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About the Tutorial

PyQt is a GUI widgets toolkit. It is a Python interface for **Qt**, one of the most powerful, and popular cross-platform GUI library. PyQt is a blend of Python programming language and the Qt library. This introductory tutorial will assist you in creating graphical applications with the help of PyQt.

Audience

This tutorial is designed for software programmers who are keen on learning how to develop graphical applications using PyQt.

Prerequisites

You should have a basic understanding of computer programming terminologies. A basic understanding of Python and any of the programming languages is a plus.

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Table of Contents

1. PyQt — Introduction

PyQt is a GUI widgets toolkit. It is a Python interface for **Qt**, one of the most powerful, and popular cross-platform GUI library. PyQt was developed by RiverBank Computing Ltd. The latest version of PyQt can be downloaded from its official website:

www.riverbankcomputing.com/software/pyqt/download

PyQt API is a set of modules containing a large number of classes and functions. While **QtCore** module contains non-GUI functionality for working with file and directory etc., **QtGui** module contains all the graphical controls. In addition, there are modules for working with XML (**QtXml**), SVG (**QtSvg**), and SQL (**QtSql**), etc.

Supporting Environments

PyQt is compatible with all the popular operating systems including Windows, Linux, and Mac OS. It is dual licensed, available under GPL as well as commercial license.

Windows

You can download and install an appropriate installer from the above download link corresponding to Python version (2.7 or 3.4) and hardware architecture (32 bit or 64 bit). Note that there are two versions of PyQt that are available namely, **PyQt 4.8** and **PyQt 5.5**.

While PyQt4 is available for Python 2 as well as Python 3, PyQt5 can be used along with Python 3.* only.

PyQt4 Windows Binaries

PyQt4-4.11.4-gpl-Py3.4-Qt4.8.7-x64.exe	Windows 64 bit installer
PyQt4-4.11.4-gpl-Py3.4-Qt4.8.7-x32.exe	Windows 32 bit installer
PyQt4-4.11.4-gpl-Py3.4-Qt5.5.0-x64.exe	Windows 64 bit installer
PyQt4-4.11.4-gpl-Py3.4-Qt5.5.0-x32.exe	Windows 32 bit installer
PyQt4-4.11.4-gpl-Py2.7-Qt4.8.7-x64.exe	Windows 64 bit installer
PyQt4-4.11.4-gpl-Py2.7-Qt4.8.7-x32.exe	Windows 32 bit installer

PyQt5 Windows Binaries

PyQt5-5.5-gpl-Py3.4-Qt5.5.0-x64.exe	Windows 64 bit installer
PyQt5-5.5-gpl-Py3.4-Qt5.5.0-x32.exe	Windows 32 bit installer

Linux

For Ubuntu or any other debian Linux distribution, use the following command to install PyQt:

```
sudo apt-get install python-qt4


or


sudo apt-get install python-qt5
```

You can also build from the source code available on the ‘download’ page.

PyQt-x11-gpl-4.11.4.tar.gz	Linux, UNIX source for PyQt4
PyQt-gpl-5.5.tar.gz	Linux, UNIX, MacOS/X source for PyQt5

Mac OS

PyQtX project (http://sourceforge.net/projects/pyqtx/) hosts binaries of PyQt for Mac. Use Homebrew installer as per the following command:

```
brew install pyqt
```

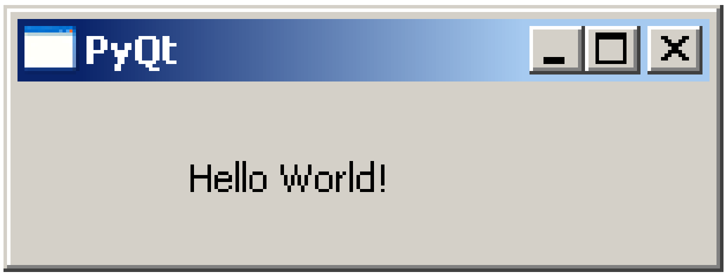
2. PyQt — Hello World

Creating a simple GUI application using PyQt involves the following steps:

