    int numlistitems,
                    int curpos,
                    void (*dragged_func)(int newslot),
                    char *upbtn, char *downbtn,
                    GSlistHandle *newlist,
                    GSsclistHandle *newscrl);
```

Registers the attributes and functions of a scrolling list.

`windowname` - the name of the window that contains the drag area that contains the scrolling list.

`dragareaname` - the name of drag area that contains the picklist.

`cols` - the number of columns of items to display in the scrolling list.

`fieldname` - the name of a field which describes the dimensions of the topmost item slot in the list drag area. The field must be declared by the application programmer in the interface file. The location of the field is relative to the location of the drag area.

`colgap` - the space, in pixels, between columns.

`rowgap` - the space, in pixels, between rows.

`just` - the justification of list items. Use `JUST_LEFT` for left justification, `JUST_CENTER` for center justification, and `JUST_RIGHT` for right justification.

`label_func` - a pointer to a function — supplied by the application programmer — that returns a pointer to the text of the item in slot `slotnum` of the current page.

`settext_func` - a pointer to a function — supplied by the application programmer — that sets the text attributes, such as color and font size, for an item.

`in_func` - a pointer to a function — supplied by the application programmer — that is called when the mouse cursor is inside the drag area. Pass `NULL` if no `in_func` is supplied.

`out_func` - a pointer to a function — supplied by the application programmer — that is called when the mouse cursor moves outside the drag area. Pass `NULL` if no `out_func` is supplied.

`click_func` - a pointer to a function — supplied by the application programmer — that is called when the user clicks the mouse within the drag area. Pass `NULL` if no `click_func` is required.

`thDaname` - the name of the drag area that contains the scroll bar.

`sbarcol` - the color of the sliding "thumb" inside the scroll bar.

`topleftcol` - the shadow color for the top and left edges of the sliding "thumb."

`botrightcol` - the shadow color for the bottom and right edges of the sliding "thumb."

`numlistitems` - the total number of items in the scrolling list.

`curpos` - the initial topmost visible item in the scrolling list. To display the first item in the list, pass 0 as this parameter.

`draggedfunc` - a pointer to a function — supplied by the application programmer — that is called when the sliding "thumb" has been dragged to a new location. Pass `NULL` if no `dragged_func` is supplied.

`upbtn` - the name of the button which causes the scrolling list to scroll up by one item.

`downbtn` - the name of the button which causes the scrolling list to scroll down by one item.

`newlist` - the address of a `GSlistHandle` data item. The `GSlistHandle` referenced by `newlist` will be assigned the handle of the new list.

`newscrl` - the address of a `GSsclistHandle` data item. The `GSsclistHandle` referenced by `newscrl` will be assigned the handle of the new scrolling list.

```
void GSdrawsclist (GSsclistHandle sclist);
```

Draws a scrolling list. This function should be called after the scrolling list has been created, and anytime the application's redraw function is called when a scrolling list is visible.

`sclist` - the handle of the scrolling list.

`void GSdrawlistitem (GSlistHandle list, DispType displaytype, int itemnum);`

Displays the item `itemnum` in a picklist.

`list` - the handle of the picklist.

`displaytype` - `Highlight` to highlight the item; `Unhighlight` to remove highlighting from the item; `New` to redraw the item.

`itemnum` - the slot number of the item to draw.

```
void GShandlelist (GSlistHandle list, int x, int y,
                   DragStatusType status);
```

Processes mouse actions in a picklist. The function associated with the list drag area must call `GShandlelist` to process mouse actions.

`list` - the handle of the picklist.

`x` - the x-coordinate passed to the drag function.

`y` - the y-coordinate passed to the drag function.

`status` - the drag status passed to the drag function.

```
void GShandlesclist (GSsclistHandle sclist, int x, int y,
                     DragStatusType status);
```

Processes mouse actions in a scrolling list's scroll bar. The function associated with the scroll bar drag area must call `GShandlesclist` to process mouse actions.

`sclist` - the handle of the scrolling list.

`x` - the x-coordinate passed to the drag function.

`y` - the y-coordinate passed to the drag function.

`status` - the drag status passed to the drag function.

`void GShandleupbutton (GSsclistHandle sclist);`

Scrolls a list's display up by one item. The function associated with the scrolling list's "up" button should call `GShandleupbutton`.

`sclist` - the handle of the scrolling list.

`void GShandledownbutton (GSsclistHandle sclist);`

Scrolls a list's display down by one item. The function associated with the scrolling list's "down" button should call `GShandledownbutton`.

`sclist` - the handle of the scrolling list.

```
void GSsetsclistnumitems (GSsclistHandle sclist, int numitems,
                          bool redraw);
```

Sets the number of items in a scrolling list.

`sclist` - the handle of the scrolling list.

`numitems` - the (new) number of items in the list.

`redraw` - `TRUE` to redraw the scrolling list to reflect the new number of items; `FALSE` to supress redrawing the scrolling list.

```
void GSsetsclistpos (GSsclistHandle sclist, int newpos, bool
redraw);
```

Sets the first visible item in a scrolling list.

`sclist` - the handle of the scrolling list.

`newpos` - the slot number of the item which will be the first visible item.

`redraw` - `TRUE` to redraw the scrolling list to reflect the new number of items; `FALSE` to supress redrawing the scrolling list.

```
int GSgetsclistpos (GSsclistHandle sclist);
```

Returns the slot number of the first visible item in a scrolling list.

`sclist` - the handle of the scrolling list.

```
void GSdismantlesclist(GSsclistHandle sclist);
```

Releases memory used by a scrolling list. After calling `GSdismantlesclist`, the handles of the scrolling list are invalid.

`sclist` - the handle of the scrolling list.

8.2.7 Color List Functions

```
GSColor GSgetlistcolor (int listnum, int colornum);
```

Returns the color at the requested index. The caller only needs to know the index for the color on the interface file's color list.

`listnum` - the number of the color list. The number of a colorlist is determined by its position in relation to other color lists in the interface file; the first color list declared in an interface file is number 0, the second is number 1, etc.

`colornum` - the number of the color in the list. The number of a color is determined by its relative position in the list; the first color listed is color 0, the second is color 1, etc.

8.2.8 Alert and Help Screen Display Utilities

```
void GSdisplayhelpmessage (int message);
```

Displays a message in the "Message" window. A window named "Message" must be declared in the interface file.

`message` - the number of the message, as specified in the interface file. The constants `PREV_MSG` and `CURR_MSG` can be used to redisplay the previous and current messages, respectively.

```
int GSgetcurrmsg (void);
```

Returns the number of the current message displayed in the "Message" window.

```
void GSalert (int helpmsg, int bstore, char *msgname, ...);
```

Draws window named "Alert" as a popup window and displays an urgent message in it. The message is specified by an arbitrary number of string arguments. There *must* be an empty string as the last argument. A window named "Alert" must be declared in the interface file. The "Alert" window becomes the current window as a result of this function.

`helpmsg` - the number of the message to be displayed in the "Message" window; "Message" window must be declared in the interface file. The enumerated constants `PREV_MSG` and `CURR_MSG` can be used to redisplay the previous and current messages, respectively.

`bstore` - `BSTORE` if backing store is to be used to save the screen area overdrawn by the "Alert" window; `NO_BSTORE` otherwise.

`msgname` - the name of a message declared in the interface file. An arbitrary number of messages may be displayed; the last string must be the empty string (`""`).

```
bool GSdohelpscreens (BigString filename, HelpScreenPage pagecommand,
                         int bstore, int helpmsg);
```

Displays help text from a file in the popup "Help" window; the "Help" window must be declared in the interface file. This function automatically splits the text into pages of 25 lines each.

`filename` - the name of the file which holds the screen's text.

`pagecommand` - `FirstPage` when "Help" window is first opened; `NextPage` to go forward one page; `PrevPage` to go back one page; `CurrPage` to redraw current page.

`bstore` - `BSTORE` if backing store is to be used to save the screen area overdrawn by the "Help" window; `NO_BSTORE` otherwise.

`helpmsg` - the number of the message to be displayed in the "Message" window; "Message" window must be declared in the interface file. The enumerated constants `PREV_MSG` and `CURR_MSG` can be used to redisplay the previous and current messages, respectively.

8.3 Functions for Screen Text, Numbers, and Graphics

8.3.1 Text and Numeric Output Functions.

```
void GSsetfont (FontSizeType size);
```

Sets the current font to either `SMALL` or `LARGE`.

`size` - the font size; either `SMALL` or `LARGE`.

```
int GStextwidth (char *str);
```

Returns the width — in pixels — of `str` in the current font.

`str` - the string of text to measure.

```
int GStextheight (char *str);
```

Returns the height — in pixels — of `str` in the current font.

`str` - the string of text to measure.

```
void GSwwritemsg (int x, int y, char *msgtext);
```

Writes `msgtext` in the current window.

`x` - the x-coordinate of the screen pixel at which to write the message, relative to the current window. The lower left corner of the message string will appear at this pixel.

`y` - the y-coordinate of the screen pixel at which to write the message, relative to the current window. The lower left corner of the message string will appear at this pixel.

`msgtext` - the text of the message to be written.

