Rapid GUI Development with QtRuby

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Introduction

1.1 Frameworks

Creating a graphical application with a scripting language isn't new. TCL, a popular scripting language of the early 1990s has Tk, a graphical extension using the Motif libraries. For years, these toolkits were the defacto standard for creating GUI applications both easily and quickly.

It's probably no surprise that Ruby comes with libraries that support TCL and Tk.

But, as time moves on, tools come onto the scene that provide new features that users want. The GUI framework Qt is one such tool, built and refined over many years of use. Today, Qt is a powerhouse framework, providing a top notch interface for building applications on all three major computing platforms.

Qt and Ruby—A Lovely Marriage

We believe that Qt provides the perfect mix of features for creating robust GUI applications. We also believe that extending the use of Qt into the Ruby domain gives us incredible power to create high quality applications.

The choice of which toolkit to use is a personal one. For some developers, there is as much passion in the choice of toolkit as there is in their choice of Ruby, Perl, or Python. When starting out with a new framework like QtRuby, we recommend that you investigate all the possible competing options before making any decisions.

We recommend you check out Qt's excellent online documentation.

Other GUI/Ruby framework combinations are:

- FXRuby (for the FOX toolkit)
- wxRuby (for wxWidgets)
- Ruby/Gnome2 (for GTK)
- RubyCocoa (for Cocoa)

1.2 Our Assumptions

In this book, we assume that you have some familiarity with Ruby—that you understand and read Ruby code and can follow examples in the book. If not, pick up a copy of Programming Ruby [TFH05].

We do *not* assume you have familiarity with Qt, although, a moderate amount of familiarity will be a plus. For this, we recommend *C++ GUI Programming with Qt 3* [BS04], which is also freely available on the web (see Appendix B, on page 89).

We also assume you're comfortable with your platform—Linux or Mac—and that you are able to follow some of the instructions on installing the software. We've attempted to make it as easy as possible, but some troubleshooting on your part may be required if something doesn't work right.

Last, we assume that you will follow through the examples as they are presented. Unfortunately, we don't have the space or time to discuss every aspect of the toolkit. However, after learning the fundamentals presented within, we feel confident that you will have enough understanding of QtRuby to feel comfortable learning more on your own.

1.3 Acknowledgements

First, thanks to the developers who were responsible for QtRuby and SMOKE: Richard Dale, Ashley Winters, Germain Garand, David Faure, and others.

Thanks to the developers at Trolltech who produce Qt and provide the GPL version to the open source community.

Thanks to the two Pragmatists, Andy and Dave, who provided input, editing, and suggestions on the book.

Thanks to the Ruby community for being helpful and friendly to new comers who tend to ask the same questions over and over again.

Finally, thanks to my wife, Anna, who put up with many evenings of her husband paying more attention to this book than to her.

Chapter 2

About Qt

The original authors of Qt chose the name based on the *Xt*, the X toolkit. The Q was used instead because it looked nice in Emacs font.

If you are already familiar with Qt and installing it on your system, you can skip ahead to Chapter 3, About QtRuby, on page 13.

Qt, by Trolltech, is a cross-platform GUI toolkit, written in C++. Some of the main selling points of Qt are:

- *Cross Platform*—Qt is available for Windows, Mac, and Unix. Qt follows the mantra: write once, compile anywhere. You literally only have to write one program that, after being compiled, will run on any supported platform.
- *Modular*—The toolkit comes with many modular, extensible components, such as the SQL, threading, and networking modules. While not all of these extra components are directly GUI related, they are very helpful for adding functionality within GUI programs while maintaining the cross platform nature of the toolkit.
- *Open Source*—Qt is licensed under the GPL. The source code is fully available and completely free. Trolltech benefits by having a large user base which can report feedback and provide source code patches for bugs found in the toolkit.
- *Binary Compatibility*—When a new version of the Qt toolkit is released, it won't alter the way your existing programs function. You can drop the latest version of Qt in place and benefit from bug fixes and feature additions without worry that something in your program will stop working properly.

2.1 A Little History

Qt was born in 1991 as a product to aid in GUI application development. In 1996, student Matthias Ettrich began using Qt as a basis for the KDE project—an opensource Unix desktop environment. By 1997, the popularity of KDE and Qt was growing, but concerns about Qt licensing issues were also starting to develop by members of the open source community.

Some people involved within the open source community worried about the direction of the Unix desktop. Qt was the Unix desktop's main toolkit, so having it controlled by a commercial entity worried many people. In 1998, the GNOME project was started to create an alternative desktop that would be more compatible with the goals of open source software.

Licensing

In response to the community's moves, Trolltech licensed Qt under the QPL, an open source license. However, the Free Software Foundation, the figurehead of the open source movement, did not regard the QPL as being compatible with the GPL, its standard open source license of the time.

In 2000, Qt 2.2 was released under a dual QPL/GPL license which allowed the author using the toolkit to decide which of the licenses they wanted their application to fall under. With Qt 2.2, a fully GPL compatible Qt was available for Unix. Since then, Trolltech has also released versions of Qt under the GPL for Mac, starting with 3.1.2, and for Windows, starting with 4.0.0.

Current releases of Qt are licensed under a dual commercial/GPL license structure. This means that Qt is freely available, with full source code, on each of the three major platforms under the GPL. This also means that any software written using the Qt libraries must abide by the GPL.

A non-GPL commercial option also exists, allowing customers to purchase a license from Trolltech so that software written using the toolkit can be licensed by the author. However, the source code between the GPL and commercial versions of Qt is the same.[1]

Philosophy

It's not our intention to dicuss the philosophy of software licensing in this book. Instead, we want to make you aware of the licensing options of Qt and let you decide what works best for you. Before beginning any QtRuby project, we encourage you to research your Qt license (GPL,QPL, or commercial) and what implications it may have on your project.

2.2 Versions

Qt is classified by its *major version number*, with 4 being the most recently released. Below the major version is a *minor version number*, like 4.*0*, and a *patch level number*, such as 4.0.*0*. Patch level releases are done periodically to fix bugs that have been found in the code. 4.0.1 represents the next patch level release from 4.0.0. Minor version releases are done less frequently and usually involve larger additions to the library, such as the addition of a new class.

[1]There are some subtle differences, but for the most part there is no difference in the commercial and GPL versions.

Qt releases with the same major version number are binary compatible. This means that you can drop in a later released version of the toolkit, and your programs will continue to function as before without the need to recompile them. You also may be able to drop in an earlier version of the same major release without problems, as long as your program doesn't make use of any functionality added between the two releases.

The 4.0 version of Qt was released on June 28, 2005. Because of big changes between the previously released 3.3 series many existing applications are still using the older, more mature version 3 of the library. Because of this, we will focus solely on the major version 3 series of Qt. We hope to provide an updated revision of the book once Qt 4 becomes more widely adopted and the QtRuby bindings fully support it.

2.3 Where to get Qt

Qt can be installed using your system's package management tools, our you can download and build it from the source (see Section 2.4, *How to install Qt from source*, on the following page).

Linux/Unix

Many Linux distributions come with Qt. Check your package management system to see what version of Qt is installed or available to be installed. You will also need any development packages (such as qt-devel) to be installed as well. On Linux, Qt relies on the X11 window management system, which must be installed and configured.

Mac OS X

Mac OS X users who use an automated installation manager such as Fink should install Qt from there. Fink users will most likely want to install all qt3 packages.

2.4 How to install Qt from source

If you're an open source junkie like us, you probably want to install Qt from the source code. It's actually pretty easy.

The first step is to download the source from the Trolltech web site and unpack the file.

Next, you need to use the configure program to set up the build. There are many configuration items, which are viewable using the -help option to configure:

When installing Qt manually, you must already have a window system installed. Windows and Mac users should be fine, but Linux/Unix users will need the X11 window system.

```
user@localhost ~/qt $ ./configure -help

Usage:  configure [-prefix dir] [-buildkey key] [-docdir dir]
    [-headerdir dir] [-libdir dir] [-bindir dir] [-plugindir dir ]
    [-datadir dir] [-translationdir dir] [-sysconfdir dir] [-debug]
    [-release] [-no-gif] [-qt-gif] [-no-sm] [-sm] [-qt-zlib]
    [-system-zlib] [-qt-libjpeg] [-system-libjpeg] [-qt-libpng]
    [-system-libpng] [-qt-libmng] [-system-libmng] [-no-thread]
    [-thread] [-no-nis] [-nis] [-no-cups] [-cups] [-no-largefile]
    [-largefile] [-version-script] [-no-stl] [-stl] [-no-ipv6 ]
    [-ipv6] [-Istring] [-lstring] [-Lstring] [-Rstring]
    [-disable-<module>] [-with-<module setting>]
    [-without-<module setting>] [-fast] [-no-fast]
```

Many of the options are documented below this output, but as you can see there are a lot of options to choose from. Luckily, Qt attempts to be smart about which options it chooses and in many cases will attempt to auto detect if certain options can be used or not.

We recommend that you use the defaults unless you explicitly know which settings are of value to you.

```
user@localhost ~/qt $ ./configure

This is the Qt/X11 Open Source Edition.

You are licensed to use this software under the terms of either
the Q Public License (QPL) or the GNU General Public License (GPL).

Type 'Q' to view the Q Public License.
Type 'G' to view the GNU General Public License.
Type 'yes' to accept this license offer.
Type 'no' to decline this license offer.

Do you accept the terms of either license?
```

At this point you should make sure you understand any implications which may be involved with the presented licenses. Type yes to continue.

Eventually, Qt will stop configuring and should tell you that it's time to start compiling. Typing make will start the compilation process.

The most popular compiler for building Qt is GCC, but C++ compilers built by other vendors are supported as well.

```
Qt is now configured for building. Just run /usr/bin/gmake.
To reconfigure, run /usr/bin/gmake confclean and configure.

user@localhost ~/qt $ make
```

Finally, when it's done, Qt needs to be installed. If during configure time you specified an installation prefix (using the -prefix) switch, then you can run make install now to install Qt to that location

Alternatively, you can simply leave everything as is and move the entire Qt directory to the desired installation location.

The installation location is a bit of a personal preference. For Linux, we like to put Qt in /usr/local/qt. For OS X, we recommend /Developer/Qt.

```
user@localhost ~/qt $ cd ..
user@localhost ~ $ sudo mv qt /usr/local/qt
user@localhost ~ $
```

It's important to make sure that after Qt is installed the libraries in the lib subdirectory are added to the dynamic linker search path. In Linux, this can be done in the /etc/ld.so.conf file or by using the LD_LIBRARY_PATH environment variable. With Mac OS, using the DYLD_LIBRARY_PATH will work as well.

It's also important that the programs in the bin subdirectory are added to the executable path. This is done with the PATH environment variable.

On OS X, it has been reported that the configure switch -thread is required when building Qt.

We recommend you take a look at the INSTALL file in the Qt package. It has some important information in it about these installation matters.

2.5 Installation Issues

Many things can go wrong when installing a new software package, especially one that is as encompassing as Qt. It's impossible to plan for every eventuality, but here are some pointers to help you try and troubleshoot what may have happened.

- Identify what phase you were in when the trouble happened. Did you get Qt unarchived? Did the problem occur after you typed make? What kind of output did you see?
- Make sure you didn't make a spelling mistake when running the commands. Misspelling an option passed to configure could cause a problem. Likewise, running mkae instead of make is problematic. Be aware of any spurious error messages that could have come up.
- Did you specify an option to configure that isn't valid for your system? Perhaps you need to specify a different value. Some options, like -thread, may be required if some of your underlying libraries that Qt links against (X11, for example) are also built as threaded.
- Did the build process die during the make stage? Try to find the error message that caused the failure. Sometimes the build process dies because different library versions are found during compile time than were found during configure time. Other times, the compiler itself has a bug and may cause a segmentation fault. We've also seen the compiler die simply because the computer was overheating during the compile process.

2.6 Exploring the toolkit

The Qt library is in the lib directory under your Qt installation prefix. If Qt was built non-threaded, the library name is something like libqt.so.3.3.5. If it is built threaded, the libraryname is libqt-mt.so.3.3.5.

Additionally, there'll be soft links that point to these libraries with various version formats.

Executables that come with Qt are in the bin directory in the installation prefix. Some of the commonly used applications are:

- *assistant*—A tool for searching the Qt API reference files and program documentation
- *designer*—A graphical program for designing GUI interfaces
- *linguist*—A GUI tool for handling internationalization of Qt applications
- *moc*—A C++ code parser that translates special Qt specific extensions into C++ code.
- *qmake*—A Makefile generator based on project (.pro) files.
- *uic*—A tool for converting .ui files created by designer into C++ files.

Qt also comes with many examples and plugins (in directories named examples and plugins) to make programming as painless as possible. Because it's impossible to explore all of the features Qt has to offer in this book, we recommend you spend some time looking at the demos, examples, and other available files to see all of the possibilities that exist for writing your application.

Chapter 3

About QtRuby

3.1 Language Bindings

Language bindings for libraries are very popular. They give freedom to you, the author, to use highly desired features within that library with the flexibility of the programming language of your choice. In fact, one reason we like Ruby so much is its intrinsic capability to extend the language from C libraries.

Creating a language binding to C++ libraries, like Qt, is difficult. Really difficult. Trust us, you're better off not knowing the specifics. There are a couple of general reasons that make it so hard.

- *Name mangling*—In C, every function has a clear and concise name which gets tucked away inside of the library. In C++, objects can have multiple functions with the same name. Virtual methods also have the same name as their ancestors. To work around this, in a C++ library names are *mangled* so that every function gets a unique name within the library. Furthermore, different compilers may implement name mangling in different ways.

- *Templates*—The C++ feature of templates, while very powerful, are also very tricky to implement in a compiler. Different compilers offer varying levels of support for template implementation. Encapsulating that functionality within a wraparound language proves to be a difficult operation.

- *Qt extensions*—Qt C++ code is extended by the *MOC*, which creates some extra C++ code that automatically gets compiled in with your application. Because of its additional MOC code, a one-size-fits-all C++ wrapper would have a hard time working with Qt.

Some tools make the process easier. The most popular C++ binding generator, SWIG, provides a powerful set of tools for creating bindings in a number of languages. Unfortunately, some of the specialized aspects of Qt listed above are beyond what SWIG is capable of handling autonomously. Luckily, there is a tool that can help us.

3.2 I smell SMOKE

SMOKE reportedly stands for Scripting Meta Object Kompiler Engine.

The SMOKE utility creates a *wrapper* library for all of the Qt (and optionally KDE) method calls. SMOKE works by parsing the header files of the installed Qt libraries, and generates code which can call each of the methods in the Qt classes. In other words, SMOKE is the go-between between Ruby and Qt.

Other Qt language bindings, including PerlQt, use SMOKE as well.

3.3 Installing QtRuby

Some Linux distributions, such as Debian and Gentoo, come with the ability to automatically install QtRuby using their respective repository installation programs. For example, on Gentoo Linux, installing QtRuby is as easy as typing `emerge qtruby`. In other distributions, QtRuby may be distributed under the `kdebindings` package.

For manual installation, the current version of QtRuby is available at http://rubyforge.org/projects/korundum. We recommend downloading the most recent version (1.0.11 as of this writing).

You should download the Korundum package if you wish to use the KDE library bindings. The Korundum package contains QtRuby, so there's no need to download both. See Chapter 8, *Korundum*, on page 80 for more information on how to use Korundum.