- Import QtGui module.
- Create an application object.
- A QWidget object creates top level window. Add QLabel object in it.
- Set the caption of label as "hello world".
- Define the size and position of window by setGeometry() method.
- Enter the mainloop of application by **app.exec_()** method.

```
import sys
from PyQt4 import QtGui
def window():
    app = QtGui.QApplication(sys.argv)
    w = QtGui.QWidget()
    b= QtGui.QLabel(w)
    b.setText("Hello World!")
    w.setGeometry(100,100,200,50)
    b.move(50,20)
    w.setWindowTitle(“PyQt”)
    w.show()
    sys.exit(app.exec_())

if __name__ == '__main__':
    window()
```

The above code produces the following output:



3. PyQt — Major Classes

PyQt API is a large collection of classes and methods. These classes are defined in more than 20 modules. Following are some of the frequently used modules:

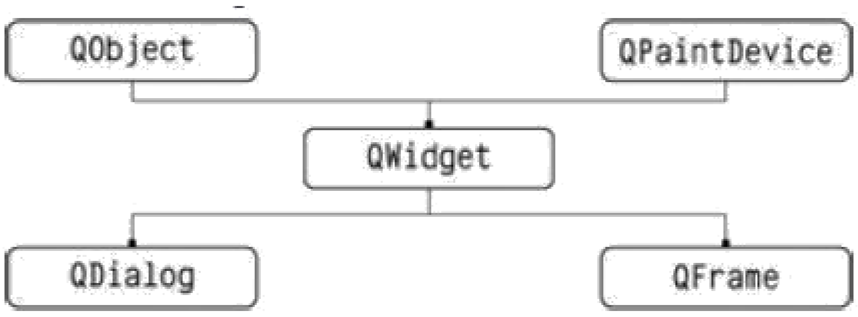
QtCore	Core non-GUI classes used by other modules
QtGui	Graphical user interface components
QtMultimedia	Classes for low-level multimedia programming
QtNetwork	Classes for network programming
QtOpenGL	OpenGL support classes
QtScript	Classes for evaluating Qt Scripts
QtSql	Classes for database integration using SQL
QtSvg	Classes for displaying the contents of SVG files
QtWebKit	Classes for rendering and editing HTML
QtXml	Classes for handling XML
QtAssistant	Support for online help
QtDesigner	Classes for extending Qt Designer

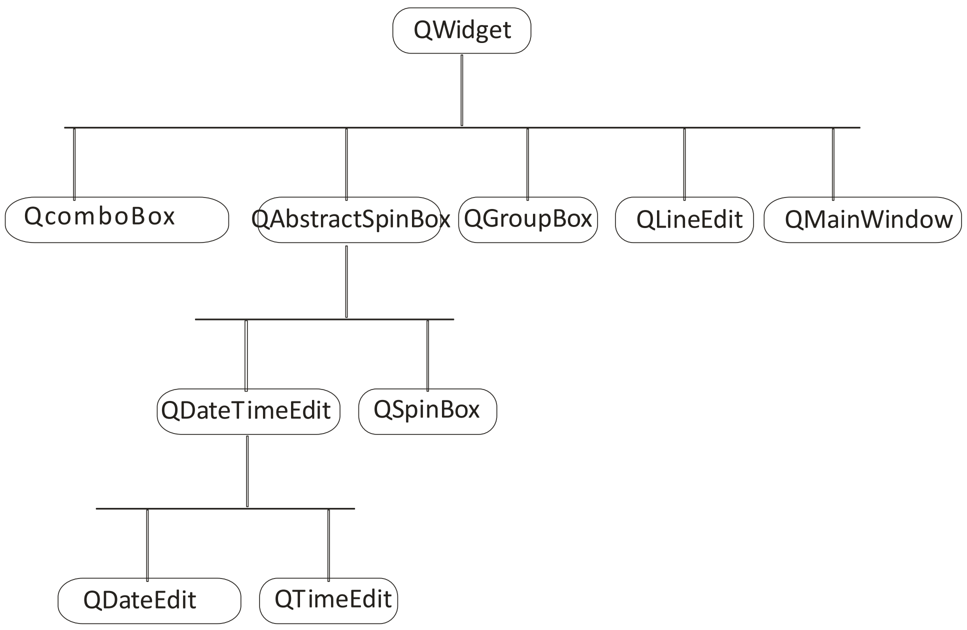
PyQt API contains more than 400 classes. The **QObject** class is at the top of class hierarchy. It is the base class of all Qt objects. Additionally, **QPaintDevice** class is the base class for all objects that can be painted.