```
void GSwwriteclippedmsg (int clipx, int clipy, int clipwd, int clipht,
                         int msgx, int msgy,
                         char *msgtext);
```

Writes `text` in the current window. The message is "clipped" to the box `clipx, clipy, clipwd, clipht`; that is, no part of the message will be drawn outside of the box.

`clipx` - the left side of the bounding box.

`clipy` - the top side of the bounding box.

`clipwd` - the width of the bounding box.

`clipht` - the height of the bounding box.

`msgx` - the x-coordinate of the screen pixel at which to write the message, relative to the current window. The lower left corner of the message string will appear at this pixel.

`msgy` - the y-coordinate of the screen pixel at which to write the message, relative to the current window. The lower left corner of the message string will appear at this pixel.

`msgtext` - the text of the message to be written.

```
void GSwwritecommanum (int x, int y, double num);
```

Converts a double to a string with commas, and writes it to the current window.

`x` - the x-coordinate of the screen pixel at which to write the number, relative to the current window. The lower left corner of the number string will appear at this pixel.

`y` - the y-coordinate of the screen pixel at which to write the number, relative to the current window. The lower left corner of the number string will appear at this pixel.

`num` - the double to convert.

```
void GSwwritereal (int wd, int precision, int x, int y, double num);
```

Writes `num` to the current window at position `(x, y)`.

`wd` - minimum number of characters to print, left padded with blanks.

`precision` - number of digits to print after the decimal point.

`x` - the x-coordinate of the screen pixel at which to write the number, relative to the current window. The lower left corner of the number string will appear at this pixel.

`y` - the y-coordinate of the screen pixel at which to write the number, relative to the current window. The lower left corner of the number string will appear at this pixel.

`num` - the real number to be written.

```
void GSwwriteint (int wd, int x, int y, long num);
```

Writes `num` to the current window at `(x, y)`.

`wd` - minimum number of characters to print, padding with blanks.

`x` - the x-coordinate of the screen pixel at which to write the number, relative to the current window. The lower left corner of the number string will appear at this pixel.

`y` - the y-coordinate of the screen pixel at which to write the number, relative to the current window. The lower left corner of the number string will appear at this pixel.

`num` - the integer to be written.

```
char *GSgetmsg (char *messagename);
```

Returns the text of the named message. This text should not be modified by the application program.

`messagename` - the name of the message to retrieve, as declared in the interface file.

```
void GSwwritenamedmsg (int x, int y, char *messagename);
```

Puts named text message in a window. Named messages are declared in the interface file.

`x` - the x-coordinate of the screen pixel at which to write the message, relative to the current window. The lower left corner of the message string will appear at this pixel.

`y` - the y-coordinate of the screen pixel at which to write the message, relative to the current window. The lower left corner of the message string will appear at this pixel.

`messagename` - the name of the message to display.

8.3.2 Functions for Graphics Support

```
void GSsetcolor (GSColor color);
```

Sets global draw color for lines, text, fills.

`color` - the color to draw in.

```
GSColor GSgetcolor (void);
```

Gets current global draw color for lines, text, fills.

`void GSsetlinesize (int size);`

Sets the thickness for all future lines to "size".

`size` - the thickness desired, in pixels. Two sizes are supported. Each size is represented by a **GIL** constant (shown in parentheses): 1-pixel (`THIN`) and 3-pixel (`THICK`).

`void GSwdrawline (int x0, int y0, int x1, int y1);`

Draws a line of current color with current thickness in the current window from (`x0, y0`) to (`x1, y1`). Coordinates `x0, y0, x1, y1` are relative to the current window.

`x0, y0, x1, y1` - the endpoints of the line.

`void GSwdrawrect (int x, int y, int wd, int ht)`

Draws a frame rectangle of current color with dimensions (`wd, ht`) at location (`x, y`), relative to the current window.

`x, y, wd, ht` - the location and dimensions of the rectangle, relative to the current window.

`void GSwfillrect (int x, int y, int wd, int ht);`

Draws a solid rectangle in the current window with dimensions (`wd, ht`) at location (`x, y`), relative to the current window.

`x, y, wd, ht` - the location and dimensions of the rectangle, relative to the current window.

`void GSwfillpoly (int numpoints, int *points);`

Draws and fills a polygon using current line style and color.

`numpoints` - the number of vertices in the polygon

`points` - an array that contains the x and y coordinates of each vertex in the polygon. The coordinates alternate $x_0, y_0, x_1, y_1, \ldots$ in the array. The array contains exactly $2 \times numpoints$ points.

`void GSwdrawpoint (int x, int y);`

Sets a pixel in the current window to current color. The current color is a global attribute set by `GSsetcolor`.

`x` - the x-coordinate of the point, relative to the left edge of the current window.

`y` - the y-coordinate of the point, relative to the top of the current window.

```
GSColor GSwgetpoint (int x, int y);
```

Gets the color value of a pixel in a window.

`x` - the x-coordinate of the point, relative to the left edge of the current window.

`y` - the y-coordinate of the point, relative to the top of the current window.

```
void GSwdrawellipse (int x, int y, int wd, int ht);
```

Draws an ellipse of current color with dimensions (`wd, ht`) centered at (`x, y`). The coordinates `x` and `y` are relative to the current window.

`x, y` - the center of the ellipse, relative to the current window.

`wd, ht` - the dimensions of the ellipse.

```
void GSwfillellipse (int x, int y, int wd, int ht);
```

Draws and fills an ellipse of current color with dimensions (`wd, ht`) centered at (`x, y`). The coordinates `x` and `y` are relative to the current window.

`x, y` - the center of the ellipse, relative to the current window.

`wd, ht` - the dimensions of the ellipse.

```
void GSdrawxorbox (int x, int y, int wd, int ht);
```

Draws an XOR box. An XOR box is a frame rectangle which is one pixel in thickness. The value of each pixel in the rectangle is obtained by taking the exclusive or of the pixel's previous value with the value for white. This makes it very likely that each pixel in the rectangle will stand out from those around it. To "erase" an XOR box, simply call `GSdrawxorbox` with the arguments used to draw the box. XOR boxes are commonly used in GUI systems to show the outline of an object as it is being dragged. This is accomplished in **GIL** by using drag functions: start by drawing the XOR box at the location of the object on a `DRAG_INIT`, then erasing it and redrawing it in the new location on a `DRAG_PROCESS`, and finally erasing the XOR box and drawing the object at the new location on a `DRAG_FINAL`.

`x, y, wd, ht` - the location and dimensions of the XOR box, relative to the current window.

```
void GSdrawinvertbox (int x, int y, int wd, int ht);
```

Draws a box by inverting the pixels under the box.

`x, y, wd, ht` - the location and dimensions of the inverted box, relative to the current window.

```
void GSwdrawxorline (int x0, int y0, int x1, int y1);
```

Draws a line in XOR mode (see above) from (`x0, y0`) to (`x1, y1`). Coordinates `x0, y0, x1, y1` are relative to the current window.

`x0, y0, x1, y1` - the endpoints of the line.

```
void GSwdrawinvertline (int x0, int y0, int x1, int y1);
```

Draws a line by inverting the pixels under the line from (`x0, y0`) to (`x1, y1`). Coordinates `x0, y0, x1, y1` are relative to the current window.

`x0, y0, x1, y1` - the endpoints of the line.

```
void  GSwfastrow (int x, int y, GSColor row[], int n);
```

Draws a row of `n` pixels beginning at (`x, y`). The array `row` must be initialized by the application to contain the desired color values of the pixels in the row. Color values can be obtained with the function `GSconvertcolor` (See page 68.)

`x, y` - the window-relative coordinates of the first pixel in the row.

`row` - an array of color index values for the pixels in the row.

`n` - the number of pixels in the row.

8.3.3 Functions for Picture Support

```
void GSwdrawfilepict (FILE *fp, int x, int y, int wd, int ht,
                      int offx, int offy,
                      GSColor (*conversion_func)(unsigned short, int, int, int));
```

Reads a runlength encoded image from the file `*fp`, and displays the requested part on the screen.

`fp` - a pointer to the file that contains the image.

`x, y, wd, ht` - the location and dimensions of the image, relative to the current window.

`offx, offy` - the row and column in the image at which drawing should start. If `offx` is greater than 0, the left edge of the image will be cropped. If `offy` is greater than 0, the top edge of the image will be cropped.

`conversion_func` - a pointer to an application program function that converts a pixel's value in the image file into a color value.

```
bool GSinitpic (FILE *fp, GSPicture *pict, void *mem);
```

Reads a runlength encoded image into memory for future processing. Returns `TRUE` iff processing the image was successful.

`fp` - a pointer to the file from which to read the image

`pict` - the structure describing the picture; this is filled in by `GSinitpic`. Space must be provided by the application programmer.

`mem` - the memory area provided in which to store the image. The size of this area should at least (size of the file - 8) bytes.

```
void GSgetpixel (GSPicture *pict, int x, int y, unsigned short *buf, int n);
```

Returns in `buf` the `n` pixel values from the row beginning at `(x, y)` in picture `pict`.

`pict` - the descriptor for the image as created by `GSinitpic`.

`x, y` - the location of the beginning of the row from which to get pixel values.

`buf` - buffer in which pixel values are returned.

`n` - number of pixels' values to return.

```
void GSgetfilepixel (FILE *pictfile, int x, int y, unsigned short *buf, int n);
```

Returns in `buf` the `n` pixel values from the row beginning at `(x, y)` in the run length encoded image stored in file `pictfile`.

`pictfile` - an open file containing a run length encoded image (see Section 5).

`x, y` - the location of the beginning of the row from which to get pixel values.

`buf` - buffer in which pixel values are returned.

`n` - number of pixels' values to return.