After unpacking the file, the QtRuby needs to be configured. To show a list of configurable options, use:

```
~/qtruby> ./configure --help
```

Building on Linux

On Linux, we configured QtRuby like this:

```
~/qtruby> ./configure --with-smoke="qt" \
  --with-qt-dir=/usr/qt/3 --prefix=/usr
```

If the configure script does not exist in your source package, it can be created by using the command make -f Makefile.cvs.

Your configuration items may vary based on where Qt is installed (--with-qt-dir) and where SMOKE will be installed (--prefix). You may also have additional options.

If all goes well, you should see a positive note to that effect and a prompt to begin the build process:

```
Good - your configure finished. Start make now
~/qtruby> make
```

The build process starts by first generating the SMOKE bindings for Qt. After this, the QtRuby specific code is compiled. When complete, you simply need to install the files.

```
~/qtruby> sudo make install
```

Building on Mac

On the Mac, we configured QtRuby like this:

```
~/qtruby> ./configure --with-qt-dir=/Developer/qt \
  --enable-mac --prefix=/usr
```

Your configuration items may vary based on where Qt is installed (--with-qt-dir) and where SMOKE will be installed (--prefix). You may also have additional options.

If all goes well, you should see a positive note to that effect and a prompt to begin the build process. After this point, we followed the steps outlined in the INSTALL file.

```
~/qtruby> cd smoke/qt
~/qtruby/smoke/qt> perl generate.pl
~/qtruby/smoke/qt> qmake -makefile
~/qtruby/smoke/qt> make
...
~/qtruby/smoke/qt> sudo make install
```

We also build the rest of the package, again using the steps highlighted in the INSTALL file.

```
~/qtruby/smoke/qt> cd ../..
~/qtruby> cd qtruby/rubylib/qtruby
~/qtruby/qtruby/rubylib/qtruby> ruby extconf.rb \
   --with-qt-dir=/Developer/qt --with-smoke-dir=/usr \
   --with-smoke-include=../../../smoke

~/qtruby/qtruby/rubylib/qtruby> make
...
~/qtruby/qtruby/rubylib/qtruby> sudo make install
...

~/qtruby/qtruby/rubylib/qtruby> cd ../../..
~/qtruby> cd qtruby/rubylib/designer/rbuic
~/qtruby/qtruby/rubylib/designer/rbuic> qmake -makefile
~/qtruby/qtruby/rubylib/designer/rbuic> make
...
```

```
~/qtruby/qtruby/rubylib/designer/rbuic> sudo make install
...
~/qtruby/qtruby/rubylib/designer/rbuic> cd ../uilib
~/qtruby/qtruby/rubylib/designer/uilib> ruby extconf.rb \
   --with-qt-ruby-include=/../../qtruby \
   --with-qt-dir=/Developer/qt
~/qtruby/qtruby/rubylib/designer/uilib> make
...
~/qtruby/qtruby/rubylib/designer/uilib> sudo make install
```

Verifying the installation

To ensure that QtRuby was correctly installed, we can use irb to verify that Ruby is able to properly find the library.

```
~> irb
irb(main):001:0> require 'Qt'
=> true
irb(main):002:0>
```

On Mac OS, if QtRuby cannot link against the Qt library it will generate a runtime error:

```
dyld: NSLinkModule() error
dyld: Library not loaded: libqt-mt.3.dylib
  Referenced from: /usr/lib/ruby/. . ./qtruby.bundle
  Reason: image not found
Trace/BPT trap
```

On Linux, it generates a similiar error:

```
libqt-mt.so.3: cannot open shared object file:
  No such file or directory - /usr/lib/ruby/. . ./qtruby.so
```

3.4 Installation Issues

Much like installing Qt, things can go wrong during this process. Here are a few points to try and help you through.

- If the error happened during the configure portion of the installation, make sure none of your arguments were misspelled. Also make sure that specified items exist. For example, if you specified the location of Qt, make sure that Qt is indeed installed in that directory.

- If the error happened during the make portion of the installation, see if it's repeatable. We've seen errors due to buggy compilers. We've also seen them happen when the system is being overused and things get too hot. Faulty hardware, such as bad RAM, can also cause compiler faults.

- If the error happened during the require 'Qt' check, make sure that QtRuby is installed in your Ruby directory. For us, that directory is /usr/lib/ruby/site_ruby/1.8. There should be a Qt subdirectory and a Qt.rb file. Also, in your platform specific subdirectory, such as i686-linux or darwin-powerpc8.0, there should be a qtruby.so. This library links against the Qt library, so making sure that the Qt library is accessible to the dynamic library loader is important.

Chapter 4

Get Your Feet Wet

Instead of going through the routine of trying to learn the arcane details of QtRuby before using it, let's jump straight into an example.

4.1 Your first program

Fire up your favorite text editor, and type in this program:

```ruby
require 'Qt'
app = Qt::Application.new(ARGV)
label = Qt::Label.new("Hello World", nil)
label.resize(150, 30)
app.setMainWidget(label)
label.show()
app.exec()
```

Then, try executing it.

```
~> ruby ex_hello_world.rb
```

If all went well, your program should popup something like Figure 4.1 .

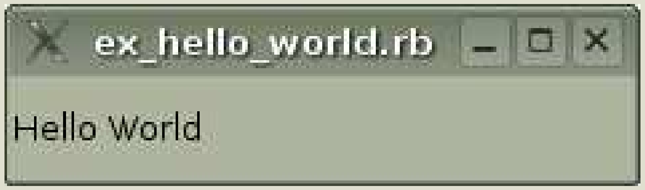


Figure 4.1: Hello World Example

By using the setCaption() method on your main widget, you can change the text that appears in the window title bar of your application.

We typically pass Ruby's ARGV array of command line arguments to the Qt::Application initializer because QtRuby applications have built in support for command line switches that can alter the behavior of the program.

Calling exec() is also known as starting the event loop.

Let's take a closer, line-by-line, look.

❶ First, we load the QtRuby library.

❷ Next, we create a Qt::Application object. Qt::Application is the foundation for all Qt programs. It handles all of the important behind-the-scenes details that are vital to our program running properly.

❸ Creates a new Qt::Label object, and sets its text to *Hello World*. The `nil` argument will be explained shortly.

❹ Resize the label to 150 pixels wide by 30 pixels tall to make sure the text is all visible.

❺ Assigns the label as the main widget of the application.

❻ Make the label visible.

❼ Finally, we tell the application to start its processing.

Comparing to C++

For comparison, the equivalent C++ code is:

```
#include <qapplication.h>
#include <qlabel.h>

int main( int argc, char **argv )
{
   QApplication app( argc, argv );

   QLabel label( "Hello world!", 0 );
```

```
    label.resize( 150, 30 );

    app.setMainWidget( &label );
    label.show();
    return app.exec();
}
```

Being the very astute reader you are, what fundamental differences did you notice between the two code styles?

Most importantly, you should have noticed the class names are slightly different. In the Qt world, all of the classes begin with the letter Q, like QApplication. The Ruby equivalent, however, lives in the Qt namespace, and as such, the Q is dropped. Thus, QApplication becomes Qt::Application. This convention holds true for all QtRuby classes.

QtRuby classes are all in the Qt namespace (Qt::). You also drop the initial Q from the Qt classname counterpart.

From this point on, we will try to stick with the Qt::Classname naming style when referring to classes, unless we are referring to something that is Qt specific. Sometimes when we go deep into the Qt library, we'll need to use the QClass syntax instead.

Now that your feet are wet, let's wade a little deeper into the framework.

4.2 Objects and Widgets and Parents, oh my!

We've created our first QtRuby program and highlighted a couple of necessities. We're ready to go a little deeper, but first we need to understand a little more about the basics of Qt.

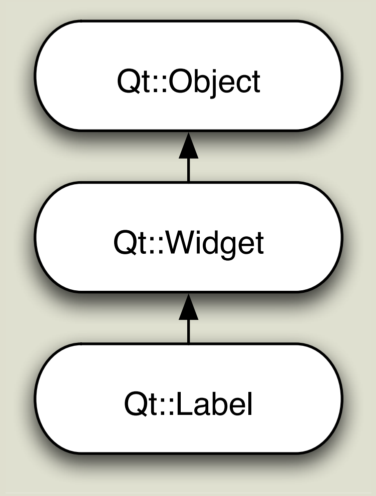


Figure 4.2: Qt::Label Inheritance Diagram

Fundamentals

The fundamental class in QtRuby is the Qt::Object. This object contains many of the settings and properties that are needed in most of the classes we will be using.

Qt::Object is a common base class for other items in QtRuby that aren't GUI widgets, but may need some of the same base properties.

Directly inheriting from Qt::Object is the Qt::Widget class. Qt::Widget is the base class for all GUI items, like sliders, text boxes, and labels.[1] In fact, the Qt::Label class we used in the example on page on page 19 inherits from Qt::Widget.

The Qt::Widget class by itself is rather boring. We like to think of it as a blank canvas on which we can make a more interesting type of widget. Luckily for us, many of the commonly used types of widgets have already been created as part of the framework, such as the

[1]In general, any GUI object is referred to generically as a *widget*

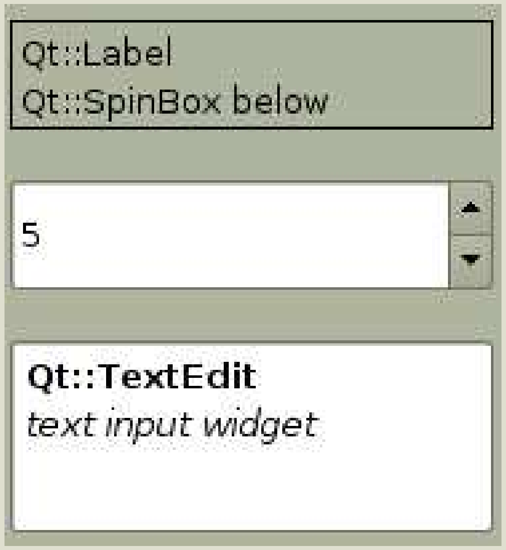


Figure 4.3: Qt::Label, Qt::SpinBox and Qt::TextEdit

Qt::Label, Qt::SpinBox, and Qt::TextEdit (screenshot on Figure 4.3).

Qt::Widget is a good base class to use to make more sophsticated widgets.

Most widgets have multiple initializers taking different arguments lists.

As seen in the previous code example, the way to bring a widget alive is to initialize it with a call to new(). For example, this code creates a new Qt::Widget instance:

```
widget = Qt::Widget.new(nil)
```

Object ancestry

But what is this mysterious parameter we've been passing to the initializer, you ask? It's the parent argument. Every time you create a new widget, you tell that widget who its parent widget is. Optionally, by passing nil, you're telling the widget it has no parent.

Classes derived from Qt::Widget must have a Qt::Widget based parent.

Classes derived from Qt::Object only need a Qt::Object derived parent, which includes Qt::Widget.

```
w1 = Qt::Widget.new(nil) # No parent
w2 = Qt::Widget.new(w1)  # w1 is parent
```

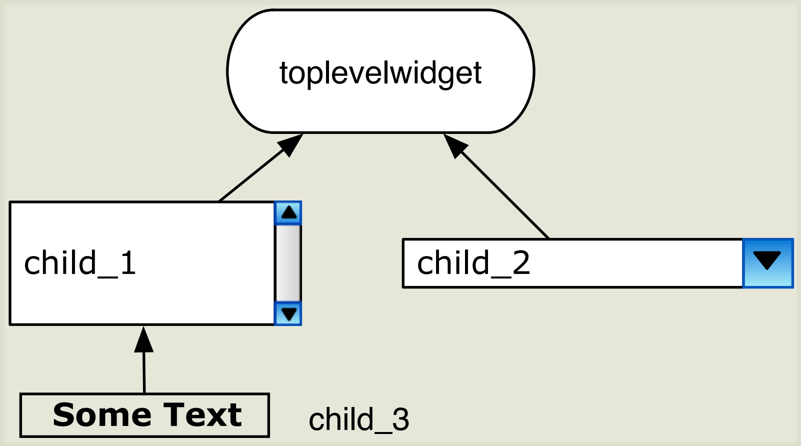


Figure 4.4: More Complex Inheritance Hierarchy

Parentless widgets are called *top level widgets*.

Here's a slightly more complex example, shown diagramatically in Figure 4.4

```
# Create a widget with no parent
toplevelwidget = Qt::Widget.new(nil)
# Create children of the toplevelwidget
child_1 = Qt::TextEdit.new(toplevelwidget)
child_2 = Qt::ComboBox.new(toplevelwidget)
# Create a grandchild of the toplevelwidget
child_3 = Qt::Label.new("Some Text", child_1)
```

How the family fits together

A parent widget owns its children. Child widgets become contained within the physical geometry of the parent. Thus, if the parent gets destroyed, disposed of, or hidden, its children will also suffer the same fate. This feature is very valuable. We can create child widgets knowing that as long as they have a parent they will be cared for. If

A widget can be given a new parent using the reparent() method.

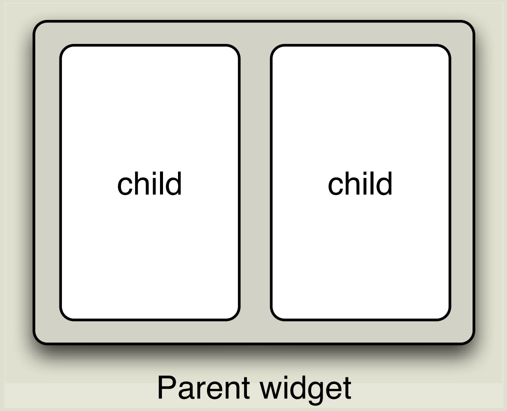


Figure 4.5: A parent widget with two contained children

this wasn't the case, we could potentially have lots of spare widgets floating (literally) around.

For example, if you destroyed the toplevelwidget from line 2 above, you can be assured that child_1 and child_2 are destroyed. child_3 would also be destroyed, since its parent, child_1, was destroyed.

Why parents and children?

The parent/child model allows us to create objects and then not worry about their ownership. After creation, QtRuby handles all of the details for us.

You may be wondering the logic behind having to specify a parent when creating a new instance of a widget. It turns out that this methodology fits the GUI model very well.

The common convention is to have one top level widget for the application of which all the other widgets are children or grandchildren (or great grandchildren. . .). The top level widget for the application can be the blank canvas of a Qt::Widget or a more complex application interface like a Qt::MainWindow.

The parent/child relationship is also used by Qt to help with the physical layout of the windows in the application, something we'll see more of Section 5.3, *Understanding Layouts*, on page 38.

Naming widgets

As well as the parent argument, Qt::Object-based initializers also accept an optional name argument. It is passed in immediately after the parent, like this:

```
widget = Qt::Widget.new(parent_widget, "Fred")
```

The name can also be specified using the setName() method.

```
widget = Qt::Widget.new(parent_widget) # Nameless
widget.setName("Fred")
```

Widgets whose names are not specified receive the name *unnamed*.

We find that in practice, naming your widgets isn't all that important.

As we'll see in the next section, there are ways to search groups of widgets by name, which is a reason why authors may choose to name their widgets. Another reason is that debugging and introspection tools can provide valueable insight when widgets have names. If your program has 100 Qt::Labels in it, and one of them was causing the program to crash, knowing the name of which one can help you track down the bug much faster.