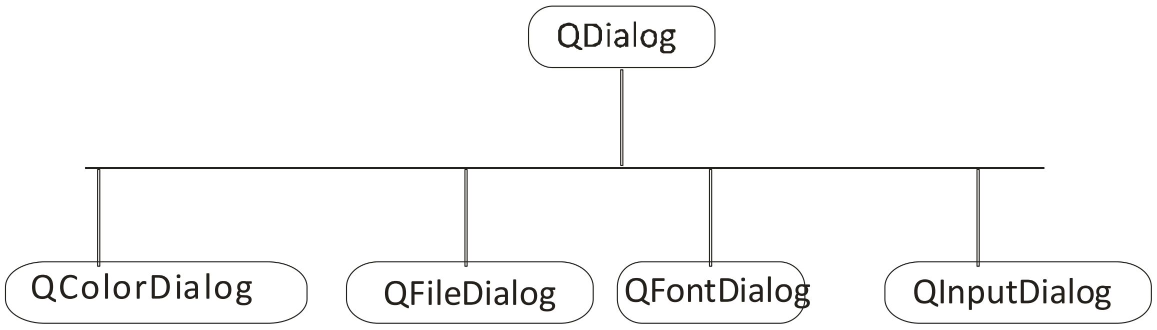
QApplication class manages the main settings and control flow of a GUI application. It contains main event loop inside which events generated by window elements and other sources are processed and dispatched. It also handles system-wide and application-wide settings.

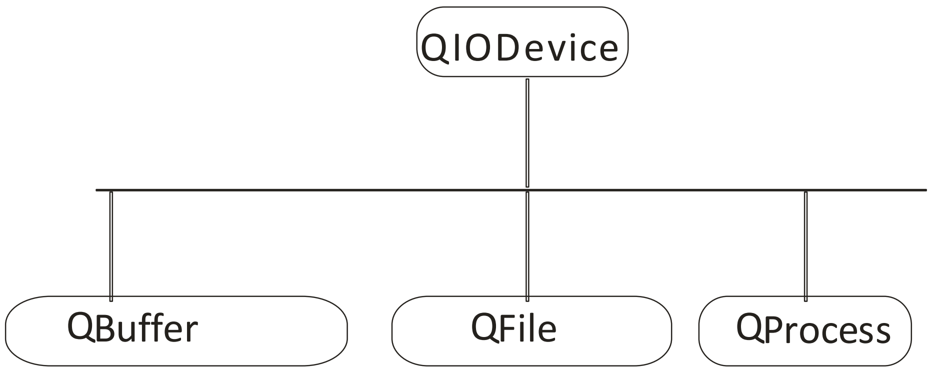
QWidget class, derived from QObject and QPaintDevice classes is the base class for all user interface objects. **QDialog** and **QFrame** classes are also derived from QWidget class. They have their own sub-class system.

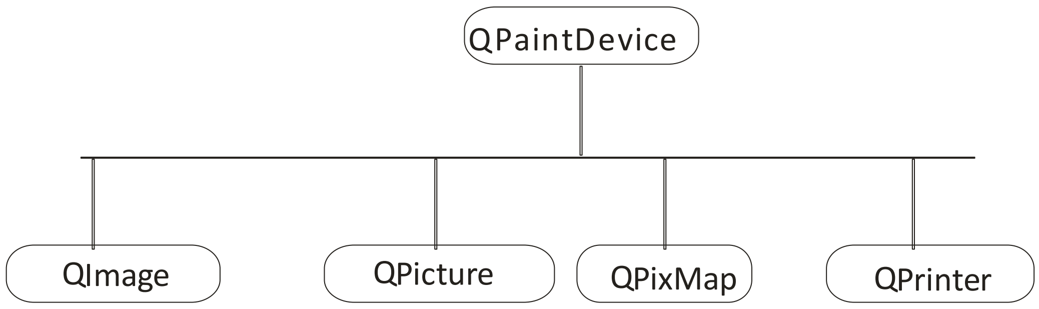
Following diagrams depict some important classes in their hierarchy.