```
void GSwdrawpict (GSPicture *pict, int x, int y, int wd, int ht,
                  int offx, int offy, int scale,
                  GSColor (*conversion_func)(unsigned short, int, int, int));
```

Draws the requested part of an in-memory runlength encoded image onto the screen.

`pict` - the descriptor for the image, initialized by `GSinitpic`.

`x, y, wd, ht` - the location and dimensions of the image, relative to the current window.

`offx, offy` - the row and column in the image at which drawing should start. If `offx` is greater than 0, the left edge of the image will be cropped. If `offy` is greater than 0, the top edge of the image will be cropped.

`scale` - determines the size of an input pixel in terms of screen pixels.

`conversion_func` - a pointer to an application program function that converts an image pixel value into a color value.

```
void GSgetfilepictspecs (FILE *pictfile,
                         unsigned short *nrows, unsigned short *ncols);
```

Returns the number of rows and number of columns in the run length encoded image stored in file `pictfile`.

`pictfile` - an open file containing a run length encoded image (see Section 5).

`nrows` - a pointer to an `unsigned short`, where the number of rows in the picture will be stored.

`ncols` - a pointer to an `unsigned short`, where the number of columsn in the picture will be stored.

8.3.4 Keyboard Support Utilities

```
void GScharfunc (char *name);
```

Activates a registered independent function to handle character events. Only one keyboard handler may be active at a time.

`name` - the name string for the function as declared in the `FuncNames` table. (The name string is the first field in the `FuncNames` declaration.) The function must also be registered via a `FUNCTION` declaration in the interface file.

```
void GSclearcharfunc (void);
```

Deactivates the active keyboard handler function (leaving no active keyboard handler).

8.3.5 Mouse Support Utilities

```
void GSwsetmouseposition (int x, int y);
```

Moves the mouse cursor to (`x, y`) on the screen. Has no effect in Macintosh version.

```
void GSmouseoff (void);
```

Hides the mouse cursor in MS-DOS. Has no effect on other platforms.

```
void GSmouseon (void);
```

Restores the mouse cursor in MS-DOS. Has no effect on other platforms.

8.3.6 Miscellaneous Support

```
void GSdologinscreen (char *prompt, int bstore,
                      bool (*return_func)(void),
                      GSColor login_text_color, BigString user_name);
```

Draws the `login` window and activates a built-in keyboard handler for a user login. This is a convenient way of getting the user's name for program output, security checks, etc. The application programmer must declare a window named `login` and a field named `login` in the interface file. The login window is treated as a popup window. The login field is for user text entry; it is positioned relative to the login window. Only keyboard input received while `login` is the current window is processed.

`prompt` - a message displayed above the login field which prompts the user to type in his or her name. The message is drawn in the login window foreground color.

`bstore` - `BSTORE` if backing store is to be used to save the screen area overdrawn by the `login` window; `NO_BSTORE` otherwise.

`return_func` - when the user presses "Return", the login window is removed from the screen, the keyboard handler is deactivated, and then `return_func` is executed. The application programmer supplies `return_func` to tell **GIL** what to do (e.g., draw another window) after removing the login window. This is mainly useful when the login window is the first one drawn; in this case, there will be nothing on screen that the user can access when the login window is removed. If other windows are drawn before `GSdologinscreen` is called, then the application programmer may want to make this argument a pointer to a null function — i.e., one with no executable statements — or pass a `NULL` pointer as the argument.

`login_text_color` - the color to use when echoing the user's input.

`user_name` - a character buffer to store the user's login input. This must be a static variable; an automatic variable would be destroyed as soon as the function which called `GSdologinscreen` returned (`GSdologinscreen` returns before the actual login starts.) The application programmer is responsible for using the login input; **GIL** does *not* write it to any of the log files.

```
void GSdisplayversion (BigString versionfile);
```

Extracts the current version number of the program from a text file and displays it in a field named `Version`. A field named `Version` must be declared in the interface file.

`versionfile` - the file containing the current version number. The version number must appear in a line in the file which begins with the word `Version`.

```
long GSmemavail (void)
```

Returns the number of bytes of available memory.

```
void GSactivatefunction (char *name);
```

Activates a registered independent function to be called repeatedly from inside the event loop until `GSdeactivatefunction` is called.

`funcname` - the name string of the function to activate, as declared in the `FuncNames` table. (The name string is the first field in the declaration.) The function must also be registered via a `FUNCTION` declaration in the interface file.

```
void GSdeactivatefunction (char *name);
```

Deactivates a registered independent function that was previously activated.

`funcname` - the name of the function to deactivate (the same name that was used to activate the function).

```
void GSgetcursorxy (int *x, int *y);
```

Returns in (`x, y`) the current position of the cursor relative to the current window.

`x, y` - pointers to integers where mouse coordinates will be stored.

`GSColor GSconvertcolor (char *colorname);`

Converts a color name to a color palette index.

`colorname` - color name to be converted.

`void GSsavewindows (FILE *fp);`

Saves the status of the interface elements to a file. This includes the status (active or inactive) of all windows, the status (enabled, disabled, or invisible) of all buttons, the status (visible or invisible) of all popup menus, the status (enabled, disabled, or invisible) of all popup menu items, and the status (checked or unchecked) of all checklist menu check marks

`fp` - file pointer for file in which to save status.

`void GSloadwindows (FILE *fp);`

Retrieves the status of the interface elements from a file. This includes the status (active or inactive) of all windows, the status (enabled, disabled, or invisible) of all buttons, the status (visible or invisible) of all popup menus, the status (enabled, disabled, or invisible) of all popup menu items, and the status (checked or unchecked) of all checklist menu check marks

`fp` - file pointer for the file from which to load status.

`bool GSdumpscreen (char *fname, GraphicsFileType filetype);`

Dumps the current screen image to a file. An application calls `GSdumpscreen` with the prefix of the filename that it wants the screen dumped to (e.g., "*giltest*") in `fname`. The function attempts to open `fname00.EXT` (where `EXT` depends on `filetype`, such as .bmp or .ps). If `fname00.EXT` already exists, it tries `fname01.EXT`, etc. up to `fname99.EXT`.

Returns TRUE and the filename saved (in `fname`) on success. On failure, returns FALSE.

`fname` - filename prefix to which to save screen. *fname* may be a path or just a filename; in either case, the actual file name should not exceed 6 characters to allow numeric suffix. The name of the saved file is returned in *fname*, so the application needs to allocate enough memory for the returned string (i.e., original length + 6).

`filetype` - the graphics format in which the screen is saved. The following are valid values:

`BMP_16` – 16 color Windows 3.1 bitmap format.

`PS_GRAY` – PostScript Level 2.0 greyscale format.
`PS_COLOR` – PostScript Level 2.0 color format.
`GIF_16` – 16 color GIF87a format.

`long GSfilesize (FILE *fp);`

Returns size in bytes of file `fp`.

`void GSgetlastcontrol (ControlType *control);`

Returns the most recently accessed control element and it's attributes in `control`.
`control` - address of variable of type `ControlType` declared in application program.

`void GSclearlastcontrol (void);`

Tells the event handler to forget the last control element accessed.

`bool GShasFPU(void);`

Returns TRUE if machine has a floating point unit, otherwise returns FALSE.

`void GSbell(void);`

Makes a short beep sound.

`void GSclick(void);`

Makes a short click sound. This function has no effect in X Window versions.

`void GSdelay(unsigned int delaytime);`

Causes the application to pause for `delaytime` milliseconds.
`delaytime` - number of milliseconds to pause.

`bool GSbigendian (void);`

Returns non-zero if this machine is big-endian; returns 0 otherwise.

`int GSnumifuncs (IntrFunction func_array[]);`

Returns the number of functions in `func_array`. Implemented as a macro.
`func_array` - an array of function name to function pointer mappings (e.g., the FuncNames array).

8.4 Functions for File Access

8.4.1 Opening Other Files

```
FILE *GSopen(char *filename, char *mode);
```

Like fopen, but portable among all **GIL** environments.

`filename` - The name of the file to open.

`mode_string` - "r" to open for reading; "w" to truncate or create for writing; "a" to open or create for writing at end of file; "r+" to open for reading and writing; "w+" to truncate or create for reading and writing; "a+" to open or create for reading and writing at end of file.

8.4.2 Log Files

The error log file (`error.log`) is initialized in `GSinterfaceinit`. `GSinitlog` must be called to initialize the file `output.log`. This file can be used to record user input as well as program output. `GSinitlog` returns `FALSE` if an error is encountered initializing `output.log`; otherwise, it returns `TRUE`.

```
bool GSinitlog (char *mode_string);
```

Initializes the error log file.

`mode_string` - "w" if the `output.log` should be overwritten each time the program is started; "a" if each user's output should be appended to the end of the file.

Sending Output to Log Files The functions used to send output to the log files are modeled closely after `printf`. They are wired directly to the files `output.log` and `error.log`, respectively, so they do not require a file pointer argument, as does `fprintf`. `GSelog` requires an integer code as an argument. If the code argument is 0, the program continues; otherwise, the program exits with the argument as its error code.

```
void GSolog (char *format, ...);
```

Like `printf`. Writes to `output.log`.