We recommend using Ruby's object introspection methods over their QtRuby counterparts if possible, as they're notably faster. For example, we benchmarked Ruby's class() *method as four times faster than* Qt::Object*'s* className() *method.*

4.3 The Qt Object Model

Through the heavily used base class Qt::Object, Qt provides a valuable set of introspection methods that can be used to query information about objects and their families. Many of these methods are fundamental to Ruby applications, but remember that Qt is a C++

toolkit and as such some of these ideas are not central to that language.

First, Qt::Object provides a className() method that returns the name of the class. Ruby provides the same information via the class() call.

```
irb(main):001:0> w = Qt::Widget.new(nil)
irb(main):002:0> w.className
=> "Qt::Widget"
irb(main):003:0> w.class
=> Qt::Widget
```

Object types are also queryable via the isA() and inherits() methods. isA() returns true if the object is an instance of the class. inherits() returns true if the object has some inheritance back to the provided class.

```
irb(main):004:0> w.isA("Qt::Widget")
=> true
irb(main):005:0> w.isA("Qt::Object")
=> false
irb(main):006:0> w.isA("QWidget")
=> false
irb(main):007:0> w.isA("QObject")
=> false

irb(main):008:0> w.inherits("Qt::Widget")
=> true
irb(main):009:0> w.inherits("Qt::Object")
=> true
irb(main):010:0> w.inherits("QWidget")
=> true
irb(main):011:0> w.inherits("QObject")
=> true
```

Note that in the previous example, inherits() returns true for both QObject and Qt::Object syntax. In previous versions of QtRuby, this

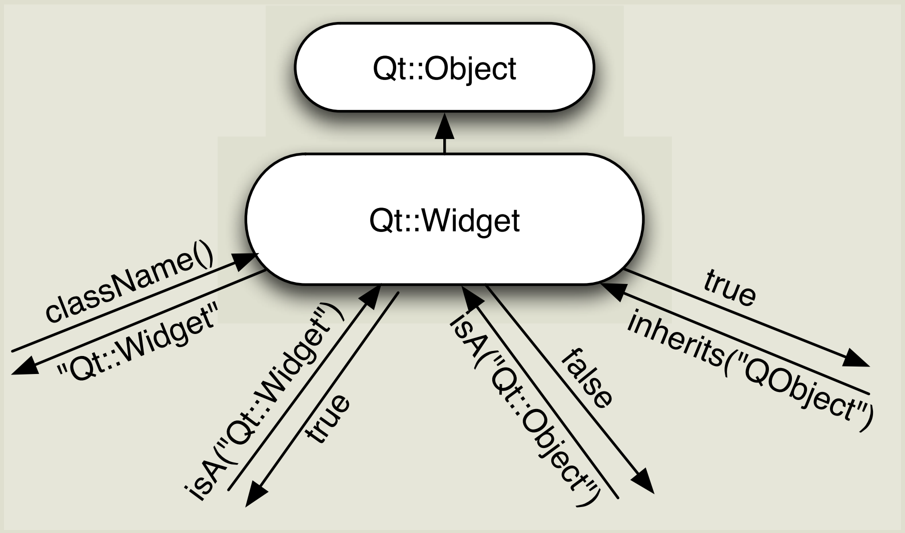


Figure 4.6: Widget Inheritance Methods

was not the case; inherits() only returned true if you used the Qt style naming convention. Be careful of this fact if you are not using the most recent version available of QtRuby.

Studying the Family

Note: The output from the irb interpreter has been formatted a little so its easier to read.

We can also inspect a widget's relatives. The parent() and children() methods return the widget's direct ancestors.

```
irb(main):013:0> w  = Qt::Widget.new(nil)
irb(main):014:0> w2 = Qt::Widget.new(w)
irb(main):015:0> w3 = Qt::Widget.new(w)
irb(main):017:0> w2.parent == w
=> true
irb(main):016:0> w.children
=> [ w2, w3 ]
```

The children() method returns the widget's children in the order in

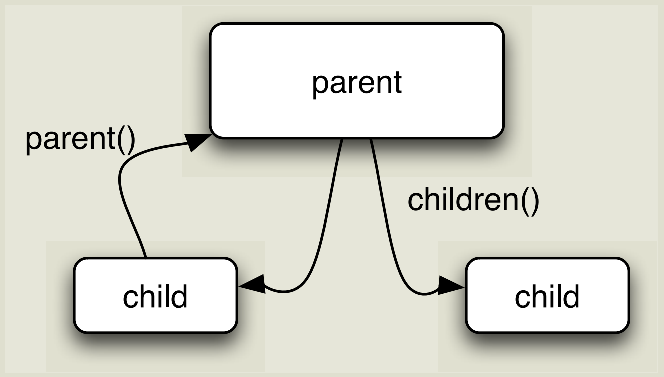


Figure 4.7: Parent and Children method calls

which they were created as children of the widget. The children() method returns only direct children of the parent, not grandchildren.

To explicitly search for a child, you can use the child() method. The syntax is child(name, inheritsClass = nil, recursiveSearch = true).

```
# Search all children and grandchildren
# for a child named "Editor"
obj = w.child("Editor")

# Search all children and grandchildren
# for a Qt::LineEdit named "Editor"
obj = w.child("Editor", "Qt::LineEdit")

# Search only direct children
# for a child "Editor"
obj = w.child("Editor", nil, false)

# Search only direct children
# for a Qt::LineEdit named "Editor"
obj = w.child("Editor", "Qt::LineEdit", false)
```

The child() method returns the first child found fitting the search criteria. To query for multiple children, the queryList() method can be used. The syntax is queryList(inheritsClass = nil, objName = nil, regexpMatch = true, recursiveSearch = true)

```
irb(main):004:0> w  = Qt::Widget.new(nil)
irb(main):005:0> w2 = Qt::Widget.new(w,"Widget")
irb(main):006:0> w3 = Qt::Widget.new(w,"Widget3")
irb(main):007:0> w4 = Qt::Widget.new(w,"Foo")

irb(main):012:0> w.queryList("Qt::Widget")
=> [ w2, w3, w4 ]
irb(main):013:0> w.queryList("Qt::Widget","Widget")
=> [ w2, w3 ]
irb(main):013:0> w.queryList("Qt::Widget","Widget", false)
=> [ w2 ]
```

4.4 Other initialization items

Notice line 7 from the example on page 24.

```
child_3 = Qt::Label.new("Some Text", child_1)
```

The initialization of the Qt::Label class also includes a string literal to set the label's value. This is very common practice with Qt widgets—many have initializers which can take extra arguments to seed initial settings of the widget. One thing to note: the parent argument usually comes after these initial value arguments.

Indeed, we also could have written:

```
child_3 = Qt::Label.new(child_1)
child_3.setText("Some Text")
```

You can also pass a block to the object initializer if preferred.

```
child_3 = Qt::Label.new(child_1) { setText("Some Text") }
```

4.5 The Qt::Application class

In Section 4.1, *Your first program*, on page 19, we briefly discussed the necessity of a Qt::Application class. Let's examine this a little further.

Qt::Application has a number of global application properties that may be of interest.

Qt::Application is the heart of the QtRuby application. It handles most of the underlying details that make up a GUI application—things like maintaining a common look and feel amongst widgets, managing an interprogram clipboard, mouse cursor settings, and internationalization of user visible text. It also talks with the window system and dispatches events to the widgets in the program.

With a few exceptions, every QtRuby program must have one instance of the Qt::Application class. Because of its importance, the Qt::Application object must be created before any other GUI related object.

The Qt::Application object is the first QtRuby object your program should initialize. Otherwise, your application most likely will abort.

```
irb(main):001:0> require 'Qt'
=> true
irb(main):002:0> w = Qt::Widget.new(nil)
QPaintDevice: Must construct a QApplication before a QPaintDevice
user@localhost ~ $
```

```
irb(main):001:0> require 'Qt'
=> true
irb(main):002:0> app = Qt::Application.new(ARGV)
=> #<Qt::Application:0xb6aa095c name="irb">
irb(main):003:0> w = Qt::Widget.new(nil)
=> #<Qt::Widget:0xb6a9d914 name="unnamed">
```

Starting the Event Loop

After the Qt::Application instance has been created, you can initialize the widgets that make up the program.

After the program has been completely set up, you call the exec() method of the Qt::Application object. The exec() method starts the event loop processing of the application. The event loop waits for GUI events to happen and processes them accordingly. For example, it might see that a keyboard button was pressed and attempt to send the information about the button press event to the widget which is interested in receiving it.

Note: it's OK to define custom widgets before creating your Qt::Application instance—just don't try to initialize one.

The exec() method only returns when the mainWidget of the application is destroyed or Qt::Application's exit() is called.

The exec() method returns the Qt::Application exit() code.

```
app = Qt::Application.new(ARGV)
widget = Qt::Widget.new(nil)
app.setMainWidget(widget)
app.exec
# We only get to this point if widget gets
# destroyed, meaning our application is
# closing.
```

Event driven programming

Many programmers, even experienced ones, struggle the first time they write a GUI application. Most GUI applications have *event driven flow*, which differs from the linear flow that most common programming languages are written in.

In a QtRuby application, the event loop handles all of the processing of information. Prior to starting the event loop (using the exec() method of the Qt::Application class), we specify the types of events we are interested in and what to do when these events happen. In the most basic form, this is handled by signal and slot connections as described in Section 5.5, *Signals and Slots*, on page 47.

We'd like to stress that once the event loop has started, there is no real direct control over what's happening. That is, we don't have a section of Ruby code that is looping over and over again like in a linear flow program. Instead, we predefine the processing we'd like to have happen when events occur and we let the event loop take care of looking for these events and dispatching them to us accordingly.

We'll see examples of how this works shortly.

Well, it seems like we've been pretty thorough in our discussion on the basics of Qt's widgets. When you're ready, let's tie together what we've learned.

4.6 Summary

- All QtRuby widgets inherit from the base class Qt::Widget. This in turn inherits from Qt::Object.
- All QtRuby widgets fit into an overall family tree structure. Child widgets are contained within the physical geometry of the parent. Destruction of a widget causes all of its descendants to be destroyed as well.
- Every QtRuby program needs one and *only one* Qt::Application instance. It must be created before any GUI widgets are initialized.
- The application event loop starts with a call to Qt::Application's exec() method. The method only returns when the main application widget is destroyed.

Chapter 5

Take the Plunge

When creating your own widget classes, it is important to remember not to give them names in the Qt namespace, such as Qt::MyWidget. While not technically wrong, classes you create in this namespace could conflict with existing classes already in the namespace, causing erratic program behavior.

As we discussed in the last chapter, widgets are the building blocks of GUI applications. With QtRuby, we can use widgets from the toolkit and combine them into more complex widgets, encapsulating their functionality.

5.1 Your First Custom Widget

Let's take a look at a more complicated program, in which we create our own custom widget. See if you can figure out what's going on.

```
require 'Qt'
class MyWidget < Qt::Widget
  def initialize(parent=nil)
    super(parent)
    @label = Qt::Label.new(self)
    @button = Qt::PushButton.new(self)
    @layout = Qt::VBoxLayout.new(self)
    @layout.addWidget(@label)
    @layout.addWidget(@button)
    @clicked_times = 0

    @label.setText("The button has been clicked " +
        @clicked_times.to_s + " times")
    @button.setText("My Button")
  end

end

a = Qt::Application.new(ARGV)
mw = MyWidget.new
a.setMainWidget(mw)
mw.show
```

```
a.exec
```

Some of the concepts discussed before are repeated in this code. However, there's some new stuff. First, note that we create a new widget, MyWidget, from an existing widget class.

```
class MyWidget < Qt::Widget
```

When creating a new GUI widget, it is important to inherit from a base QtRuby widget class such as Qt::Widget. By doing so, we gain the built in methods and properties that all widgets should have, such as a size.

Since our goal is to make a new widget that is the combination of a couple of other widgets, we base our widget off of Qt::Widget. If we wanted to extend an already existing widget, we could have based our new class directly off of it instead.

In the next part, we define the initialization code for our widget.

```
def initialize(parent=nil)
  super(parent)
  @label = Qt::Label.new(self)
  @button = Qt::PushButton.new(self)
  @layout = Qt::VBoxLayout.new(self)
```

The first thing we do in our initializer is make a call to super(). This step is very important. Calling super() explicitly runs the initializer in our inherited class (Qt::Widget in this case). Setup code defined within our base class initializer will only be executed with a call to super().

Note: Supplying the argument list to super() is optional in Ruby, as long as the superclass has the same argument list as the subclass.

We also create some child widgets in our MyWidget class. In this case, we are creating a Qt::Label, Qt::PushButton, Qt::VBoxLayout.

When creating new widgets, we pass self as their parent argument. This tells each of the new widgets that their parent is the instance of the widget currently being defined.

In the next section, we add our child widgets to the layout:

Okay, we fibbed a little. Some items that get used from the toolkit aren't technically widgets. In the example above, Qt::Label and Qt::PushButton are both widgets, because they inherit from the Qt::Widget class. However, items such as the Qt::VBoxLayout class don't inherit from Qt::Widget (because they don't need to).

```
@layout.addWidget(@label)
@layout.addWidget(@button)
```

We put our widgets into the layout because we want to make use of the layout's ability to automatically resize and maintain our widgets within the program boundaries.

Finally, we put a few finishing touches on our widgets:

```
@clicked_times = 0

@label.setText("The button has been clicked " +
    @clicked_times.to_s + " times")
@button.setText("My Button")
```

Both the Qt::Label and Qt::PushButton classes have setText() methods that, well, set the text displayed on the widget.

With our MyWidget widget class fully defined, we can finally create a Qt::Application to display the widget on screen.

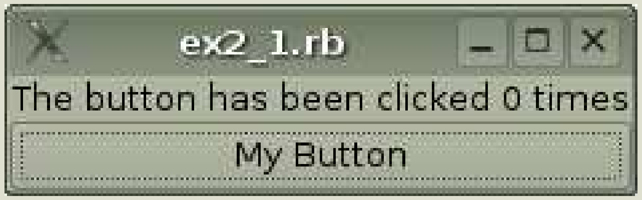
In these examples, we could have gotten away with *not* creating a layout, but the widgets would not change size if we resized the application window and they may have overlapped each other. This is usually not desirable behavior.

```
a = Qt::Application.new(ARGV)
mw = MyWidget.new
a.setMainWidget(mw)
mw.show
a.exec
```

Finally, we can run the code and see our program pop up a window like that in Figure 5.1, on the following page

5.2 Widget Geometry

Qt::Widget classes provide several functions used in dealing with the widget geometry. The methods width() and height() return the width



The button has been clicked 0 times

Figure 5.1: Screenshot of Example 2

and height of the widget, in pixels. The width and height values do not take into account a window frame which may surround a top level widget.

The method size(), which returns a Qt::Size object, contains the same information encapsulated inside of a Qt::Size object.

Another method, geometry() returns a Qt::Rect object containing both the widget's size and relative position within its parent. The position is defined in x and y coordinates, with x being the pixel distance from the left side of the parent and y being the pixel distance from the top of the parent.

Other methods include: x(), y(), and pos() which also return the widget's relative position from within its parent. These methods, however, *do* take into account a window frame if the widget happens to be a top level widget.