QWidget
QcomboBox
QAbstractSpinBox
QGroupBox
QLineEdit
QMainWindow
QDateTimeEdit
QSpinBox
QDateEdit
QTimeEdit


QDialog
QColorDialog
QFileDialog
QFontDialog
QInputDialog


QIODevice
QBuffer
QFile
QProcess

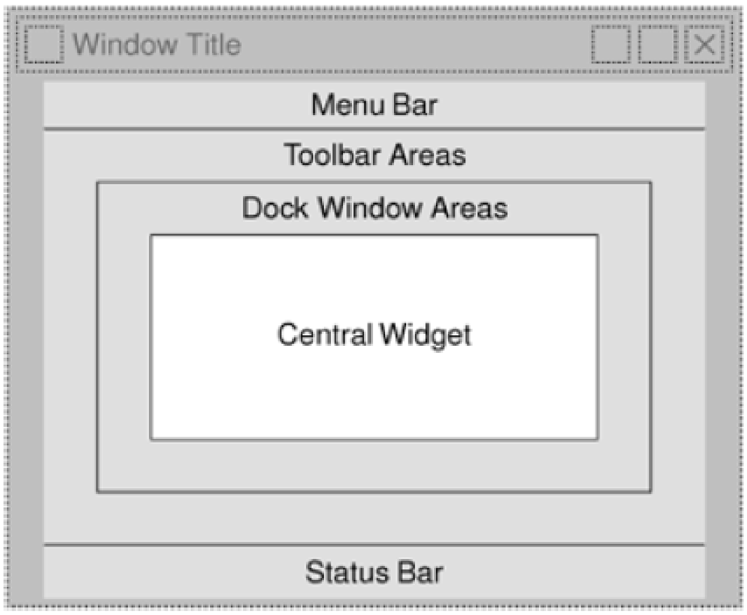


Here is a select list of frequently used widgets:

QLabel	Used to display text or image
QLineEdit	Allows the user to enter one line of text
QTextEdit	Allows the user to enter multi-line text
QPushButton	A command button to invoke action
QRadioButton	Enables to choose one from multiple options
QCheckBox	Enables choice of more than one options
QSpinBox	Enables to increase/decrease an integer value
QScrollBar	Enables to access contents of a widget beyond display aperture
QSlider	Enables to change the bound value linearly.
QComboBox	Provides a dropdown list of items to select from
QMenuBar	Horizontal bar holding QMenu objects
QStatusBar	Usually at bottom of QMainWindow, provides status information.
QToolBar	Usually at top of QMainWindow or floating. Contains action buttons
QListView	Provides a selectable list of items in ListMode or IconMode
QPixmap	Off-screen image representation for display on QLabel or QPushButton object
QDialog	Modal or modeless window which can return information to parent window

A typical GUI based application's top level window is created by **QMainWindow** widget object. Some widgets as listed above take their appointed place in this main window, while others are placed in the central widget area using various layout managers.

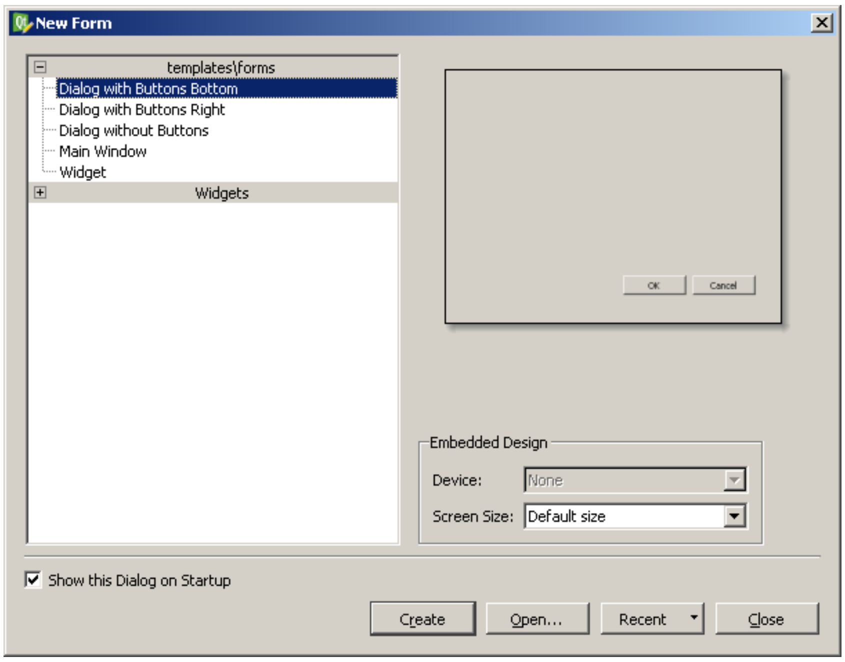
The following diagram shows the QMainWindow framework:


Window Title
Menu Bar
Toolbar Areas
Dock Window Areas
Central Widget
Status Bar

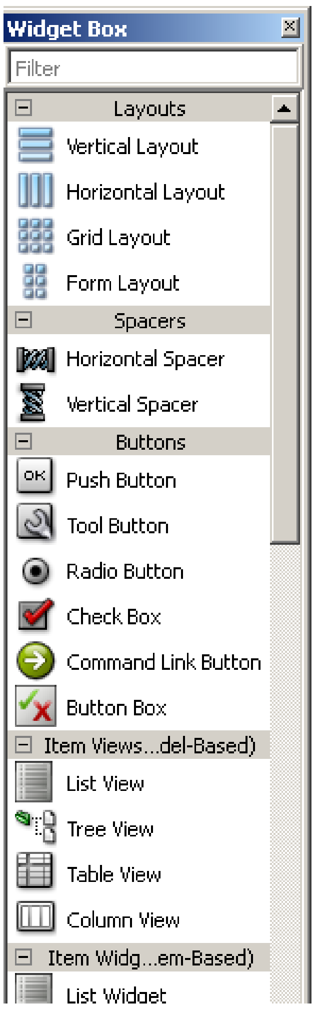
4. PyQt — Using Qt Designer

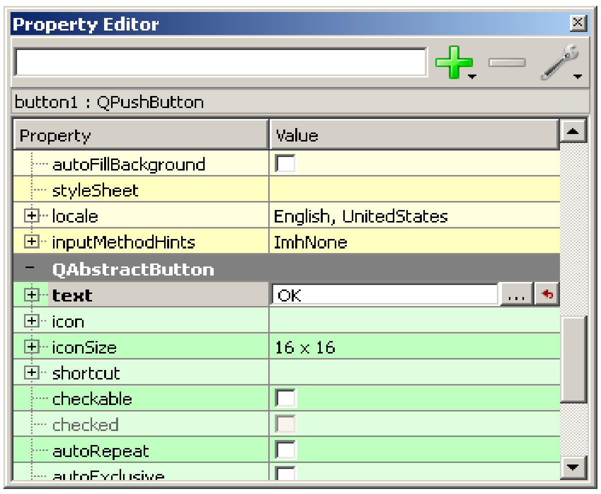
The PyQt installer comes with a GUI builder tool called **Qt Designer**. Using its simple drag and drop interface, a GUI interface can be quickly built without having to write the code. It is however, not an IDE such as Visual Studio. Hence, Qt Designer does not have the facility to debug and build the application.

Creation of a GUI interface using Qt Designer starts with choosing a top level window for the application.



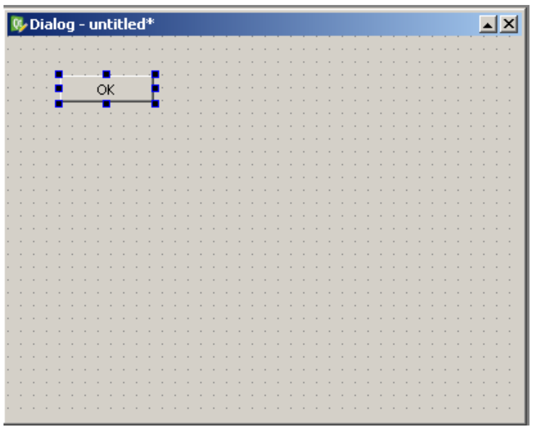
You can then drag and drop required widgets from the widget box on the left pane. You can also assign value to properties of widget laid on the form.