```
void GSelog (int code, char *format, ...);
```

Like `printf`. Writes to `error.log`. If `code` is nonzero, the message is also written to stdout, and the program exits with error code == `code`.

8.4.3 Database Reader Routines

```
bool GSgenreader (FILE *fp,
                  bool (*reader_func)(BigString keyword, int status,
                                      void *data),
                  char *dbident, void *data)
```

This function is the driver for reading all **GIL** ASCII tagged databases. It is given a file pointer to the database file, an application-specific function (called the "local reader") that is called when a keyword is read, a database identifier string, and a pointer to (optional) data space used by the local reader. `GSgenreader` then scans through the database looking for keywords. A keyword is any string of non-white space characters which ends in '='. When a keyword is found, the local reader is called to process it. The local reader uses the library of generic reader I/O routines appearing below to access data values from the database. When the local reader returns, `GSgenreader` continues with the file pointer where the local reader left it. `GSgenreader` returns `TRUE` if successful, `FALSE` if there is an error.

`fp` - file pointer to database file.

`reader_func` - local reader function. The parameters of a local reader function are:

`keyword` - a keyword read from the database file. All keywords must end with '=' (e.g., `mykeyword=`).

`status` - one of `READ_INIT`, `READ_PROCESS`, or `READ_FINAL`. `GSgenreader` always calls the local reader the first time with `READ_INIT` to allow it to do initialization, and the last time with `READ_FINAL` to allow it to do post-processing. When `GSgenreader` reads a keyword from the database file, it calls the local reader with `READ_PROCESS`, so the local reader can process the record which follows. Any `READ_PROCESS` calls come in between the `READ_INIT` call and the `READ_FINAL` call.

`data` - the same pointer (if any) supplied to the `data` parameter in `GSgenreader`. This parameter should be declared, even if it is not used.

`dbident` - expected identifier tag for database. `GSgenreader` will return `FALSE` if the first keyword is not `database=`, or if the word immediately following it is not the string passed to `dbident`.

`data` - pointer to a optional block of data used to communicate information from the local reader to the routine that calls `GSgenreader`. Use `NULL` if you don't want to use this parameter.

Data Item Reader Functions The following functions are for reading a **GIL** ASCII tagged database. They should be called *only* from within a local reader.

`bool GSrdstringeol (char *string, int size);`

Reads and returns the rest of the current line (ignoring comments), compressing multiple spaces to one space. Return value is `TRUE` iff `size` characters or less are read; `FALSE` if `EOF` is encountered before `size` characters are read, or if more than `size` characters are read. (No more than `size` characters will be returned).

`string` - string read and returned to the calling procedure.

`size` - maximum length for string.

`bool GSrdphrase (char *string, int size);`

Reads and returns a string terminated by `'\n'`, `'\t'`, `EOF`, or `'#'`, or *multiple* spaces (single spaces are returned in `string`.) Maximum string length is `size`. Return value is `TRUE` iff `size` characters are read; `FALSE` if `EOF` is encountered before `size` characters are read, or if more than `size` characters are read. (No more than `size` characters will be returned).

`string` - string read and returned to the calling procedure.

`size` - maximum length for string.

`bool GSrdword (char *string, int size);`

Reads and returns a string delimited by `' '` (space), `'\n'`, `'\t'`, `EOF`, or `'#'`, with maximum length `size`. Equivalent to `fscanf(GSDbfp, "%s", string)`, except that `GSrdword` won't read more characters than the `size` limit. Return value is `TRUE` iff `size` characters are read; `FALSE` if `EOF` is encountered before `size` characters are read, or if more than `size` characters are read. (No more than `size` characters will be returned).

`string` - string read and returned to the calling procedure.

`size` - maximum length for string.

`long GSrdinteger (void);`

Interprets the next string in the database file as a long integer, and returns this value.

`double GSrdreal (void);`

Interprets the next string in the database file as a double, and returns this value.

`bool GSrdboolean (void);`

Returns a bool value — `TRUE` iff the word read is "TRUE" (ignoring case), else `FALSE`.

`bool GSrdformat (int *numwords, FormatList keywords)`

Reads the keywords following the "format" keyword and return these in an array. Keywords are scanned until the "tamrof" keyword is encountered. The rest of the line after "tamrof" is then skipped. Returns `FALSE` if there is a premature `EOF`. The list of keywords can be used by the local reader to process multiple records which have the same format before returning to `GSgenreader`. For example, the India city database shown in figure 3 contains records for 24 different cities. All of these records can be processed at one time by the local reader function based on the list of format strings that appears above them.

`numwords` - the number of format keywords read.

`keywords` - format keywords returned.

8.4.4 Opening Other Files

`FILE *GSopen(char *filename, char *mode);`

Like `fopen`, but portable among all **GIL** environments.

`filename -` The name of the file to open.

`mode_string -` "r" to open for reading; "w" to truncate or create for writing; "a" to open or create for writing at end of file; "r+" to open for reading and writing; "w+" to truncate or create for reading and writing; "a+" to open or create for reading and writing at end of file.

9 *giltest*

giltest is a program designed to demonstrate the functionality of many of the **GIL** routines. Users of *giltest* can type input into a text field, or draw rectangles in a draw area. The message window at the bottom of the screen explains to users how to navigate through the program. *giltest* is included with the **GIL** distribution. We recommend that you try running it, and follow its execution in the source code below.

9.1 Interface File for *giltest*

```
PALETTE
#            R   G   B
#           ------------
( black      0   0   0 )
( dgray     50  45  45 )
( mgray     30  30  55 )
( lgray     53  53  53 )
( aqua       0  50  50 )
( lblue     10  10  55 )
( peach     63  47  50 )
( blue       0   0  36 )
( green      0  36   0 )
( lpurple   63  50  63 )
( red       55   0   0 )
( yellow    63  63  21 )
( lcyan     50  59  63 )
( magenta   44   6  44 )
( sandy     63  51  51 )
( white     63  63  63 )
END #PALETTE

#  Aliases for colors for ease of modification
#       alias        color
#       ----------   ------
                                # Window colors.
ALIAS ( rootbg       aqua   )     # background color for root window
ALIAS ( rootfg       black  )     # foreground color for root window
ALIAS ( wbdr         black  )     # border color for windows
                                # Button colors.
ALIAS ( bbg          lblue  )     # background color for buttons
ALIAS ( befg         white  )     # text color for enabled buttons
ALIAS ( bdfg         mgray  )     # text color for disabled buttons
                                # Menu colors.
ALIAS ( popefg       black  )     # text color for enabled popup menu items
ALIAS ( popdfg       dgray  )     # text color for disabled popup menu items
ALIAS ( popbg        peach  )     # background color for popup menus
ALIAS ( popbdr       black  )     # border color for popup menus
                                # Color List colors.
ALIAS ( fillcolor0   black  )     # first color in menu
ALIAS ( fillcolor1   yellow )     # second color in menu
ALIAS ( fillcolor2   white  )     # third color in menu
ALIAS ( fillcolor3   lblue  )     # fourth color in menu
```

```
ALIAS ( fillcolor4   red    )     # fifth color in menu
                                # Other colors.
ALIAS ( text         black  )     # color of text in text entry field
ALIAS ( dragbg       white  )     # background color of draw dragarea

COLORLIST ( fillcolor0 fillcolor1 fillcolor2 fillcolor3 fillcolor4 )

HIGHLIGHT ( aqua )
SPEEDUP ( 100 )
BUTTONSTUFF ( black 0 white black )
FUNCTION ( intro 0 1 )
FUNCTION ( kbd_hndlr 0 0 )
REDRAWFUNC ( redraw_func )

MSG ( hm10 |Look here for help messages as you go through the program.| )
MSG ( hm11 |Press "Again", or type a message, or press "Box Style" to| )
MSG ( hm12 |set parameters for drawing boxes in the Drawing Area.| )

MSG ( hm20 |Notice how the "Again" button has disappeared.| )
MSG ( hm21 |This was done with GSinvisiblebutton.| )
MSG ( hm22 |You can type a message if you like.| )

MSG ( hm30 |This is a regular menu.| )
MSG ( hm31 |It allows you to select a function.| )
MSG ( hm32 |Select a function, or click outside the menu to close it.| )

MSG ( hm40 |This is a checklist menu.| )
MSG ( hm41 |Each item on this menu represents a parameter.| )
MSG ( hm42 |Select one of the items and watch what happens to the menu.| )

MSG ( hm50 |A checkmark has appeared next to the selected item.| )
MSG ( hm51 |This program uses this to show that the corresponding parameter| )
MSG ( hm52 |has been turned on. Try drawing a box in the Draw Area.| )

MSG ( hm60 |The checkmark next to the selected item has disappeared.| )
MSG ( hm61 |This program uses this to show that the corresponding parameter| )
MSG ( hm62 |has been turned off. Try drawing a box in the Draw Area.| )

MSG ( hm70 |This is a checklist menu. Each item on this| )
MSG ( hm71 |menu represents a legal value for the FillColor parameter.| )
MSG ( hm72 |Select an unchecked item and watch what happens to the menu.| )

MSG ( hm80 |The checkmark has moved to the selected value.| )
MSG ( hm81 |Note that the code to remove the checkmark from the old value| )
MSG ( hm82 |is in the application program.| )

MSG ( hm90 |You selected the current value.| )
MSG ( hm91 |The checkmark appears to be unchanged, but it was really| )
MSG ( hm92 |removed by GIL, and then redrawn by the application.| )

MSG ( typedtoofar |You have reached the end of the text box.| )