Since some methods take into account window frame geometry (for top level widgets) and others don't, we recommend reading over Qt's Window Geometry documentation. It also includes tips on how to save and restore a widget's geometry between application sessions.

Changing Geometry

It is possible to move a widget around within its parent using the methods move(int x,int y) and move(Qt::Point). You can also resize a widget using the methods resize(int x,int y) and resize(Qt::Size).

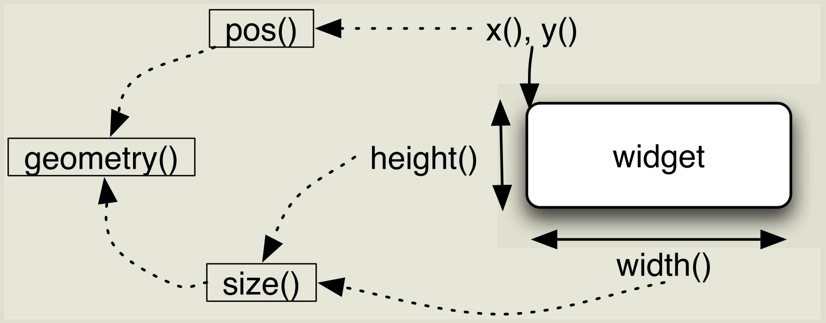


Figure 5.2: Widget Geometry

To perform both operations at the same time, use the methods setGeometry(int x,int y,int h, int w) or setGeometry(Qt::Rect).

5.3 Understanding Layouts

As we've seen, we can set the widget size and position within its parent manually. However, manual geometry management of widgets is tough. Each application is only given a select amount of screen real estate to work with and each widget in that application has to have its geometry managed. If a parent widget gets resized smaller, for example, at least one child will need to be resized as well, or some clipping of the child will occur.

Fortunately, QtRuby comes with a rich set of layout management classes which greatly simplify this task.

The class Qt::Layout is at the heart of layout management. Qt::Layout provides a very robust interface for management of widget layout. In many cases, there is no need for the complex interface provided by Qt::Layout. For the simpler cases, QtRuby provides three conve-

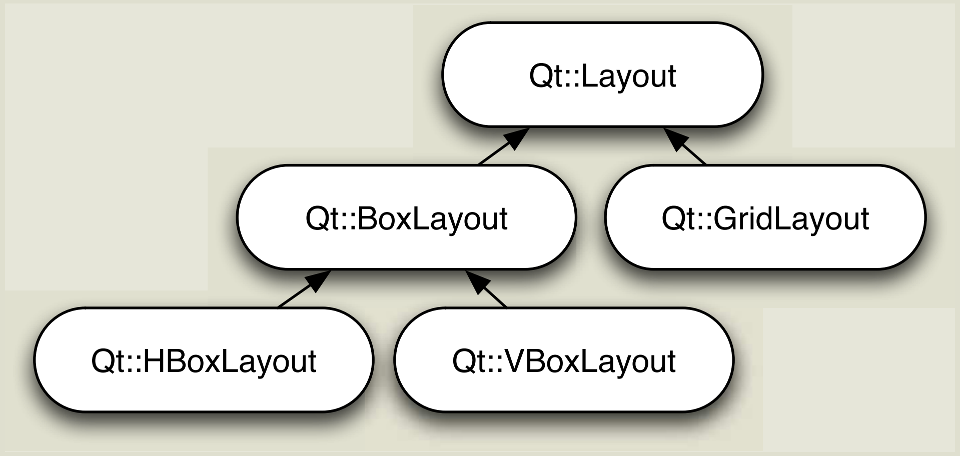


Figure 5.3: Layout class inheritance diagram

nience classes based on Qt::Layout: Qt::HBoxLayout, Qt::VBoxLayout, and Qt::GridLayout.

The Qt Layout Classes guide gives some more insight into the use of these classes.

Layout classes

The BoxLayout classes handle laying out widgets in a straight line (vertically with Qt::VBoxLayout or horizontally with Qt::HBoxLayout). To utilize a BoxLayout class, simply create an instance of whichever layout is desired and use its addWidget() method to add widgets into the layout.

Alternatively, the Qt::GridLayout allows you to place widgets into a grid as shown in Figure 5.4, on the next page.

```
w = Qt::Widget.new(nil)
gl = Qt::GridLayout.new(3,4) # 3 rows by 4 columns
# put w into the first row and column
```

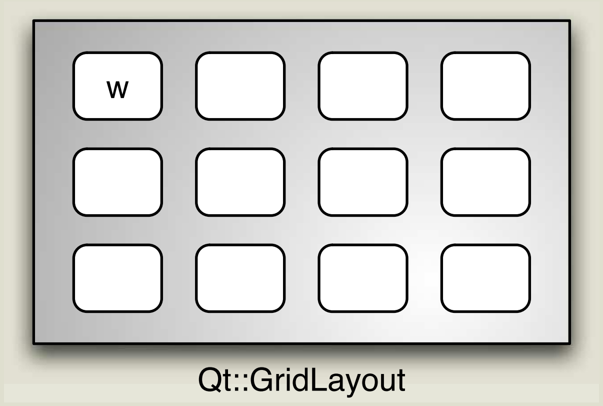


Figure 5.4: Qt::GridLayout Example

```
gl.addWidget(w, 0, 0)
```

Sublayouts

Layouts can also have sublayouts contained within them. For example this code creates a sublayout as shown on Figure 5.5, on the following page.

```
@layout = Qt::HBoxLayout.new

@sublayout = Qt::VBoxLayout.new
@w1 = Qt::Widget.new
@w2 = Qt::Widget.new
@w3 = Qt::Widget.new

@sublayout.addWidget(w1)
@sublayout.addWidget(w2)

@layout.addLayout(@sublayout)
@layout.addWidget(@w3)
```

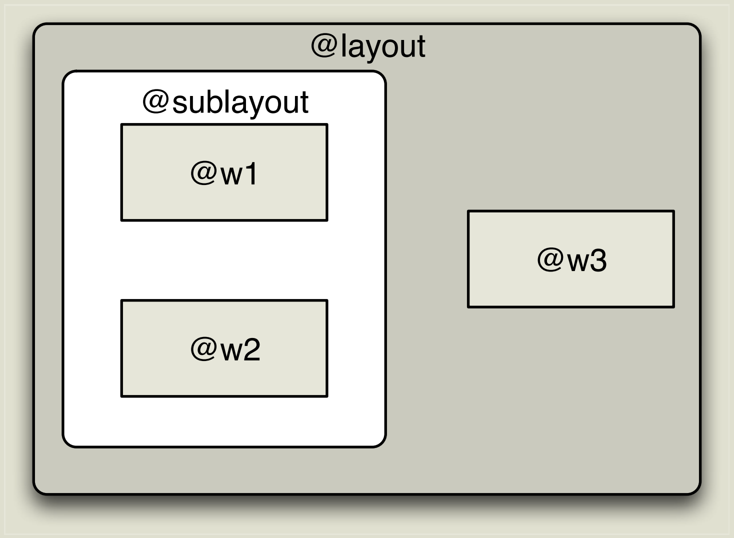


Figure 5.5: Layout and Sublayout Example

In Figure 5.6, on the next page we demonstrate why sublayouts are convenient. On the left side we created a Qt::VBoxLayout containing three Qt::CheckBoxes. Then we nested this layout inside of a Qt::HBoxLayout and also put in a Qt::Dial. As you can see, the sublayout allows us to group related items together in a logical way and maintain the size and spacing policies we desire.

Layout properties

All layouts have two fundamental properties, margin and spacing. These are shown on Figure 5.7, on page 43. *Spacing* represents the pixel space between each of the items within the layout. *Margin* represents an outer ring of pixel space surrounding the layout. Both are settable properties using the setMargin() and setSpacing() methods.

In lieu of adding a widget or a sublayout into a Qt::Layout, there are

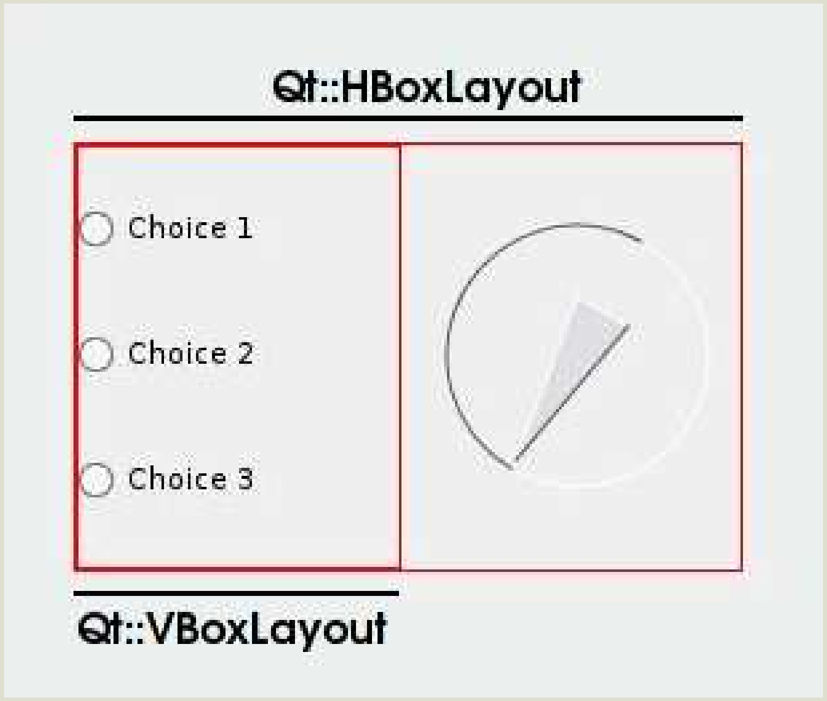


Figure 5.6: A Layout with a Nested Sublayout

some other interesting additions. addSpacing() allows you to add a fixed amount of space directly in the widget. addStretch() adds a stetchable space in the widget.

We highly recommend using the layout classes over manual manipulation of widget geometry.

Sizing up the situation

Layouts only define the placement of objects, not the space that they are allotted. From an outside perspective it may seem as though all of the widgets should take up a proportionate amount of space based on how many other widgets are in the layout. This layout style, though, is not always ideal.

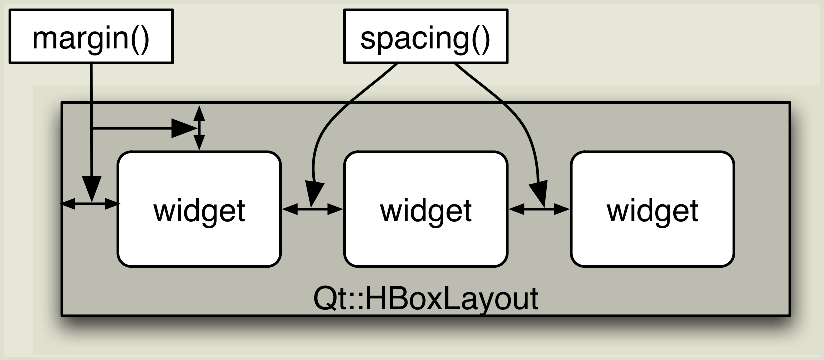


Figure 5.7: Layout Margin and Spacing

Enter Qt::SizePolicy. This class, which is also a settable property of Qt::Widget (using the setSizePolicy() method), contains the information a widget uses to determine the amount of space it will take up inside a layout. When coupled with all of the other widgets in the layout, the SizePolicies are all calculated and a final overall layout is achieved.

Each size policy utilizes a calculated geometry called a sizeHint(). The sizeHint()is a method built into Qt::Widget which calculates the recommended size of the widget. A sizeHint() is calculated based on the design of the widget. For example, a Qt::Label's sizeHint() is calculated based on the text that is written on the label. This is to help ensure that all of the text always fits on the Qt::Label.

The sizeHint() method returns a Qt::Size object, which is nothing more than an encapsulated set of width and height properties.

```
irb(main):001:0> require 'Qt'
=> true
irb(main):002:0> app = Qt::Application.new(ARGV)
=> #<Qt::Application:0xb6adfb24 name="irb">
irb(main):003:0> Qt::Label.new("Blah",nil).sizeHint
=> #<Qt::Size:0xb6adc44c width=30, height=17>
irb(main):004:0> Qt::Label.new("BlahBlahBlahBlahBlah",nil).sizeHint
=> #<Qt::Size:0xb6ad86bc width=142, height=17>
```

The above shows that a sizeHint() for a Qt::Label is dependent on the text being displayed on the label.

There are seven types of size policies:

Qt::SizePolicy	Size Minimum	Size Maximum	Size Preferred
Fixed	sizeHint()	sizeHint()	sizeHint()
Minimum	sizeHint()	none	sizeHint()
Maximum	none	sizeHint()	sizeHint()
Preferred	none	none	sizeHint()
Minimum-Expanding	sizeHint()	none	all available space
Expanding	none	none	sizeHint(), will expand as necessary
Ignored	none	none	all available space

These Qt::SizePolicy types are set independently for both the horizontal and vertical directions.

In Figure 5.8, on the next page we show two different ways of sizing widgets within the same layout. On the left side, we set the vertical Qt::SizePolicy of each of the contents to MinimumExpanding, which equalizes the spacing of all of the widgets. On the right, we set the Qt::SizePolicy of the two widgets to Preferred, which only takes up the amount of space the widget internally calculates that it needs. The spacer at the top has a Qt::SizePolicy of Expanding, which allows it to take up the rest of the space available in the layout.

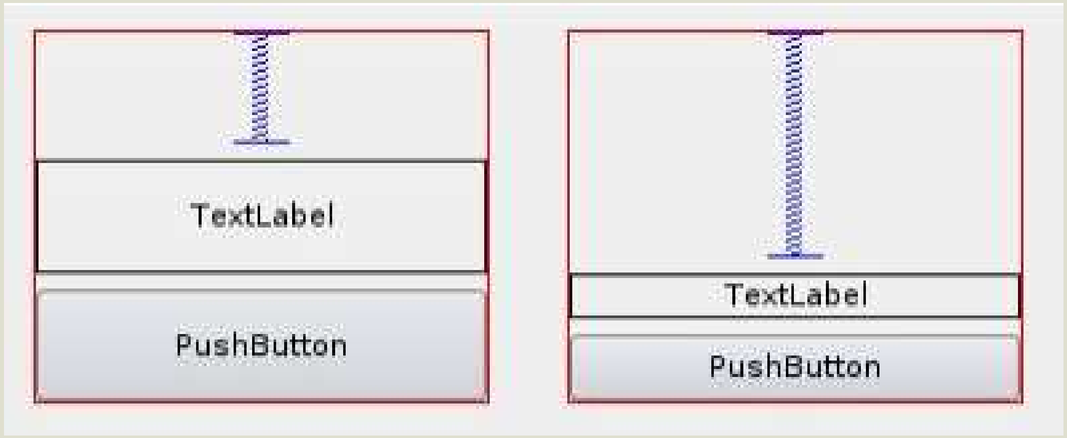


Figure 5.8: Same Layout, Two Different Size Policies

5.4 Automating a task

In our example program at the beginning of the chapter there was an initialization of the text on @label to how many times the button has been clicked.

```
@clicked_times = 0

@label.setText("The button has been clicked " +
    @clicked_times.to_s + " times")
@button.setText("My Button")
```

Note: We could have avoided these calls to setText() by using the initializers that set the text for us.