button1 : QPushButton

Property	Value
autoFillBackground	☐
styleSheet	
locale	English, UnitedStates
inputMethodHints	ImhNone
QAbstractButton	
text	OK
icon	
iconSize	16 x 16
shortcut	
checkable	☐
checked	☐
autoRepeat	☐
autoExclusive	☐



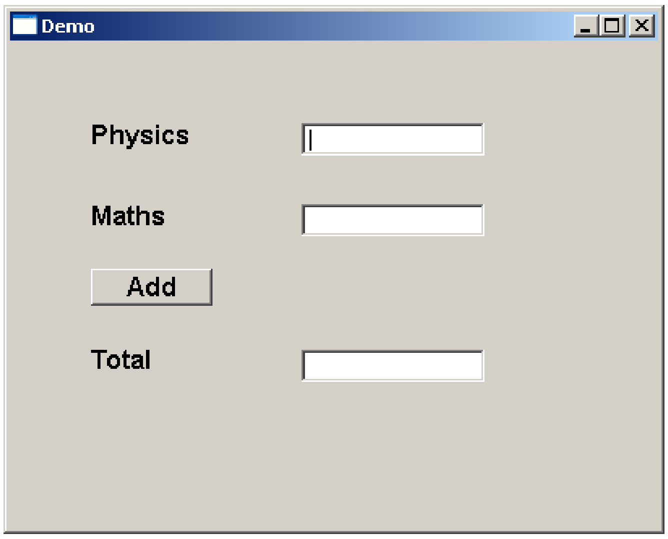
The designed form is saved as demo.ui. This ui file contains XML representation of widgets and their properties in the design. This design is translated into Python equivalent by using pyuic4 command line utility. This utility is a wrapper for uic module. The usage of pyuic4 is as follows:

```
pyuic4 –x demo.ui –o demo.py
```

In the above command, -x switch adds a small amount of additional code to the generated XML so that it becomes a self-executable standalone application.

```
if __name__ == "__main__":
    import sys
    app = QtGui.QApplication(sys.argv)
    Dialog = QtGui.QDialog()
    ui = Ui_Dialog()
    ui.setupUi(Dialog)
    Dialog.show()
    sys.exit(app.exec_())
```

The resultant python script is executed to show the following dialog box:



The user can input data in input fields but clicking on Add button will not generate any action as it is not associated with any function. Reacting to user-generated response is called as **event handling**.

5. PyQt — Signals and Slots

Unlike a console mode application, which is executed in a sequential manner, a GUI based application is event driven. Functions or methods are executed in response to user's actions like clicking on a button, selecting an item from a collection or a mouse click etc., called **events**.

Widgets used to build the GUI interface act as the source of such events. Each PyQt widget, which is derived from QObject class, is designed to emit '**signal'** in response to one or more events. The signal on its own does not perform any action. Instead, it is 'connected' to a '**slot'**. The slot can be any **callable Python function**.

In PyQt, connection between a signal and a slot can be achieved in different ways. Following are most commonly used techniques:

```
QtCore.QObject.connect(widget, QtCore.SIGNAL('signalname'), slot_function)
```

A more convenient way to call a slot_function, when a signal is emitted by a widget is as follows:

```
widget.signal.connect(slot_function)
```

Suppose if a function is to be called when a button is clicked. Here, the clicked signal is to be connected to a callable function. It can be achieved in any of the following two techniques:

```
QtCore.QObject.connect(button, QtCore.SIGNAL("clicked()"), slot_function)
```

or

```
button.clicked.connect(slot_function)
```

Example

In the following example, two QPushButton objects (b1 and b2) are added in QDialog window. We want to call functions b1_clicked() and b2_clicked() on clicking b1 and b2 respectively.