POPUP ( funcs_menu 9 48 popefg popdfg popbg popbdr 0 )
  PLABEL ( ClearText 0 clear_text_func |Clear Text Field| )
  PLABEL ( ClearDraw 0 clear_draw_func |Clear Draw Area| )
  PLABEL ( QuitProg 1 quit_prog_func |Quit| )
```

```
POPUP ( col_menu 9 198 popefg popdfg popbg popbdr 1 )
  PLABEL ( Black 1 set_color_func |Black| )
  PLABEL ( Yellow 1 set_color_func |Yellow| )
  PLABEL ( White 1 set_color_func |White| )
  PLABEL ( Blue 1 set_color_func |Blue| )
  PLABEL ( Red 1 set_color_func |Red| )

POPUP ( box_menu 9 123 popefg popdfg popbg popbdr 1 )
  PLABEL ( DrawBorder 1 toggle_border_func |Draw Black Border| )
  PLABEL ( Fill 1 toggle_fill_func |Fill With Color| )



WINDOW ( root 0 0 640 480 white rootbg wbdr 2 1 0 )
  BUTTON ( funcs |Functions| 9 23 105 25 befg bdfg bbg @funcs_menu 1 1 0 C )
  BUTTON ( box |Box Style| 9 98 105 25 befg bdfg bbg @box_menu 1 1 0 C )
  BUTTON ( color |Fill Color:| 9 173 105 25 befg bdfg bbg @col_menu 1 1 0 L )
  LABEL ( 235 15 white |GeoSim Interface Library (GIL) Test| black )
  LABEL ( 550 15 rootfg |GeoSim| )
  FIELD ( version 450 5 60 19 rootfg )
  FIELD ( fillcolor 69 178 10 10 rootfg )

WINDOW ( io 130 23 380 384 black mgray wbdr 2 1 0 )
  BUTTON ( again |Hello Again| 220 75 105 25 befg bdfg bbg agn_func 1 1 0 C )
  DRAGAREA ( drawarea 2 191 376 177 dragbg draw_func 1 )
  FIELD ( hello1 220 70 121 16 yellow )
  FIELD ( hello2 220 110 121 16 white )
  FIELD ( dragfg 2 191 376 191 text )
  FIELD ( dragbg 2 191 376 177 dragbg )
  FIELD ( coordbg 2 370 120 12 white )
  FIELD ( coordfg 2 380 378 12 black )
  FIELD ( textbg 220 18 126 16 dgray )
  FIELD ( textfg 222 30 120 370 text )
  FIELD ( logo 20 20 155 155 white )
  LABEL ( 135 380 rootfg |Drawing Area| )
  LINE ( 0 368 380 368 2 black )
  LINE ( 0 189 380 189 2 black )
  RECT ( 2 370 376 12 white 2 fill )
  RECT ( 218 16 130 20 dgray 2 fill )
  RECT ( 218 16 130 20 wbdr 2 hollow )
  LINE ( 218 35 347 35 1 white )
  LINE ( 219 34 346 34 1 white )
  LINE ( 347 35 347 16 1 white )
  LINE ( 346 34 346 17 1 white )

WINDOW ( alert 145 150 350 100 popefg popbg popbdr 2 0 1 )
  BUTTON ( OK |Acknowledged| 239 70 105 25 befg bdfg bbg done_func 1 1 0 C )

WINDOW ( message 5 428 630 39 black popbg wbdr 2 1 0 )
```

9.2 Source Code for *giltest*

```
#include  <stdlib.h>
#include  <stdio.h>
#include  <string.h>
#include  <ctype.h>
#include  "geosim.h"

/*----------------------------------------------------------------------------
  Named Constants
----------------------------------------------------------------------------*/

#define  CLEAR_DRAW_MENU_ITEM     "ClearDraw"
#define  CLEAR_TEXT_MENU_ITEM     "ClearText"
#define  FILL_COLOR_LIST          0
#define  INITIAL_ITEM             0
#define  TIME_TO_READ_MSG         2
#define  FILL_COLOR_BUTTON_LABEL  "Fill Color:"

/*--- Help message numbers ---*/
#define  AGAIN_MSG                2
#define  BOX_STYLE_CHECK_OFF_MSG  6
#define  BOX_STYLE_CHECK_ON_MSG   5
#define  BOX_STYLE_MENU_MSG       4
#define  FILL_COLOR_MENU_MSG      7
#define  INTRO_MSG                1
#define  MENU_MENU_MSG            3
#define  NEW_FILL_COLOR_MSG       8
#define  SAME_FILL_COLOR_MSG      9

/*----------------------------------------------------------------------------
  Drawing Object declarations
----------------------------------------------------------------------------*/

typedef enum {
  rectObj, textObj
  } ObjType;

typedef struct {
  int x, y;
  char *str;
  GSColor t_col;
  } TextObj;

typedef struct {
  int x, y, wd, ht;
  bool fill, border;
  GSColor f_col, b_col;
  } RectObj;

typedef struct DrawObj {
  ObjType type;
  union {
    TextObj text;
    RectObj rect;
  } object;
  struct DrawObj *next_object;
```

```
  } DrawObj;

/*---------------------------------------------------------------------------
  Function Prototypes
---------------------------------------------------------------------------*/

void     add_cursor_if_space  (char *out_string, int  field_wd);
DrawObj  *add_rect            (int x, int y, int wd, int ht,
                               bool fill, bool border,
                               GSColor f_col, GSColor b_col);
DrawObj  *add_text            (int x, int y, char *str, GSColor t_col);
bool     alert_done           (void);
bool     char_is_legal        (char ch);
bool     clear_draw           (void);
bool     clear_text           (void);
bool     do_again             (void);
bool     do_draw              (int mouse_x, int mouse_y, DragStatusType status);
bool     do_intro             (void);
bool     do_quit              (void);
bool     do_text              (int mouse_x, int mouse_y, char ch);
void     draw_all_objects     (void);
void     draw_object          (DrawObj *object);
void     init_pict            (GSPicture *pict_ptr, FileName pict_file);
void     init_colors          (void);
GSColor  logo_converter       (unsigned short code, int x, int y, int z);
bool     set_color            (char *item_name);
bool     show_funcs_menu      (void);
bool     show_box_styles      (void);
bool     show_colors          (void);
void     show_fill_color      (GSColor);
bool     toggle_border        (char *item_name);
bool     toggle_fill          (char *item_name);
void     write_hello          (void);
void     write_hello_again    (void);
bool     redraw_all           (void);
void     remove_all_objects   (void);

/*---------------------------------------------------------------------------
  Global Variables
---------------------------------------------------------------------------*/

bool       AlertShowing = FALSE;    /*--- Blocks typing when TRUE ---*/
bool       DrawBorder = FALSE;      /*--- Boxes get borders iff TRUE ---*/
bool       FillBorder = FALSE;      /*--- Boxes get filled iff TRUE ---*/
GSColor    FillColor;               /*--- Color to fill boxes with ---*/
FileName   GlobeFile = "logo.rl4";  /*--- File that contains globe logo ---*/
/*FileName   GlobeFile = "usmap.rl4";  /*--- File that contains globe logo ---*/
GSPicture  LogoPict;                /*--- Structure for globe logo ---*/
BigString  TextString;              /*--- User's input string ---*/
DrawObj    *first_object, *last_object;  /*--- Object list start and end ---*/
GSColor    aqua_color, mgray_color, white_color;  /*--- Logo colors ---*/

/*---------------------------------------------------------------------------
  Function Definitions
---------------------------------------------------------------------------*/
```

```
/*---------------------------------------------------------------------------
  add_cursor_if_space
    Add a text cursor ('_') to end of output string if there is enough
    space (in memory and on screen) for it.
---------------------------------------------------------------------------*/
void add_cursor_if_space (
  char *out_string, /*--- output string ---*/
  int  field_wd     /*--- width of output field ---*/
)
{
  /*--- if space in memory for text cursor, add it to temp buffer ---*/
  if (strlen(out_string) < BIGSTRINGLEN)
  {
    strcat(out_string, "_");
    /*--- if not enough space on screen for text cursor, remove it ---*/
    if (GStextwidth(out_string) > field_wd)
    {
      out_string[strlen(out_string)-1] = '\0';
    }
  }
}


/*---------------------------------------------------------------------------
  add_rect
    Add a rectangle to the list of drawing objects.
---------------------------------------------------------------------------*/
DrawObj *add_rect(
  int x, int y, int wd, int ht,
  bool fill, bool border,
  GSColor f_col, GSColor b_col
)
{
  DrawObj *new_object;
  RectObj *rect;

  if ((fill == FALSE) && (border == FALSE))
    return NULL;

  new_object = (DrawObj *) malloc(sizeof(DrawObj));
  if (new_object == NULL) {
    GSelog(0, "Out of memory for new rectangle.\n");
    return NULL;
    }

  new_object->type = rectObj;

  rect = &(new_object->object.rect);
  rect->x = x;
  rect->y = y;
  rect->wd = wd;
  rect->ht = ht;
  rect->fill = fill;
  rect->border = border;
  rect->f_col = f_col;
  rect->b_col = b_col;
```

```
  /* put new object in object list */
  if (first_object == NULL)
    first_object = new_object;
  else
    last_object->next_object = new_object;
  last_object = new_object;
  new_object->next_object = NULL;