But, any further clicks on the button do not change the text of label. Using QtRuby's concept of signals and slots, we can change this behavior.

The first step is to define a method in our MyWidget class that handles updating the label text each time the button gets clicked.

```
def button_was_clicked
```

```
  @clicked_times += 1

  @label.setText("The button has been clicked " +
      @clicked_times.to_s + " times")
end
```

What we want to do next is call this method any time that @button is clicked. Widget events, like the clicking of @button, are referred to as widget *signals*. The reactionary methods that we want to happen when these signals take place are called *slots*. By *connect*ing these signals and slots together, we can automate the process of having @label update its text.

Slots are nothing more than ordinary methods that we've specified as being QtRuby slots using the slots call. In Qt programs, slots get *connected* to signals in order to automate tasks. See Section 5.5, *Signals and Slots*, on the following page for more details.

Before we get too far into signals and slots, let's go back to our program to see just how easy using them really is. In order to take advantage of the automation, we need to define exactly what is a signal and what is a slot. Since our @button widget is a built in Qt::PushButton, its clicked() signal is already defined for us. However, the slot we will be connecting it to, button_was_clicked() has not been defined as a slot. A simple line in our MyWidget class handles that for us:

```
slots 'button_was_clicked()'
```

And last, in the MyWidget initializer, we need to connect the signal and slot together:

```
connect(@button, SIGNAL('clicked()'),
  self, SLOT('button_was_clicked()'))
```

When put all together, our final program looks like this:

```
require 'Qt'
class MyWidget < Qt::Widget
  slots 'button_was_clicked()'
  def initialize(parent=nil)
```

```
    super(parent)
    @label = Qt::Label.new(self)
    @button = Qt::PushButton.new(self)
    @layout = Qt::VBoxLayout.new(self)
    @layout.addWidget(@label)
    @layout.addWidget(@button)
    @clicked_times = 0

    @label.setText("The button has been clicked " +
        @clicked_times.to_s + " times")
    @button.setText("My Button")

    connect(@button, SIGNAL('clicked()'),
      self, SLOT('button_was_clicked()'))

  end

  def button_was_clicked
    @clicked_times += 1

    @label.setText("The button has been clicked " +
        @clicked_times.to_s + " times")
  end

end

a = Qt::Application.new(ARGV)
mw = MyWidget.new
a.setMainWidget(mw)
mw.show
a.exec
```

5.5 Signals and Slots

C# users will find that Qt's signals and slots are very similiar to delegates from that language.

The example from the previous section showed how the connection of signals and slots can be harnessed to create dynamic applications. In this section, we will explore the concept of signals and slots even further.

Signals are triggers that happen in response to some kind of event. A widget whose signal has been activated is said to be *emitting* its signal. Usually, signals are emitted when a very simple event has occured, such as the clicking of a button. Most widgets emit multiple types of signals to inform other widgets that an event has occurred. For example, a Qt::LineEdit, which is a one line text editor, emits signals when the text has changed, the return key was pressed, someone selects text with the mouse, or when the widget loses focus (see Figure 5.9, on the next page).

Losing focus means that the mouse was clicked elsewhere in the application or a keyboard shortcut was used that gave another widget the *focus*

Some signals convey all of their information within their names. The returnPressed() signal from the Qt::LineEdit, for example, explains exactly what happened (the return key was pressed) when that signal is emitted. Other signals, like Qt::LineEdit's textChanged() signal, tell us that the text has changed, and also contain the text that has changed in the signal.

The QString class is Qt's internal string class. QtRuby handles the conversion between Qt's QString and Ruby's String automatically.

This extra signal information is passed as an argument to the signal. In this case, the method signature is textChanged(const QString &). When the signal gets emitted, this extra information goes with it.

An emitted signal that is connected to no slots simply vanishes into thin air.

Slots, the things we connect signals to, are ordinary methods within a widget class. Defining these methods as slots creates the ability to use signals to activate these slot methods automatically.

Signals and Slots—The Connection

Signals and slots are connected together using the connect() method defined in the Qt::Object class. The syntax of the connect() is:

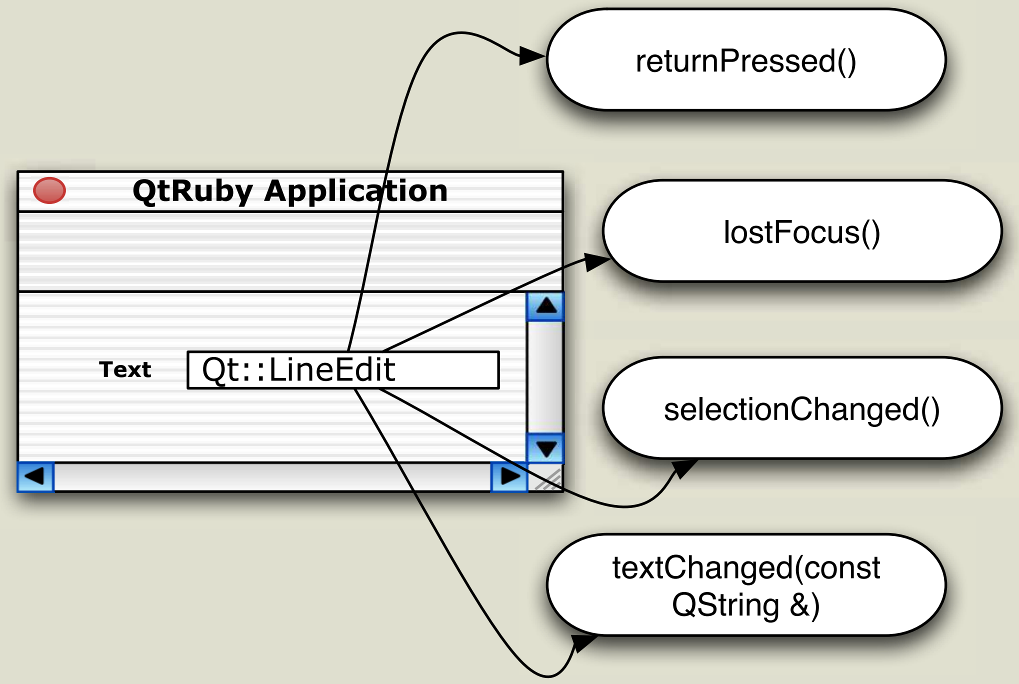


Figure 5.9: Qt::LineEdit signals

The code snippets in this section demonstrate the syntax of making signal and slot connections. Remember, as we discussed in Chapter 4, *Get Your Feet Wet*, on page 19, a full Qt program will need a few more things set up (such as an instance of the Qt::Application class).

```
connect( object_with_signal, SIGNAL( 'signalName()' ),
         object_with_slot, SLOT( 'slotName()' ) )
```

This syntax works as long as the connect() method is being used from within an object that inherits from Qt::Object. To make connections outside of a Qt::Object class, the method must be called more explicitly:

```
Qt::Object::connect( object_with_signal, SIGNAL( 'signalName()' ),
  object_with_slot, SLOT( 'slotName()' ) )
```

The most basic form of connection is between a signal and slot that have no arguments. For example, the following code causes

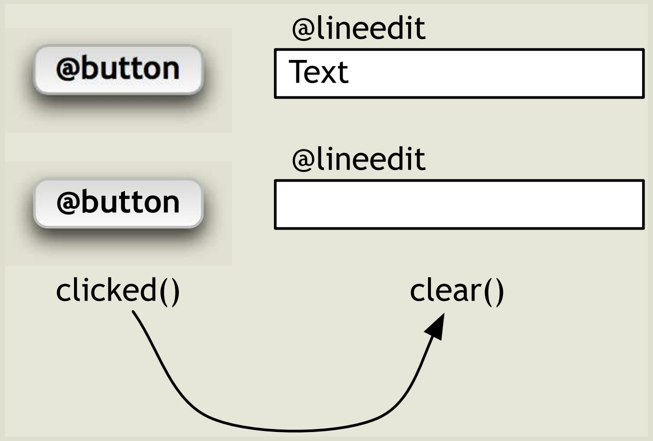


Figure 5.10: Simple Slot Connection

a Qt::LineEdit to clear when a Qt::PushButton is clicked (as seen in Figure 5.10).

If you misspell a signal or slot name during connection QtRuby will generate a runtime error message on the application's standard error file descriptor.

```
@button = Qt::PushButton.new
@lineedit = Qt::LineEdit.new
Qt::Object::connect( @button, SIGNAL( 'clicked()' ),
  @lineedit, SLOT( 'clear()' ) )
```

Signals and slots with arguments connect in the exact same way, as long as their arguments are of the same type (as seen in Figure 5.11, on the following page).

```
@lineedit = Qt::LineEdit.new
@label = Qt::Label.new
Qt::Object::connect( @lineedit,
   SIGNAL( 'textChanged(const QString &)' ),
   @label,
   SLOT( 'setText(const QString &)' ) )
```

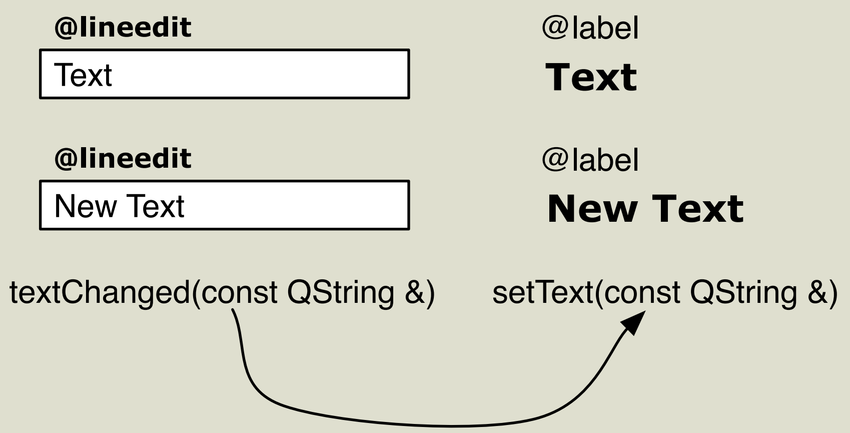


Figure 5.11: Slot Connection with Arguments

Note that in the above example, the SIGNAL and SLOT arguments are listed using the Qt style syntax like `textChanged(const QString &)` and not the QtRuby style syntax like `textChanged(const Qt::String)` . This detail is very important. While QtRuby handles the conversion of Qt's `QString` to Ruby's `String` automatically, the definition of signals, slots, and the connection of the two must utilize the Qt style syntax. This is a QtRuby limitation, and is anticipated to be fixed in a later release of the toolkit.

When connecting signals and slots, the Qt style syntax (*not* the QtRuby style syntax) is used. The method names and arguments are passed as strings wrapped by either SIGNAL() or SLOT().

More advanced connections

Another feature of signals and slots is the ability to connect a signal to more than one slot. Consider this code (the resulting structure is outlined in Figure 5.12, on the next page):

```
@lineedit_1 = Qt::LineEdit.new
@lineedit_2 = Qt::LineEdit.new
```

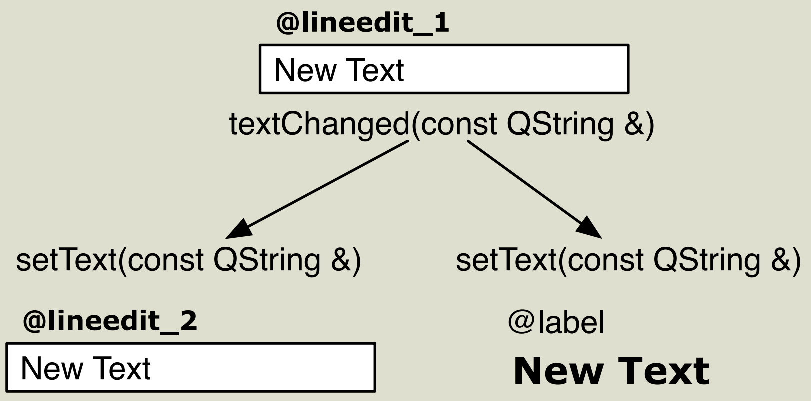


Figure 5.12: Signal to Multiple Slot Connection

```
@label = Qt::Label.new
Qt::Object::connect( @lineedit_1,
   SIGNAL( 'textChanged(const QString &)' ),
   @label,
   SLOT( 'setText(const QString &)' ) )
Qt::Object::connect( @lineedit_1,
   SIGNAL( 'textChanged(const QString &)' ),
   @lineedit_2,
   SLOT( 'setText(const QString &)' ) )
```

One caveat to multiple slot connections is that there is no defined order in which the slots are executed. That is, the order in which you make the connections is not guaranteed to be the order in which the slots are called.

When a signal is emitted, the order that the connected slots are executed in is arbitrary.

It's also okay to connect a signal to another signal (as shown on Figure 5.13, on the following page).

```
@lineedit_1 = Qt::LineEdit.new
@lineedit_2 = Qt::LineEdit.new
@label = Qt::Label.new
```

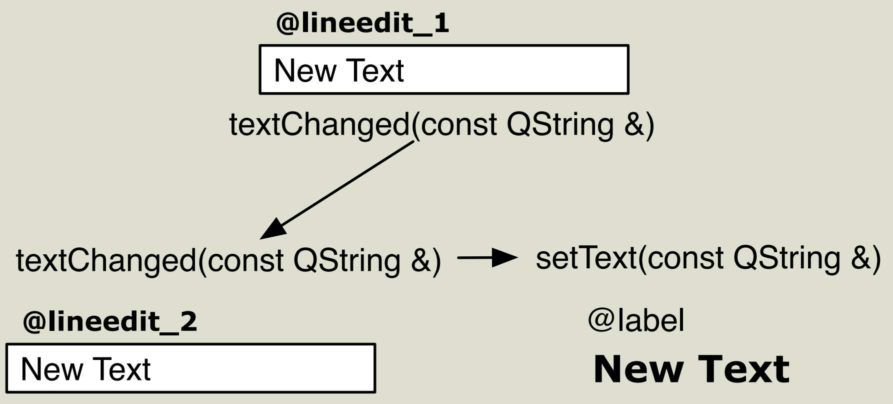


Figure 5.13: Signal to Signal Connection

```
Qt::Object::connect( @lineedit_1,
   SIGNAL( 'textChanged(const QString &)'  ),
   @lineedit_2,
   SIGNAL( 'textChanged(const QString &)' ) )
Qt::Object::connect( @lineedit_2,
   SIGNAL( 'textChanged(const QString &)' ),
   @label,
   SLOT( 'setText(const QString &)' ) )
```

This syntax allows one signal to trigger another signal, which then would trigger any slots connected to the second signal.

You can even connect to a slot which takes fewer arguments:

```
@lineedit = Qt::LineEdit.new
@bar = Qt::StatusBar.new
Qt::Object::connect( @lineedit,
   SIGNAL( 'textChanged(const QString &)' ),
   @bar,
   SLOT( 'clear()' ) )
```

The information that would normally be passed via the signal argu-

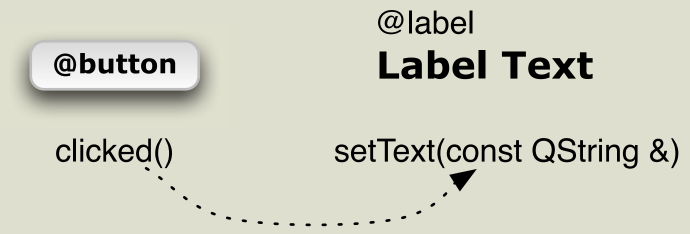


Figure 5.14: Slot Connection with mis-matched arguments

ment is discarded.