When b1 is clicked, the clicked() signal is connected to b1_clicked() function

```
b1.clicked.connect(b1_clicked())
```

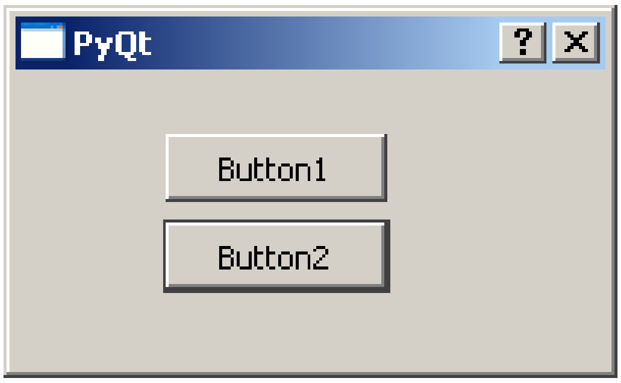
When b2 is clicked, the clicked() signal is connected to b2_clicked() function

```
 QObject.connect(b2, SIGNAL("clicked()"), b2_clicked)
```

Example

```
import sys
from PyQt4.QtCore import *
from PyQt4.QtGui import *
def window():
    app = QApplication(sys.argv)
    win = QDialog()
    b1= QPushButton(win)
    b1.setText("Button1")
    b1.move(50,20)
    b1.clicked.connect(b1_clicked)

    b2=QPushButton(win)
    b2.setText("Button2")
    b2.move(50,50)
    QObject.connect(b2,SIGNAL("clicked()"),b2_clicked)

    win.setGeometry(100,100,200,100)
    win.setWindowTitle("PyQt")
    win.show()
    sys.exit(app.exec_())

def b1_clicked():
    print "Button 1 clicked"

def b2_clicked():
    print "Button 2 clicked"

if __name__ == '__main__':
    window()
```

The above code produces the following output:



Output:

```
Button 1 clicked

Button 2 clicked
```

6. PyQt — Layout Managers

A GUI widget can be placed inside the container window by specifying its absolute coordinates measured in pixels. The coordinates are relative to the dimensions of the window defined by setGeometry() method.

setGeometry() syntax:

```
QWidget.setGeometry(xpos, ypos, width, height)
```

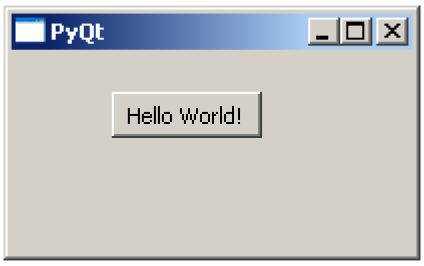
In the following code snippet, the top level window of 300 by 200 pixels dimensions is displayed at position (10, 10) on the monitor.

```
import sys
from PyQt4 import QtGui
def window():
    app = QtGui.QApplication(sys.argv)
    w = QtGui.QWidget()
    b = QtGui.QPushButton(w)
    b.setText("Hello World!")
    b.move(50,20)
    w.setGeometry(10,10,300,200)
    w.setWindowTitle(“PyQt”)
    w.show()
    sys.exit(app.exec_())

if __name__ == '__main__':
    window()
```

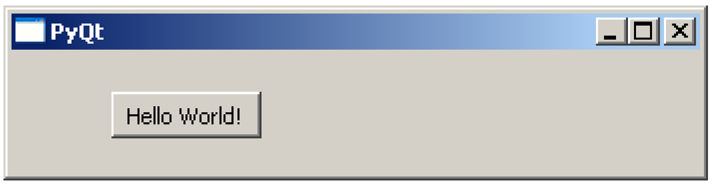
A **PushButton** widget is added in the window and placed at a position 50 pixels towards right and 20 pixels below the top left position of the window.

This **Absolute Positioning**, however, is not suitable because of following reasons:

- The position of the widget does not change even if the window is resized.
- The appearance may not be uniform on different display devices with different resolutions.
- Modification in the layout is difficult as it may need redesigning the entire form.



Original window



Resized window. Position of button is unchanged.

PyQt API provides layout classes for more elegant management of positioning of widgets inside the container. The advantages of Layout managers over absolute positioning are:

- Widgets inside the window are automatically resized.
- Ensures uniform appearance on display devices with different resolutions
- Adding or removing widget dynamically is possible without having to redesign.

QLayout class is the base class from which QBoxLayout, QGridLayout and QFormLayout classes are derived.