  GSenablemenuitem("funcs_menu", CLEAR_DRAW_MENU_ITEM);

  return new_object;
}


/*--------------------------------------------------------------------------------
  add_rect
    Add a text object to the list of drawing objects.
--------------------------------------------------------------------------------*/
DrawObj *add_text(
  int x, int y,
  char *str,
  GSColor t_col
)
{
  DrawObj *new_object;
  TextObj *text;

  if (strlen(str) == 0)
    return NULL;

  new_object = (DrawObj *) malloc(sizeof(DrawObj));
  if (new_object == NULL) {
    GSelog(0, "Out of memory for new text.\n");
    return NULL;
    }

  text = &(new_object->object.text);

  text->str = malloc(strlen(str) + 1);

  if (text->str == NULL) {
   free(new_object);
    GSelog(0, "Out of memory for text string %s.\n", str);
    return NULL;
    }

  new_object->type = textObj;

  text->x = x;
  text->y = y;
  text->t_col = t_col;
  strcpy(text->str, str);

  /* put new object in object list */
  if (first_object == NULL)
    first_object = new_object;
  else
```

```
    last_object->next_object = new_object;
  last_object = new_object;
  new_object->next_object = NULL;

  GSenablemenuitem("funcs_menu", CLEAR_DRAW_MENU_ITEM);

  return new_object;
}


/*-----------------------------------------------------------------------------
  alert_done
    Called when "Done" button in PopUpMessage window is pushed.
    Removes the PopUpMessage window from the screen.
-----------------------------------------------------------------------------*/
bool alert_done (
  void
)
{
  GSremovenamedwindow("alert");
  GSsetcurrentnamedwindow("root");
  show_fill_color(FillColor);
  GSsetcurrentnamedwindow("io");
  AlertShowing = FALSE;
  return TRUE;
}


/*-----------------------------------------------------------------------------
  char_is_legal
    Returns TRUE if ch is a legal input character (A-Z, a-z, '.', '-', or ' ').
    Returns FALSE if ch is not a legal input character.
-----------------------------------------------------------------------------*/
bool char_is_legal (
  char  ch  /*--- character to check for legality ---*/
)
{
  return ((isalnum(ch)) || (ch == '.') || (ch == '-') || (ch == ' '));
}


/*-----------------------------------------------------------------------------
  clear_draw
    Called when "Clear Draw Area" item on "Menu" menu is selected.
    Clears the draw area.
-----------------------------------------------------------------------------*/
bool clear_draw (
  void
)
{
  int      draw_area_x, draw_area_y, draw_area_wd, draw_area_ht;
  GSColor  draw_area_color;

  remove_all_objects();

  /*--- draw area is part of "io" window ---*/
  GSsetcurrentnamedwindow("io");
```

```
  /*--- 'clear' draw area by refilling with its background color ---*/
  GSgetfieldrect("dragbg", &draw_area_x, &draw_area_y, &draw_area_wd,
                 &draw_area_ht, &draw_area_color);
  GSsetcolor(draw_area_color);
  GSwfillrect(draw_area_x, draw_area_y, draw_area_wd, draw_area_ht);

  /*--- disable "Clear Draw Area" menu item, since area is now cleared ---*/
  GSdisablemenuitem("funcs_menu", CLEAR_DRAW_MENU_ITEM);
  return TRUE;
}

/*------------------------------------------------------------------------------
  clear_text
    Called when "Clear Text Field" item on "Menu" menu is selected.
    Clears the text input field.
------------------------------------------------------------------------------*/
bool clear_text (
  void
)
{
  int      background_x, background_y, background_wd, background_ht;
  GSColor  background_color;
  int      cursor_x, cursor_y;
  GSColor  cursor_color;

  strcpy(TextString, "");
  GSsetcurrentnamedwindow("io");

  /*--- 'clear' field by refilling it with its background color ---*/
  GSgetfieldrect("textbg", &background_x, &background_y, &background_wd,
                 &background_ht, &background_color);
  GSsetcolor(background_color);
  GSwfillrect(background_x, background_y, background_wd, background_ht);

  /*--- draw text cursor; use NULL for unneeded wd, ht in GSgetfieldrect ---*/
  GSgetfieldrect("textfg", &cursor_x, &cursor_y, NULL, NULL, &cursor_color);
  GSsetcolor(cursor_color);
  GSwwritemsg(cursor_x, cursor_y, "_");

  /*--- disable "Clear Text Area" button, since area is now cleared ---*/
  GSdisablemenuitem("funcs_menu", CLEAR_TEXT_MENU_ITEM);
  return TRUE;
}


/*------------------------------------------------------------------------------
  do_again
    Called when "Again" button in "IOwin" window is pressed.
    Writes "Hello World" in field "hello2".
------------------------------------------------------------------------------*/
bool do_again (
  void
)
{
  write_hello_again();
```

```
  /*--- erase button, since pressing it again will have no effect ---*/
  GSinvisiblebutton("io", "again", DRAW);

  GSdisplayhelpmessage(AGAIN_MSG);
  return TRUE;
}

/*----------------------------------------------------------------------------
  do_draw
    Processes drag events in the draw area.
----------------------------------------------------------------------------*/
bool do_draw (
  int  mouse_x, /*--- x-coordinate of mouse cursor ---*/
  int  mouse_y, /*--- x-coordinate of mouse cursor ---*/
  DragStatusType  status   /*--- type of mouse event ---*/
)
{
  int         dfg_x, dfg_y;
  GSColor     dfg_color;
  int         dbg_x, dbg_y;
  int         cfg_x, cfg_y;
  GSColor     cfg_color;
  int         cbg_x, cbg_y, cbg_wd, cbg_ht;
  GSColor     cbg_color;
  static int  initial_x, initial_y;
  static int  xor_x, xor_y, xor_wd, xor_ht;
  BigString   coordinate_string;
  DrawObj     *new_object;

  switch (status)
  {
    case MOUSE_CLICK: /*--- write contents of text area at mouse cursor ---*/
      GSgetfieldrect("dragfg", &dfg_x, &dfg_y, NULL, NULL, &dfg_color);

      new_object = add_text(mouse_x+dfg_x, mouse_y+dfg_y, TextString, dfg_color);
      if (new_object != NULL)
        draw_object(new_object);
      break;

    case DRAG_INIT: /*--- initilize XOR box coordinates and dimensions ---*/
      xor_x = initial_x = mouse_x;
      xor_y = initial_y = mouse_y;
      xor_wd = xor_ht = 0;
      break;

    case DRAG_PROCESS: /*--- move XOR box ---*/
      GSgetfieldrect("dragbg", &dbg_x, &dbg_y, NULL, NULL, NULL);

      /*--- erase old XOR box ---*/
      GSdrawxorbox(dbg_x+xor_x, dbg_y+xor_y, xor_wd, xor_ht);

      /*--- compute location and dimensions of new XOR box ---*/
      xor_x = MIN(mouse_x, initial_x);
      xor_y = MIN(mouse_y, initial_y);
      xor_wd = abs(mouse_x - initial_x);
      xor_ht = abs(mouse_y - initial_y);
```

```
      /*--- draw new XOR box ---*/
      GSdrawxorbox(dbg_x+xor_x, dbg_y+xor_y, xor_wd, xor_ht);
      break;

    case DRAG_FINAL: /*--- erase XOR box; draw a box if parameters are set ---*/
      GSgetfieldrect("dragbg", &dbg_x, &dbg_y, NULL, NULL, NULL);

      /*--- erase XOR box ---*/
      GSdrawxorbox(dbg_x+xor_x, dbg_y+xor_y, xor_wd, xor_ht);

      GSgetfieldrect("dragfg", &dfg_x, &dfg_y, NULL, NULL, &dfg_color);

      new_object = add_rect(dbg_x+xor_x, dbg_y+xor_y, xor_wd, xor_ht,
                            FillBorder, DrawBorder, FillColor, dfg_color);
      if (new_object != NULL)
        draw_object(new_object);
      break;

    case MOUSE_INSIDE: /*--- show current mouse cursor coordinates ---*/
      /*--- 'erase' old coordinates ---*/
      GSgetfieldrect("coordbg", &cbg_x, &cbg_y, &cbg_wd, &cbg_ht, &cbg_color);
      GSsetcolor(cbg_color);
      GSwfillrect(cbg_x, cbg_y, cbg_wd, cbg_ht);
      /*--- show new coordinates ---*/
      GSgetfieldrect("coordfg", &cfg_x, &cfg_y, NULL, NULL, &cfg_color);
      GSsetcolor(cfg_color);
      sprintf(coordinate_string, "(%d, %d)", mouse_x, mouse_y);
      GSwwritemsg(cfg_x, cfg_y, coordinate_string);
      break;

    case MOUSE_OUTSIDE: /*--- erase mouse cursor coordinates ---*/
      GSgetfieldrect("coordbg", &cbg_x, &cbg_y, &cbg_wd, &cbg_ht, &cbg_color);
      GSsetcolor(cbg_color);
      GSwfillrect(cbg_x, cbg_y, cbg_wd, cbg_ht);
      break;

  } /*--- switch (status) ---*/
  return(TRUE);
}

/*--------------------------------------------------------------------------------
  do_intro
    Writes "Hello World" in field "hello1".
    Demonstrates the use and deactivation of independent functions.
    This function is activated in the main function.
--------------------------------------------------------------------------------*/
bool do_intro (
  void
)
{
  int      logo_x, logo_y, logo_wd, logo_ht;
  int      text_x, text_y, text_wd, text_ht;
  GSColor  text_color;