However, the opposite is not true:

```
@button = Qt::PushButton.new
@label = Qt::Label.new

# This doesn't work
Qt::Object::connect( @button, SIGNAL( 'clicked()' ),
   @label, SLOT( 'setText(const QString &)' ) )
```

The above code generates the following error which is displayed during runtime:

```
QObject::connect: Incompatible sender/receiver arguments
Qt::PushButton::clicked() --> Qt::Label::setText(const QString &)
```

Disconnecting Signals and Slots

Signal/slot connections can also be disconnected via the same syntax:

```
@button = Qt::PushButton.new
@bar = Qt::StatusBar.new
Qt::Object::connect( @button, SIGNAL( 'clicked()' ),
   @bar, SLOT( 'clear()' ) )
# Perform a disconnection
```

```
Qt::Object::disconnect( @button, SIGNAL( 'clicked()' ),
   @bar, SLOT( 'clear()' ) )
```

Tying it all together

The power with signals and slots lies in their flexibility. Signals can be used from existing widgets, or created in new widgets. New slots can be made in custom widgets that mask internal child widgets. Most importantly, these signals and slots cross widget boundaries and allow us to encapsulate child widgets through a parent widget interface.

Let's see it in action. Consider this class:

```
class MyTimer < Qt::Widget
  signals 'tripped_times_signal(int)'
  slots 'timer_tripped_slot()'

  def initialize(parent)
    super(parent)

    @timer = Qt::Timer.new(self)
    @label = Qt::Label.new(self)
    @tripped_times = 0

    connect(@timer, SIGNAL('timeout()'),
      self, SLOT('timer_tripped_slot()'))
    # Make the timer trip every second (1000 milliseconds)
    @timer.start(1000)
  end

  def timer_tripped_slot()
    @tripped_times += 1;
    @label.setText("The timer has tripped " +
      @tripped_times.to_s + " times")
```

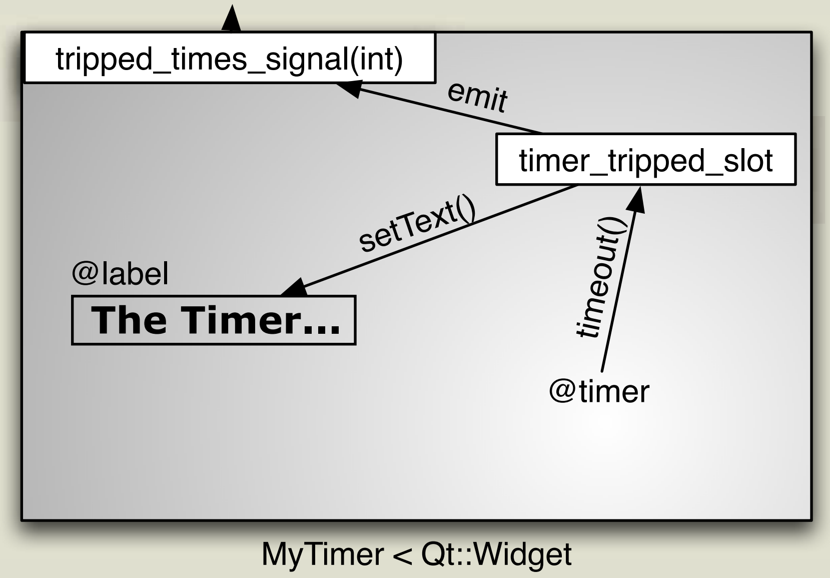


Figure 5.15: Custom Widget with Signals and Slots

```
    emit tripped_times_signal(@tripped_times)
  end

end
```

Qt::Timer is a very convenient class for repeatedly calling a slot at a certain frequency. In most cases, a Qt::Timer can be accurate to 1 millisecond.

In this example, we create a Qt::Timer that gets activated every second (1000 milliseconds). Each time @timer is activated, its timeout() signal is emitted. We've connected the timeout() signal to the timer_tripped_slot() slot. This slot updates the text on the label to reflect the total number of times the timer has tripped. The slot also emits the tripped_times_signal(), telling how many times the timer has tripped. The MyTimer does not make use of the tripped_times_signal() signal, but an external class might use that information by connecting the signal to one of its slots. We highlight this code example on Figure 5.15 .

5.6 Slot Senders

Sometimes during a slot it is useful to know how the slot got started. The sender() returns the Qt::Object which was responsible for the slot call. The sender() method only works for a slot when it was activated by a signal—manually calling the slot does not work.

Consider the following code:

```
require 'Qt'

class SignalObject < Qt::Object
  signals 'mySignal()'

  def initialize(parent=nil)
    super(parent)
  end

  def trigger
    emit mySignal()
  end

end

class SlotObject < Qt::Object
  slots 'mySlot()'

  def initialize(parent=nil)
    super(parent)
  end

  def mySlot
    puts "Slot called by #{sender.class}"
  end
end

sig  = SignalObject.new
```

```
slot = SlotObject.new

Qt::Object::connect(sig, SIGNAL('mySignal()'),
  slot, SLOT('mySlot()') )
```

Now look at the effects on the sender() method in a slot when it's activated by a signal:

```
irb(main):001:0> sig.trigger
Slot called by SignalObject
```

versus when it's called manually:

```
irb(main):002:0> slot.mySlot
Slot called by NilClass
```

5.7 Summary

- Custom widgets should inherit from base class Qt::Widget.
- Widgets have a two-dimensional geometry. This geometry can be set manually or handled automatically through layouts.
- Widgets define signals that are emitted when certain spontaneous events occur. They also define slots which are reactionary methods that can be connected to these signals.
- Widget slots can use the sender() method to find out how they were activated.

Chapter 6

Sink or Swim

At this point, we've really tackled most of the concepts needed to make a robust QtRuby application. However, there's still a bit more to do.

6.1 Event Methods

Our earlier discussion about event driven programming led into the concept of signals and slots. But there's more to events than just signal emission. Remember, in the GUI world, events are the underlying paradigm of the program operation.

It turns out that many of the these GUI events are so important that they are handled in a much more direct way than just as an emitted signal. Instead, there are *event methods* which are directly called within a Qt::Widget object.

Qt::Widget based classes have many specialized event methods for handling most of the common events that can happen in a GUI application. See Appendix A, on page 88 for an overview.

One event from start to finish

For the moment, let's look at one type of event: the mouse press. When a mouse button is pressed the following series of things happens:

Obviously, the mouse press event has to happen within the geometry of our application. Clicking the mouse elsewhere on the screen has no effect on our program.

1. The window system recognizes the mouse press, and passes the mouse information to the QtRuby application.
2. The application uses the information to create a Qt::MouseEvent object, containing information about which button was pressed and the location of the mouse when the button was pressed.

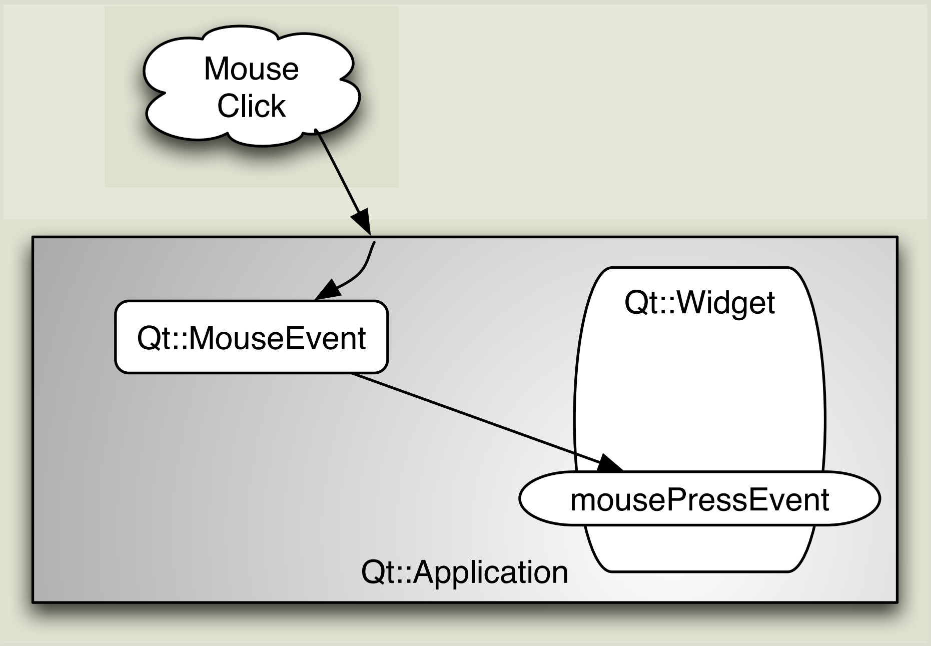


Figure 6.1: A Mouse Event delivered to a Qt::Widget

3. The application then determines which widget the mouse was directly on top of when the button was pressed. It dispatches the Qt::MouseEvent information to this widget's mousePressEvent() method.

4. The widget chooses what do to at this point. It can act on this information, or can ignore it. If it ignores the information, the Qt::MouseEvent then gets sent on to the parent of the widget, to be acted upon.

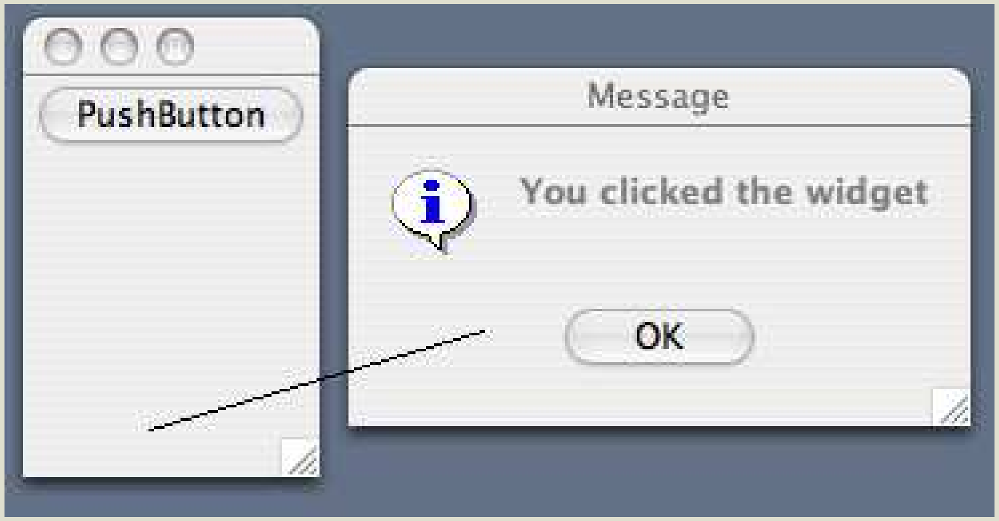
5. The Qt::MouseEvent continues up the hierarchy until a widget accepts the event, or it reaches the top level and cannot go any further.

An Example of Qt::MouseEvent

```
require 'Qt'

class MouseWidget < Qt::Widget

  def initialize(parent=nil)
    super(parent)
    @button = Qt::PushButton.new("PushButton", self)
    @layout = Qt::VBoxLayout.new(self)
    @layout.addWidget(@button)
    @layout.addStretch(1)
  end

  def mousePressEvent(event)
    if(event.button == Qt::RightButton)
      Qt::MessageBox::information(self,"Message",
        "You clicked the widget")
    else
      event.ignore
    end
  end

end

app = Qt::Application.new(ARGV)
mw = MouseWidget.new
app.setMainWidget(mw)
mw.show
app.exec
```

In this example the MouseWidget has implemented the mousePressEvent(Qt::MouseEvent) method, meaning that it wishes to handle this mouse event internally (see Figure 6.2, on the next page).

The MouseWidget checks the mouse button that was pressed to start the event—if it was the right (as opposed to the left) button, then



You clicked the widget

Figure 6.2: MousePressEvent Override Snapshot

it pops up a message. Otherwise, it ignores the event, which then would get passed on to the parent (if there was one).

When creating a custom event method, such as mousePressEvent(), it's important to remember that you are overriding the base class method with your own. If your goal is not to replace the base class functionality, but to extend it, then you must be sure to call the base class event method from within your event method.

The mousePressEvent() only gets invoked for presses in the empty space of the MouseWidget, however. Notice that the MouseWidget also contains a Qt::PushButton, but if that Qt::PushButton gets pressed, it has its own internal handling of the mousePressEvent(), and the MouseWidget never sees a mousePressEvent().

More methods

Obviously, there are more event classes than just Qt::MouseEvent. Qt::Widget also has specialized handlers for these events. We've created a chart to overview the event methods and handlers available in QtRuby in Appendix A, on page 88

We've seen how to create event methods that are invokeded automatically when certain events happen. Another powerful aspect of the QtRuby toolkit is the ability to install *event filters* between objects.

6.2 Event Filters

Event filters allow objects to listen in to and intercept events from other objects. To create an event filter, we use the installEventFilter() method that is part of Qt::Object.

```
object_to_be_filtered.installEventFilter( intercepting_object )
```

With this syntax, all of object_to_be_filtered's events get sent directly to intercepting_object's eventFilter().

The eventFilter() method has two arguments, the Qt::Object that is being filtered and the Qt::Event that was received. With this information, the eventFilter() method can intercept the event and perform the desired action.

If eventFilter() returns true, the event is considered to have been successfully intercepted. Otherwise, the event will continue to propogate through the normal event handling chain. We show the event filter logic on Figure 6.3, on the next page.