  /*--- deactivate this function (it should only ve called once) ---*/
  GSdeactivatefunction("intro");
```

```
  /*--- initialize fill color field to first color of fillcolor list ---*/
  GSsetcurrentnamedwindow("root");
  FillColor = GSgetlistcolor(FILL_COLOR_LIST, INITIAL_ITEM);
  show_fill_color(FillColor);
  GStogglecheck("col_menu", GSgetmenuitemname("col_menu",INITIAL_ITEM));
  GSdisplayversion("version.txt");

  write_hello();

  GSdisplayhelpmessage(INTRO_MSG);

  /*--- draw text cursor in text output field ---*/
  GSgetfieldrect("textfg", &text_x, &text_y, &text_wd, &text_ht, &text_color);
  GSsetcolor(text_color);
  GSwwritemsg(text_x, text_y, "_");

  /*--- draw globe logo ---*/
  GSgetfieldrect("logo", &logo_x, &logo_y, &logo_wd, &logo_ht, NULL);
  GSwdrawpict(&LogoPict, logo_x, logo_y, logo_wd, logo_ht, 0, 0, 1,
              logo_converter);
  return TRUE;
}

/*---------------------------------------------------------------------------
  do_quit
    Called when "Quit" item on "Menu" menu is selected.
    Quits giltest.
---------------------------------------------------------------------------*/
bool do_quit (
  void
)
{
  GSquit(NULL);
  return TRUE;
}

/*---------------------------------------------------------------------------
  do_text
    Called when a character is typed at the keyboard.
    Processes a character typed at the keyboard.
---------------------------------------------------------------------------*/
bool do_text (
  int   mouse_x,    /*--- not used here, but required by event handler ---*/
  int   mouse_y,    /*--- not used here, but required by event handler ---*/
  char  ch          /*--- character typed at the keyboard ---*/
)
{
  int        text_x, text_y, text_wd, text_ht;
  GSColor    text_color;
  int        background_x, background_y, background_wd, background_ht;
  GSColor    background_color;
  int        length;
  BigString  current_window;
  BigString  out_string;
  int        i;

  /*--- Don't process character if alert window is up. ---*/
```

```
if (AlertShowing)
{
  GSbell();
  return (FALSE);
}

/*--- Don't process character unless "io" is the current window. ---*/
GSgetcurrentwindowname(current_window);
length = strlen(current_window);
for (i = 0; i < length; i++)
{
  current_window[i] = tolower(current_window[i]);
}
if (strcmp(current_window, "io") != 0)
{
  GSbell();
  return (FALSE);
}

GSsetcurrentnamedwindow("io");
GSgetfieldrect("textfg", &text_x, &text_y, &text_wd, &text_ht, &text_color);
if (char_is_legal(ch))
{
  length = strlen(TextString);
  /*--- check length of string (in characters) in memory ---*/
  if (length < BIGSTRINGLEN)
  {
    /*--- copy string and add character to temporary buffer ---*/
    strcpy(out_string, TextString);
    out_string[length] = ch;
    out_string[length+1] = '\0';
    /*--- check length of string (in pixels) on screen ---*/
    if (GStextwidth(out_string) <= text_wd)
    {
      /*--- update permanent buffer if string still fits in field ---*/
      strcpy(TextString, out_string);
      if (strlen(TextString) == 1)
      {
        GSenablemenuitem("funcs_menu", CLEAR_TEXT_MENU_ITEM);
      }
    }
    else /*--- string will not fit in field with new character added ---*/
    {
      /*--- alert user that string would be too long ---*/
      GSalert(-1, TRUE, "typedtoofar", "");
      show_fill_color(GSconvertcolor("mgray"));
      /*--- disable typing until alert window is removed by user ---*/
      AlertShowing = TRUE;
      return FALSE;
    }
  }
}
else if ((ch == '\b') && (strlen(TextString) > 0))
{ /*--- rubout last character ---*/
  TextString[strlen(TextString)-1] = '\0';
  if (strlen(TextString) == 0) /*--- then there is no more text to clear ---*/
  {
```

```
      GSdisablemenuitem("funcs_menu", CLEAR_TEXT_MENU_ITEM);
    }
    strcpy(out_string, TextString);
  }
  else
  {
    return FALSE;
  }
  /*--- if we get here, the string has been updated, so rewrite it ---*/
  add_cursor_if_space(out_string, text_wd);
  GSgetfieldrect("textbg", &background_x, &background_y, &background_wd,
                 &background_ht, &background_color);
  GSsetcolor(background_color);
  GSwfillrect(background_x, background_y, background_wd, background_ht);
  GSsetcolor(text_color);
  GSsetfont(LARGE);
  GSwwritemsg(text_x, text_y, out_string);
  return TRUE;
}


/*-----------------------------------------------------------------------------
  draw_all_objects
    Display all drawing objects.
-----------------------------------------------------------------------------*/
void draw_all_objects(
  void
)
{
  DrawObj *object = first_object;

  while (object != NULL) {
    draw_object(object);
    object = object->next_object;
    }
}


/*-----------------------------------------------------------------------------
  draw_object
    Display a drawing object.
-----------------------------------------------------------------------------*/
void draw_object(
  DrawObj *object
)
{
  TextObj *text;
  RectObj *rect;

  GSsetcurrentnamedwindow("io");

  switch(object->type) {

    case rectObj:
      rect = &(object->object.rect);
      if (rect->fill) {
        GSsetcolor(rect->f_col);
```

```
        GSwfillrect(rect->x, rect->y, rect->wd, rect->ht);
        }
      if (rect->border) {
        GSsetcolor(rect->b_col);
        GSwdrawrect(rect->x, rect->y, rect->wd, rect->ht);
        }
      break;

    case textObj:
      text = &(object->object.text);
      GSsetcolor(text->t_col);
      GSwwritemsg(text->x, text->y, text->str);
      break;

    default:
      GSelog(-1, "Error:  unknown object type: %d.\n", object->type);
      break;
    }
}


/*---------------------------------------------------------------------------
  init_colors
    Convert color names to GSColors for logo.
---------------------------------------------------------------------------*/
void init_colors(
  void
)
{
  aqua_color = GSconvertcolor("aqua");
  mgray_color = GSconvertcolor("mgray");
  white_color = GSconvertcolor("white");
}

/*---------------------------------------------------------------------------
  init_pict
    Initialize the file for a picture and initialize the picture.
---------------------------------------------------------------------------*/
void init_pict (
  GSPicture *pict_ptr,  /*--- GIL picture structure ---*/
  FileName   pict_file  /*--- name of file which contains picture image ---*/
)
{
  FILE *fp;
  long  file_size;
  void *picture_memory;

  fp = GSopen(pict_file, "rb");
  if (fp == NULL)
  {
    GSelog(-1, "Unable to open logo file %s\n", pict_file);
  }
  file_size = GSfilesize(fp);
  picture_memory = (void *)malloc(file_size-8);
  if (picture_memory == NULL)
  {
    GSelog(-1, "Unable to allocate space for picture in file %s\n", pict_file);
```

```
  }
  if (!GSinitpic(fp, pict_ptr, picture_memory))
  {
    GSelog(-1, "Unable to initialize picture in file %s\n", pict_file);
  }
  fclose(fp);
}


/*-------------------------------------------------------------------------------
  logo_converter
    Converts a pixel code from a runlength encoded image file to a color
    palette index.
-------------------------------------------------------------------------------*/
GSColor logo_converter (
  unsigned short code,    /*--- pixel code from image run ---*/
  int x,
  int y,  /* x, y, z - unused params */
  int z
)
{
  switch (code)
  {
    case 255:
      return((unsigned char)-1);
    case 0:
      return(mgray_color);
    case 1:
      return(aqua_color);
    default:
      return(white_color);
  }
}


/*-------------------------------------------------------------------------------
  redraw_all
    Called when the application window is exposed after being covered by
    another window. Redraws the application window.
-------------------------------------------------------------------------------*/
bool redraw_all (
  void
)
{
  ButtonStatusType button_status;
  int              text_x, text_y, text_wd;
  GSColor          text_color;
  int              logo_x, logo_y, logo_wd, logo_ht;
  BigString        out_string;

  /*--- GSredrawnamedwindow is used to redraw a window which already
        appears on the screen ---*/
  GSredrawnamedwindow("root");
  GSdisplayversion("version.txt");
  show_fill_color(FillColor);
  GSredrawnamedwindow("io");
```

```
  /*--- redraw globe logo ---*/
  GSgetfieldrect("logo", &logo_x, &logo_y, &logo_wd, &logo_ht, NULL);
  GSwdrawpict(&LogoPict, logo_x, logo_y, logo_wd, logo_ht, 0, 0, 1,
              logo_converter);

  /*--- redraw text string in text input field ---*/
  GSgetfieldrect("textfg", &text_x, &text_y, &text_wd, NULL, &text_color);
  GSsetcolor(text_color);
  GSsetfont(LARGE);
  strcpy(out_string, TextString);
  add_cursor_if_space(out_string, text_wd);
  GSwwritemsg(text_x, text_y, out_string);

  /*--- first hello is written in intro, so it is always redrawn ---*/
  write_hello();

  /*--- second hello is written only after "again" button has been pressed ---*/
  GSgetbuttonspecs("io", "again", NULL, NULL, NULL, NULL, &button_status);
  if (button_status == INVISIBLE) /*--- then it has been pressed ---*/
  {
    write_hello_again();
  }

  /*--- redraw the current help message (GIL remembers it for you) ---*/
  GSdisplayhelpmessage(CURR_MSG);

  /*--- redraw alert window if it was showing ---*/
  if (AlertShowing)
  {
    GSalert(-1, TRUE, "typedtoofar", "");
  }

  draw_all_objects();

  GSsetcurrentnamedwindow("io");
  return TRUE;
}



/*---------------------------------------------------------------------------------
  remove_all_objects
    Remove drawing objects from list.
---------------------------------------------------------------------------------*/
void remove_all_objects(
  void
)
{
  DrawObj *object = first_object, *next_object;

  while (object != NULL) {

    next_object = object->next_object;

    if (object->type == textObj)
      free(object->object.text.str);
    free(object);
```

```
    object = next_object;
    }

  first_object = NULL;
  last_object = NULL;
}


/*----------------------------------------------------------------------------
  set_color
    Called when a fill color is selected from "Fill Color" menu.
    Sets the fill color to the color listed in position itemnum on the menu.
----------------------------------------------------------------------------*/
bool set_color (
  char *item_name /*--- name of selected menu item ---*/
)
{
  static int  prev_item_num = INITIAL_ITEM;

  int item_num;  /*--- number of selected menu item
                      (top item is 0, next lower item is 1, etc.) ---*/
  item_num = GSgetmenuitemnum("col_menu", item_name);
/*-------------------------------------------------------------------------
    if selected item is different from old item, GIL turns checkmark
    for selected item on, and GStogglecheck here turns old checkmark off;
    if selected item is the same as the old item, GIL turns old
    checkmark off, and GStogglecheck here turns it back on.
  -----------------------------------------------------------------------*/
  GStogglecheck("col_menu", GSgetmenuitemname("col_menu",prev_item_num));
  FillColor = GSgetlistcolor (FILL_COLOR_LIST, item_num);
  show_fill_color(FillColor);

  /*--- show a different message if color value is unchanged ---*/
  if (prev_item_num == item_num)
    GSdisplayhelpmessage(SAME_FILL_COLOR_MSG);
  else
    GSdisplayhelpmessage(NEW_FILL_COLOR_MSG);

  prev_item_num = item_num;
  return TRUE;
}

/*----------------------------------------------------------------------------
  show_box_styles
    Called when "Box Style" button is pushed.
    Shows the menu of box styles.
----------------------------------------------------------------------------*/
bool show_box_styles (
  void
)
{
  GSdisplayhelpmessage(BOX_STYLE_MENU_MSG);
  return TRUE;
}

/*----------------------------------------------------------------------------
```

```
  show_colors
    Called when "Fill Colors" button in "root" window is pressed.
    Shows the menu of fill colors to choose from.
--------------------------------------------------------------------------------*/
bool show_colors (
  void
)
{
  GSdisplayhelpmessage(FILL_COLOR_MENU_MSG);
  return TRUE;
}
/*--------------------------------------------------------------------------------
  show_fill_color
    Shows fill color in a box on the "Fill Colors" button.
--------------------------------------------------------------------------------*/
void show_fill_color (
  GSColor fill_color
)
{
  int        button_x, button_y, button_wd, button_ht;
  int        rect_x, rect_y, rect_wd, rect_ht;
  BigString  current_window;

  GSgetcurrentwindowname(current_window);
  GSsetcurrentnamedwindow("root");
  GSsetcolor(fill_color);

  /*--- determine area of button available for fill color rectangle ---*/
  GSgetbuttonspecs("root", "color", &button_x, &button_y, &button_wd,
                   &button_ht, NULL);
  GSsetfont(LARGE);
  rect_x = button_x + GStextwidth(FILL_COLOR_BUTTON_LABEL) + 10;
  rect_y = button_y + 7;
  rect_wd = button_wd - GStextwidth(FILL_COLOR_BUTTON_LABEL) - 15;
  rect_ht = button_ht - 13;

  /*--- draw a solid rectangle of current fill color on "color" button ---*/
  GSwfillrect(rect_x, rect_y, rect_wd, rect_ht);

  /*--- if color _is_ "mgray", button is disabled, so make border "mgray" ---*/
  if (fill_color != GSconvertcolor("mgray"))
    GSsetcolor(GSconvertcolor("white"));

  /*--- draw a border around the solid rectangle ---*/
  GSwdrawrect(rect_x - 1, rect_y - 1, rect_wd + 2, rect_ht + 2);
  GSsetcurrentnamedwindow(current_window);
}


/*--------------------------------------------------------------------------------
  show_funcs_menu
    Called when "Menu" button is pushed.
    Shows the menu of user functions to choose from.
--------------------------------------------------------------------------------*/
bool show_funcs_menu (
  void
)
```

```
{
  GSdisplayhelpmessage(MENU_MENU_MSG);
  return TRUE;
}


/*----------------------------------------------------------------------------
  toggle_border
    Called when "Draw Black Border" item on "Box Styles" menu is selected.
    Toggles the DrawBorder parameter.
----------------------------------------------------------------------------*/
bool toggle_border (
  char *item_name  /*--- name of selected menu item ---*/
)
{
  DrawBorder = !DrawBorder;
  if (DrawBorder)
  {
    GSdisplayhelpmessage(BOX_STYLE_CHECK_ON_MSG);
  }
  else
  {
    GSdisplayhelpmessage(BOX_STYLE_CHECK_OFF_MSG);
  }
  return TRUE;
}

/*----------------------------------------------------------------------------
  toggle_fill
    Called when "Fill With Color" item on "Box Style" menu is selected.
    Toggles the FillBorder parameter.
----------------------------------------------------------------------------*/
bool toggle_fill (
  char *item_name  /*--- name of selected menu item ---*/
)
{
  FillBorder = !FillBorder;
  if (FillBorder)
  {
    GSdisplayhelpmessage(BOX_STYLE_CHECK_ON_MSG);
  }
  else
  {
    GSdisplayhelpmessage(BOX_STYLE_CHECK_OFF_MSG);
  }
  return TRUE;
}

/*----------------------------------------------------------------------------
  write_hello
    write "Hello World." in field "hello1" in "io" window.
----------------------------------------------------------------------------*/
void write_hello (
  void
)
{
  int      hello1_x, hello1_y;
```

```
  GSColor  hello1_color;

  /*--- write "Hello World" ---*/
  GSgetfieldrect("hello1", &hello1_x, &hello1_y, NULL, NULL, &hello1_color);
  GSsetcolor(hello1_color);
  GSsetfont(LARGE);
  GSsetcurrentnamedwindow("io");
  GSwwritemsg(hello1_x, hello1_y, "Hello World.");
}
/*----------------------------------------------------------------------------
  write_hello_again
    write "Hello World, again." in field "hello2" in "io" window.
----------------------------------------------------------------------------*/
void write_hello_again (
  void
)
{
  int      hello2_x, hello2_y;
  GSColor  hello2_color;

  /*--- get coordinates and color for message text ---*/
  GSgetfieldrect("hello2", &hello2_x, &hello2_y, NULL, NULL, &hello2_color);

  /*--- set text attributes and write message ---*/
  GSsetcolor(hello2_color);
  GSsetfont(LARGE);
  GSwwritemsg(hello2_x, hello2_y, "Hello World, again.");
}

/*----------------------------------------------------------------------------
  FuncNames array
    function name -> function pointer mapping
----------------------------------------------------------------------------*/
IntrFunction FuncNames[] = {
/* string in .inf file    function pointer
   -------------------    ------------------------ */
  { "agn_func",           do_again              },
  { "box_menu",           show_box_styles       },
  { "clear_draw_func",    clear_draw            },
  { "clear_text_func",    clear_text            },
  { "col_menu",           show_colors           },
  { "done_func",          alert_done            },
  { "draw_func",          (bool(*)())do_draw },
  { "funcs_menu",         show_funcs_menu       },
  { "intro",              do_intro              },
  { "kbd_hndlr",          (bool(*)())do_text },
  { "quit_prog_func",     do_quit               },
  { "redraw_func",        redraw_all            },
  { "set_color_func",     set_color             },
  { "toggle_border_func", toggle_border         },
  { "toggle_fill_func",   toggle_fill           },
};

int NumFuncs = GSnumifuncs(FuncNames);

/*----------------------------------------------------------------------------
  Main routine: Do initializations and start interface handler.
```

```
---------------------------------------------------------------------------*/
int main (
  int  argc,
  char **argv
)
{
  first_object = last_object = NULL;

  /*--- initialize output.log ---*/
  if (!GSinitlog ("wt"))
  {
    printf("Unable to initialize output.log\n");
    GSdelay(TIME_TO_READ_MSG);
    exit(-1);
  }

  init_pict(&LogoPict, GlobeFile);

  /*--- initialize giltest interface ---*/
  GSinterfaceinit("GeoSim Interface Library (GIL) Test", /*--- progrm name ---*/
                  "giltest.inf", /*--- interface file name ---*/
                  BSTORE,        /*--- use backing store ---*/
                  "w",           /*--- error.log mode ---*/
                  G640x480x16,   /*--- 16-color graphics mode ---*/
          argc, argv);

  init_colors();

  /*--- activate keyboard input function (do_text) ---*/

  GScharfunc("kbd_hndlr");

  /*--- start event loop ---*/
  GSinterface();
  return(0);
}
```

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