Here's an example of an event filter:

```
require 'Qt'

class MouseFilterWidget < Qt::Widget

  def initialize(parent=nil)
    super(parent)
    @button = Qt::PushButton.new("PushButton", self)
    @layout = Qt::VBoxLayout.new(self)
    @layout.addWidget(@button)
```

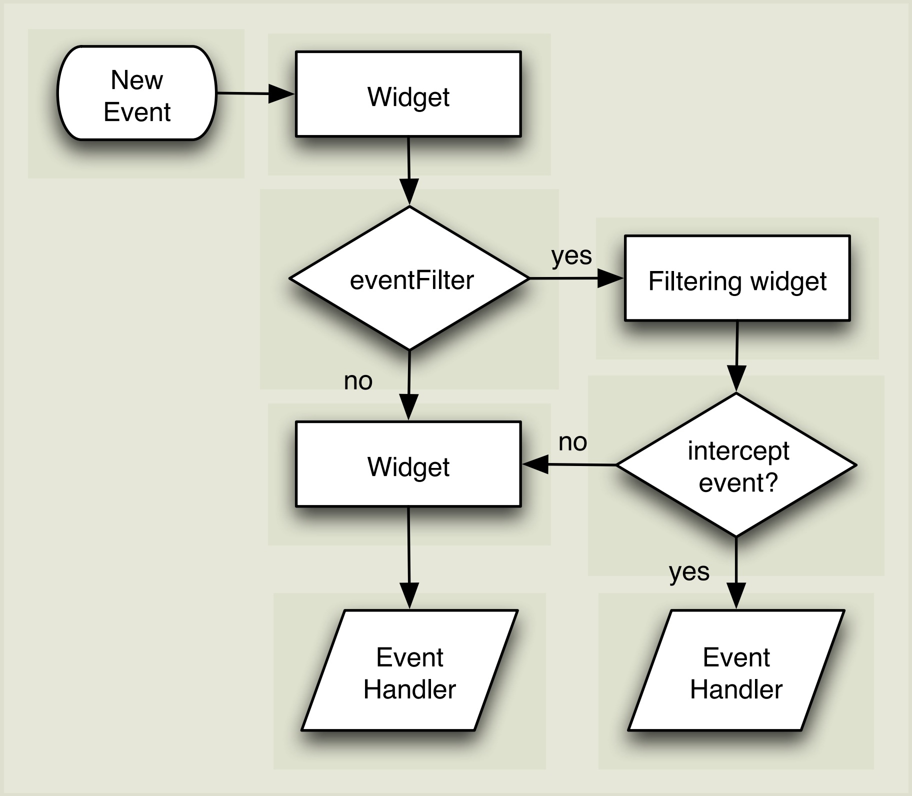


Figure 6.3: Event Filter Flow

```
  @layout.addStretch(1)

  # Override events for the button
  @button.installEventFilter(self)
end

def eventFilter(obj,event)
  if(obj == @button && event.type == Qt::Event::MouseButtonPress)
    if(event.button == Qt::RightButton)
      Qt::MessageBox::information(self,"Message",
        "You right clicked the button")
```

```
          return true
        end
      end
    end

end

app = Qt::Application.new(ARGV)
mw = MouseFilterWidget.new
app.setMainWidget(mw)
mw.show
app.exec
```

This code installs an event filter on a Qt::PushButton referenced by @button. The eventFilter() method then checks if we've received a button press for the @button and if it's the right mouse button, display a message. Otherwise, event handling occurs as normal. This means that a left button click results in the same thing that would normally happen—the button accepts the click.

6.3 The Main Event

The event methods we've seen so far are specialized event methods that get called for specific types of events. Qt::Object also has a generic event method, which handles the dispatching of the specialized events. This method, aptly named event(), can also be overridden to provide customized behavior. Qt::Widget overrides this method to handle GUI related events.

Thus, the overall logic of a widget's event handling is as follows:

1. A new event (Qt::Event) is created, and gets passed to the event() method.

Which event methods to override is up to you. The specialized event methods are higher level and easier to implement, but less flexible than the low level event().

2. Assuming that the default event() method has not been overridden, Qt::Widget's event() method is executed. Otherwise, the custom event() method is called.
3. The default event() checks for any installed event filters, and sends the event to the filter if installed.
4. If the event is intercepted, then we're done. Otherwise, event() determines what type of Qt::Event it's processing, and converts the Qt::Event into the a new class (such as Qt::MouseEvent).
5. The proper specialized event method then gets called (in this case, that's mousePressEvent()).

6.4 The Event Loop

When a new event occurs, the QtRuby application does not act on it immediately. Instead, the event goes into a waiting queue. The mandatory Qt::Application object is the keeper of this event queue. Periodically, Qt::Application checks this queue and dispatches the pending events to their proper places. These events are referred to as *asynchronous* events. This cycle of storing the events and then acting on them is referred to as the *event loop*.

One advantage to posting events in the event loop is that repeated events, such as multiple repaint requests, are folded into one event. This saves processing time.

A typical QtRuby program has only one thread of execution. This means that when the Qt::Application is ready to act on the queued events, it must dispatch all of them to the proper objects before it can come back to handle the next batch. Ideally, this process happens very quickly. If, however, your program has some computationally intensive code, such as the opening of a large file, this could lead to a slowdown of the event loop processing.

If your application spends a large amount of time handling a certain event it may become unresponsive to other events that occur later. To a user of a GUI program, this unresponsiveness is highly undesirable. For example, if you click on the mouse, you want the receiving widget to act relatively fast. Waiting a few seconds for the widget to respond to the mouse click is usually unacceptable.

Maintaining a Responsive Application

There are a few ways to keep the application responsive. One is to use threads. In the Qt world, it is possible to create a separate thread of execution using a QThread. Unfortunately, a compatible Qt::Thread class doesn't exist in the QtRuby toolkit. We hope that a future version of QtRuby will include one.

An alternative is to use Ruby's Thread *class and break the operation into multiple threads of control.*

Another common method of maintaining a responsive application is to break the intensive computation up into smaller segments and use a Qt::Timer to periodcally trigger a slot that does a small amount of the work. This method keeps the application responsive to events and also allows a good portion of work to continue on in the background.

```
# Bad
def someSlot()
  really_expensive_computation()
end

# Better
timer = Qt::Timer.new(self)
connect(timer, SIGNAL('timeout()'), self, SLOT('someSlot()'))
timer.start(100) # Trigger the timer every 100 milliseconds

def someSlot()
```

```
  small_portion_of_expensive_computation()
end
```

6.5 Event posting

Sometimes we want to generate our own events to send to other objects. The easiest way uses Qt::Application's postEvent() method. This takes the event and receiver that you define and puts the event in the event queue.

```
button = Qt::PushButton.new(nil)
# Construct a Qt::MouseEvent
event = Qt::MouseEvent.new(
  Qt::Event::MouseButtonPress,
  Qt::Point.new(0,0),
  Qt::LeftButton,
  0 )

# Send the event to button, asynchronously
Qt::Application::postEvent(button,event)
# Continue on - the mouse event will be sent later
```

The event loop takes control of the event once you post it. Thus, any event you construct and send to an object via postEvent() becomes the property of the event loop. You shouldn't attempt to use the same event again. Construct a new event, if necessary.

It's also possible to *synchronously* send an event directly to another object using the sendEvent() method. This works just like postEvent(), except there is no delay—the event is handled immediately.

```
# Send the event to button, synchronously
Qt::Application::sendEvent(button,event)
```

```
# At this point, button has already received the mouseEvent
```

sendEvent() returns a boolean value specifying whether the object accepted the event or not.

postEvent() is favored over sendEvent(), because it allows the event system to work asynchronously.

6.6 Summary

- Widgets have a collection of event methods (mousePressEvent(), resizeEvent(), . . .) that get called when these certain events happen to the widget.
- Widgets can choose to ignore events, in which case the event gets sent on to the widget's parent.
- Widgets can intercept and filter events that were destined to go to other widgets.
- New events can be posted directly into the event queue. They can be created both synchronously and asynchronously.

Chapter 7

Home Stretch

7.1 Qt Modules

Qt comes with a set of extra modules also available through QtRuby. Some of these modules are not directly GUI related, but useful functions for many GUI applications.

There is an overlap of functionality between these Qt modules and the libraries and modules that come with Ruby. In some instances, it may make more sense to use the Ruby libraries instead of the Qt ones. In other cases, the QtRuby classes may integrate easier with your QtRuby application, because of their built in signal and slot methods.

Network Module

The network module simplifies network programming. There are three levels of classes available in the module.

- *Low level*—classes such as Qt::Socket and Qt::ServerSocket, a TCP client and TCP server, respectively.
- *Abstract Level*—abstract classes such as Qt::NetworkOperation and Qt::NetworkProtocol that can be used to create subclasses that implement network protocols.
- *Passive Level*—classes such as Qt::Url which handles URL parsing and decoding.

SQL Module

The SQL module provides a database-neutral way of handling common SQL database operations: updates, inserts, and selects, and so on.

In order to be able to handle connections of a specific database, Qt has to be configured for that database during its initial setup. This is specified as a configure option, as noted in Section 2.4, *How to install Qt from source*, on page 8. This also requires database drivers to be present at configuration time.

XML Module

Qt provides interfaces to two XML parsers:

- *SAX2*—an event-based standard for XML parsing, and
- *DOM*—a mapping of XML to a tree structure

OpenGL Module

OpenGL is a standard API for creating three-dimensional objects. Qt provides a set of classes that support OpenGL drawing from within an appliation.

OpenGL support must be specified as a configure option, as noted in Section 2.4, *How to install Qt from source*, on page 8. This requires that the OpenGL libraries be present at configuration time.

Canvas Module

The Canvas module provides a two-dimensional blank canvas on which primitive geometric and text drawing structures can be created to form complex pictures.

Other GUI related modules

Qt also provides a number of GUI related modules:

- *Iconview*. Qt::IconView visualizes multiple items in icon form.
- *Table*. Qt::Table displays and edits tabular data.
- *Workspace*. Qt::Workspace can contain a number of windows.

7.2 QtRuby tools

QtRuby comes with a number of additional tools which can help you create custom GUI applications.

QtRuby UIC

One facet of Qt is Qt Designer, a GUI application that allows you to design custom widgets graphically.

Qt Designer generates .ui (user interface) files, which are XML files describing the widget properties. Qt's build system uses these .ui files to generate valid C++ code that gets compiled into the project. The Qt utility that does this is uic, or User Interface Compiler.

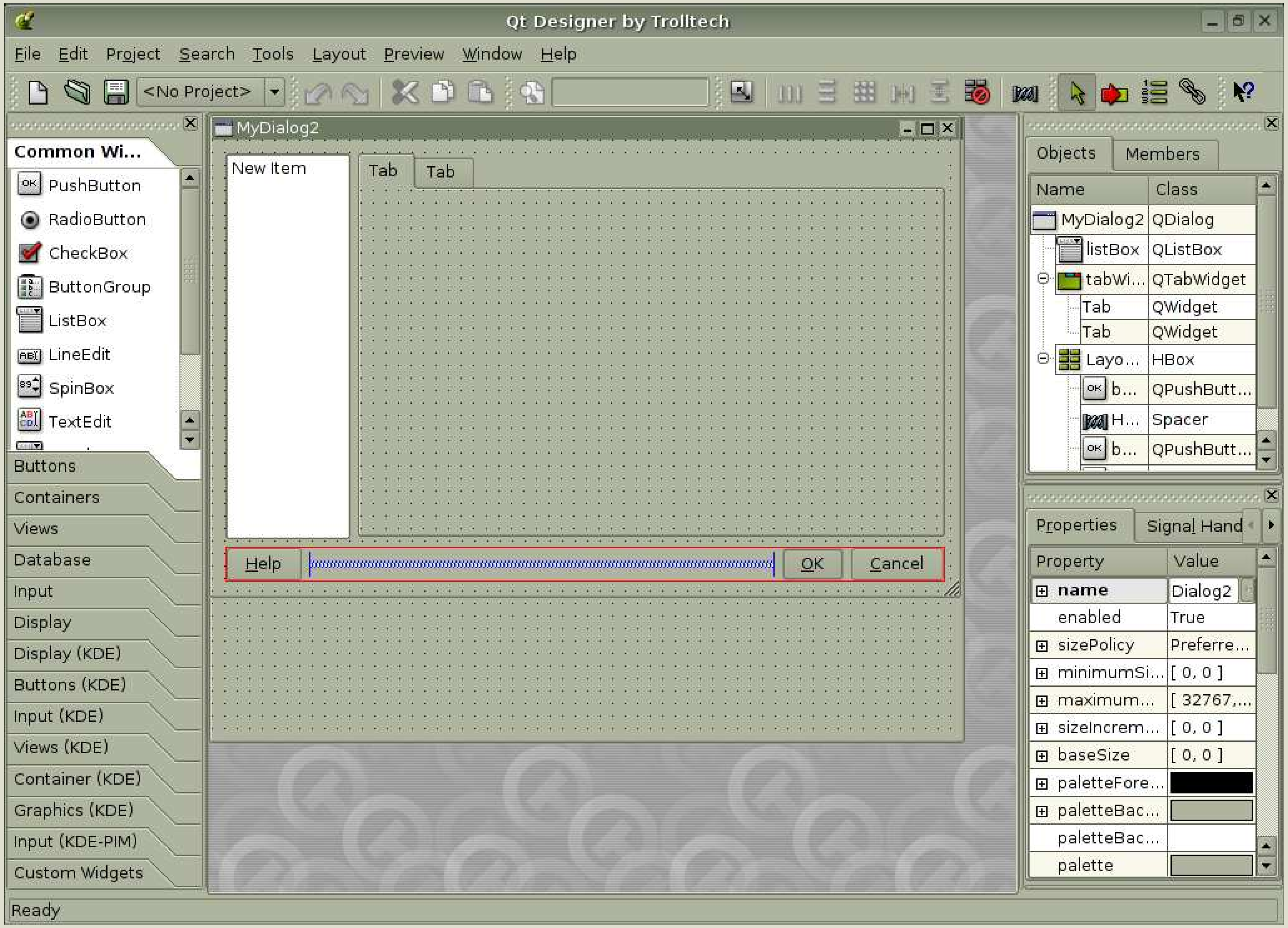
For GUI program design, we also recommend checking out Kommander, a graphical program similiar to Qt Designer.

QtRuby comes with the rbuic utility to generate Ruby code out of .ui files. To generate QtRuby code from a .ui file, use this syntax:

```
$ rbuic mywidget.ui -o mywidget.rb
```

You can use the -x switch to direct rbuic to generate the code to handle the creation of the Qt::Application.

```
$ rbuic mywidget.ui -x -o mywidget.rb
```



Name	Class
MyDialog2	QDialog
listBox	QListBox
tabWi...	QTabWidget
Tab	QWidget
Tab	QWidget
Layo...	HBox
b...	QPushButt...
H...	Spacer
b...	QPushButt...

Property	Value
name	Dialog2
enabled	True
sizePolicy	Preferre...
minimumSi...	[0, 0]
maximum...	[32767,...
sizeIncrem...	[0, 0]
baseSize	[0, 0]
paletteFore...	⬛
paletteBac...	▨
paletteBac...	
palette	▨

Figure 7.1: Screenshot of Qt Designer

This generates the Ruby code, and adds the following to the end of the file:

```
if $0 == __FILE__
    a = Qt::Application.new(ARGV)
    w = MyWidget.new
    a.setMainWidget(w)
    w.show
    a.exec
end
```

With this code in place, you're got a Ruby application that's ready to run:

```
$ ruby mywidget.rb
```

QtRuby API lookup

The rbqtapi command will look up methods available for a class in the QtRuby API.

```
$ rbqtapi QTimer
      QTimer* QTimer::QTimer()
      QTimer* QTimer::QTimer(QObject*)
      QTimer* QTimer::QTimer(QObject*, const char*)
      void QTimer::changeInterval(int)
      const char* QTimer::className() const
      ...
```

It's also possible to search for classes containing certain method names using the -r option.

```
$ rbqtapi -rsetName
     void QColor::setNamedColor(const QString&)
      void QDir::setNameFilter(const QString&)
      QDomNode QDomNamedNodeMap::setNamedItem(const QDomNode&)
      QDomNode QDomNamedNodeMap::setNamedItemNS(const QDomNode&)
      void QFile::setName(const QString&)
```

```
        void QObject::setName(const char*)
        void QSqlCursor::setName(const QString&)
        ...
```

7.3 Taking Advantage of Ruby

So far, in all of our discussion about QtRuby we've attempted to keep the syntax as close to pure Qt as possible. We've done this to keep the interface and examples similiar to what they would be had they been written in C++.

Now we're going to present some Ruby specific extensions to the language.

Qt object properties are typically written to using the setPropertyName() syntax. For example, the Qt::Application class has the method setMainWidget() which we've used in many previous examples

QtRuby simplifies this a little bit by allowing you to use the more Rubylike propertyName = syntax. This means that:

```
app = Qt::Application.new(ARGV)
app.setMainWidget(widget)
```

becomes:

```
app = Qt::Application.new(ARGV)
app.mainWidget = widget
```

Similiarly, methods with names beginning *is* or *has* can be changed into the more idiomatic predicate method form:

```
widget = Qt::Widget.new(nil)
widget.isTopLevel and puts "Widget is top level"
widget.hasMouse and puts "Mouse is over widget"
```

becomes:

```
widget = Qt::Widget.new(nil)
puts "Widget is top level" if widget.topLevel?
puts "Mouse is over widget" if widget.mouse?
```

Note that you can use either style in your QtRuby programs. The first style is more Qt like while the second is more Ruby like.

Your Choice of Case

As you may have noticed, Qt class methods use the camel case naming convention, with the first word always being lower case.

QtRuby also provides an interface (via Ruby's method_missing() functionality) to use an all lowercase notation with underscores between the words. For example, the following two lines of code are equivalent.

```
widget.someLongMethodName      # Qt way
widget.some_long_method_name   # ok in QtRuby
```

7.4 Disposing of Widgets

In a native C++ Qt program, widgets are created using the operator *new*, similiar to Ruby's new() initializer. However, since C++ lacks automatic memory management, it also has a *delete* operator which can destroy objects. Ruby has no such command, instead relying on garbage collection to remove objects which are no longer being referenced.

Note: The dispose() method is local to QtRuby and is not available in the Qt toolkit.

While this usually "just works," there are times when it is valuable to be able to destroy objects that are not lined up for garbage collection. QtRuby provides this ability with the *dispose* methods.

To free an object, use the dispose() method. You can also use the disposed?() method to see if an object has been disposed.

```
@parent = Qt::Widget.new(nil)
@child = Qt::Widget.new(@parent)

# Dispose the parent
@parent.dispose

# @child should be disposed if @parent was
@child.disposed? and puts "Child disposed"
```

7.5 Debugging a QtRuby Application

When things don't quite work right, you sometimes need the ability to view a little deeper within the goings-on of the toolkit to see exactly what is going wrong. QtRuby provides some debugging methods for this.

The most common problem by far is the unresolved method error:

```
irb(main):001:0> require 'Qt'
=> true
irb(main):002:0> app = Qt::Application.new(ARGV)
=> #<Qt::Application:0xb6b1795c name="irb">
irb(main):005:0> w1 = Qt::Widget.new("blah", nil)
ArgumentError: unresolved constructor call Qt::Widget
```

This error happens when you attempt to call the method (in our case, the initializer) with an argument list not recognized by QtRuby.

Turning on QtRuby debugging output can be very handy if you get runtime errors about missing methods. The output shows possible candidates and how QtRuby decides which methods to call.

To diagnose this, you can turn on more extensive debugging output by setting the variable Qt.debug_level. The debug levels are:

- Off

- Minimal
- High
- Extensive

```
irb(main):007:0> Qt.debug_level = Qt::DebugLevel::High
=> 2
irb(main):008:0> w1 = Qt::Widget.new("MyWidget", nil)
classname    == QWidget
:: method == QWidget
-> methodIds == []
candidate list:
No matching constructor found, possibles:
      QWidget* QWidget::QWidget()
      QWidget* QWidget::QWidget(QWidget*, const char*)
      QWidget* QWidget::QWidget(QWidget*)
      QWidget* QWidget::QWidget(QWidget*, const char*, Qt::WFlags)
setCurrentMethod()
ArgumentError: unresolved constructor call Qt::Widget
```

The output shows that Qt::Widget has four forms of initializer, none of which fit the syntax we were trying.

Debug Channels

QtRuby also has a number of debug channels which can be turned on or off. These let you look into the toolkit at runtime.

- QTDB_NONE—No debug information
- QTDB_AMBIGUOUS—unused
- QTDB_METHODMISSING—unused
- QTDB_CALLS—show method call information
- QTDB_GC—show garbage collection information
- QTDB_VIRTUAL—display virtual method override information
- QTDB_VERBOSE—unused

- QTDB_ALL—Turn on all debug channels

These debug channels are set using:

```
Qt::Internal::setDebug(Qt::QtDebugChannel::QTDB_VIRTUAL)
```

Chapter 8

Korundum

The KDE project is an open source Unix desktop environment. As discussed in Section 2.1, *A Little History*, on page 5, it is heavily based on Qt.

Many aspects of KDE are extensions of things available in Qt, so there are many Qt widgets that have been extended in KDE. Korundum provides a set of Ruby bindings to these additional classes. In other words, QtRuby is to Qt as Korundum is to KDE.

8.1 Installing Korundum

You need the Korundum package, available from the same location as QtRuby.

First, the KDE libraries must be installed. This can be accomplished in a very simliar manner to the installation of Qt as described in Section 2.4, *How to install Qt from source*, on page 8. KDE is readily available from most Linux distributions and from Fink on Mac OS. KDE can be installed from source as well. To find out how to install KDE, we recommend the excellent documentation at http://www.kde.org/downloa

Second, SMOKE must be configured to generate bindings for KDE. One of the configuration options described in Section 3.3, *Installing QtRuby*, on page 14 was --with-smoke="qt". This needs to be changed to --with-smoke="qt kde". Alternatively, the whole option can be dropped, as building bindings for both Qt and KDE is the default behavior.

Finally, generate the Korundum bindings in the same way as you did for QtRuby.

8.2 Using Korundum

Although using the Korundum classes is as easy as using QtRuby classes, you'll need to change your programs slightly.

1. Change require 'Qt' to require 'Korundum'.
2. KDE classnames go into the KDE namespace, and the initial K is dropped. For example, the class KPopupMenu becomes KDE::PopupMenu.
3. Use KDE::Application instead of Qt::Application.

KDE::Application requires a little bit more setup than Qt::Application.

```
about = KDE::AboutData.new("appname", "MyProgramName", "1.0")
KDE::CmdLineArgs.init(ARGV, about)
app = KDE::Application.new()
w = KDE::DateTimeWidget.new
app.setMainWidget(w)
w.show
app.exec
```

As you can see, the KDE::Application class requires the initialization of KDE::AboutData and the KDE::CmdLineArgs classes.

KDE classes

KDE comes with a large number of classes, grouped into libraries. Some of these are:

- kdeui—Widgets that provide standard user interface elements.
- kdecore—Classes that aren't widgets, but are very useful to GUI programs.
- kio—A library of easy-to-use file management related classes.

- khtml—HTML rendering classes
- DCOP—A library for interprocess communication among KDE programs. We describe DCOP in more detail in the next section.

8.3 DCOP—Interprocess Communication

DCOP allows our Korundum programs to call remote methods in other Korundum (or KDE) programs.

KDE comes with a command line utility dcop that can be used to inspect and call DCOP methods in a running application.

To make a method callable by DCOP, define it in the same way we defined a regular Qt slot.

```
require 'Korundum'

class MyWidget < KDE::Dialog
  k_dcop 'QSize mySize()'

  def initialize(parent=nil, name=nil)
    super(parent,name)
  end

  def mySize()
    return size()
  end
end
```

In this case, we used the k_dcop declaration to make the mySize() method remotely callable. We can then initialize and run the widget.

```
about = KDE::AboutData.new("app1", "MyApplication", "1.0")
KDE::CmdLineArgs.init(ARGV, about)
a = KDE::Application.new()
w = MyWidget.new
a.dcopClient.registerAs("app1",false)
a.setMainWidget(w)
```

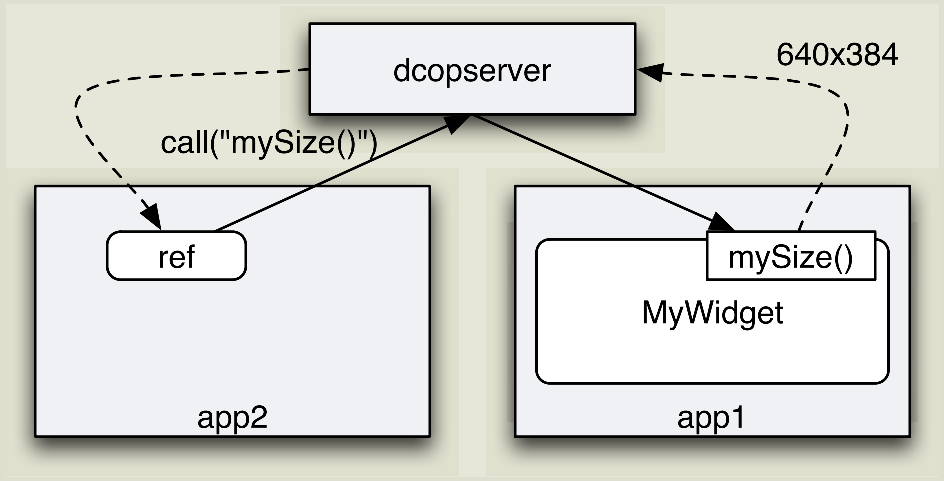


Figure 8.1: DCOP Remote Method Call

```
w.show
a.exec
```

In a second program, we can attempt to call this remote method.

```
require 'Korundum'

about = KDE::AboutData.new("app2", "App2", "1.0")
KDE::CmdLineArgs.init(ARGV, about)
a = KDE::Application.new()

ref = KDE::DCOPRef.new("app1", "MyWidget")
res = ref.call("mySize()")

puts "W: #{res.width} H: #{res.height}"
```

```
$ ruby ex_korundum_size_remote.rb
>>>> W: 640 H: 384
```

We illustrate this example in figure Figure 8.1 .

What's going on here

What's we're seeing here is a lot of behind-the-scenes magic. First, applications wishing to use DCOP are considered DCOP clients and need to register with the DCOP server (which runs automatically after the KDE desktop starts). Clients can communicate with each other via message calls which get sent to the server and dispatched to the appropriate destination client. Some messages are one-way; they are sent and the client continues without waiting for a reply. Others are sent by clients who await a reply.

The KDE::Application class provides the method dcopClient() which returns a DCOPClient client connection to the server. The client can attach() to or, detach() from the server. It can also change its registration information with registerAs().

By default, a client attaches to the DCOP server with the name of *appname + "-" + pid.* This allows multiple applications with the same name to utilize the DCOP server. Changing the registered name is as simple as using the registerAs() method of DCOPClient class.

Objects within an application can use the DCOPObject object to create an interface via the DCOPClient for remote method calls. By using the *k_dcop* syntax, this DCOPObject interface is automatically created for us.

Finally, remote applications can use DCOPRef to create a connection to a remote DCOPObject. The DCOPRef initializer has two arguments, the name of the application to connect to (as was specified by the DCOPClient registerAs() method), and the remote object to connect to (as specified by the objId() of the DCOPObject.

The DCOPRef class can then use call() to call remote functions.

```
ref = DCOPRef.new("appname","objname")
ref.call("someFunction") # objname.someFunction
ref.call("someFunction()") #objname.someFunction
ref.call("someFunction()","arg") # objname.someFunction(arg)
```

For methods that have no return value, there is the send() method.

```
ref = DCOPRef.new("appname","objname")
ref.send("someFunction","arg") # objname.someFunction(arg)
```

DCOP Signals

DCOP has signals, just like Qt. We can make remote signal/slot connections in a very similiar manner. Consider the following program:

```
require 'Korundum'

class SignalWidget < KDE::Dialog
  k_dcop_signals 'void mySizeSignal(QSize)'
  slots 'timerSlot()'

  def initialize(parent=nil, name=nil)
    super(parent,name)
    t = Qt::Timer.new(self)
    connect(t, SIGNAL('timeout()'), self,
      SLOT('timerSlot()') )
    t.start(5000)
  end

  def timerSlot
    puts "emitting signal"
    emit mySizeSignal(size())
  end
end

about = KDE::AboutData.new("appname",
  "MyApplication", "1.0")
KDE::CmdLineArgs.init(ARGV, about)
a = KDE::Application.new()
w = SignalWidget.new
a.dcopClient.registerAs("appname",false)
a.setMainWidget(w)
```

```
w.show
a.exec
```

The corresponding remote application:

```
require 'Korundum'

class SlotWidget < KDE::Dialog
  k_dcop 'void mySlot(QSize)'

  def initialize(parent=nil, name=nil)
    super(parent,name)
  end

  def mySlot(size)
    puts "mySlot called #{size}"
    dispose
  end
end

about = KDE::AboutData.new("remote",
  "Remote", "1.0")
KDE::CmdLineArgs.init(ARGV, about)
a = KDE::Application.new()
w = SlotWidget.new(nil)
w.connectDCOPSignal("appname","SignalWidget",
  "mySizeSignal(QSize)", "mySlot(QSize)",
  false)
a.setMainWidget(w)
a.exec
```

In executing these two programs, the follow logic occurs:

1. We create the SignalWidget. Every five seconds its internal timer calls its slot timerSlot(), which emits the DCOP signal mySizeSignal().

2. We create the SlotWidget in a separate application. We a DCOP

slot called mySlot() and connect SignalWidget's signal to this slot.

3. We run the program and watch as every five seconds the DCOP signal and slots get activated.

8.4 Summary

- Applications using KDE classes must use KDE::Application instead of Qt::Application.
- DCOP provides an interface for calling remote methods in running applications.

Appendix A

Event Method Map

Event Type	Event Class	Event Method
Mouse	Qt::MouseEvent	mousePressEvent
		mouseDoubleClickEvent
		mouseMoveEvent
		mouseReleaseEvent
	Qt::WheelEvent	wheelEvent
	Qt::Event	enterEvent
		leaveEvent
Keyboard	Qt::KeyEvent	keyPressEvent
		keyReleaseEvent
Tablet	Qt::TabletEvent	tabletEvent
Input Method	Qt::KeyEvent	imStartEvent
		imComposeEvent
		imEndEvent

Event Type	Event Class	Event Method
Drag and Drop	Qt::DragEnterEvent	dragEnterEvent
	Qt::DragMoveEvent	dragMoveEvent
	Qt::DragLeaveEvent	dragLeaveEvent
	Qt::DropEvent	dropEvent
Drawing	Qt::ShowEvent	showEvent
	Qt::HideEvent	hideEvent
	Qt::PaintEvent	paintEvent
	Qt::ResizeEvent	resizeEvent
	Qt::CloseEvent	closeEvent
Tablet	Qt::TabletEvent	tabletEvent
Qt::Object Events	Qt::TimerEvent	timerEvent
	Qt::ChildEvent	childEvent
	Qt::CustomEvent	customEvent

Appendix B

Resources

B.1 Web Resources

Qt
Trolltech's homepage

KDE
KDE homepage

KDE Ruby Bindings Homepage
Brief introduction to QtRuby and Korundum

Qt Documentation
Online documentation for Qt and utilities

QtRuby Online Tutorial
Learn Qt and QtRuby online with this 14 step tutorial

QtRuby/Korundum at RubyForge
Rubyforge download site for QtRuby

C++ GUI Programming with Qt 3
Link to book website, with freely downloadable PDF.

B.2 Bibliography

[BS04] Jasmin Blanchette and Mark Summerfield. *C++ GUI Programming with Qt 3*. Prentice Hall, Englewood Cliffs, NJ, 2004.

[TFH05] David Thomas, Chad Fowler, and Andrew Hunt. *Programming Ruby: The Pragmatic Programmers' Guide*. The Pragmatic Programmers, LLC, Raleigh, NC, and Dallas, TX, second edition, 2005.