

Python course II

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Objective

This course provides an introduction into advanced features of Python such as classes and objects, installing and using third party libraries (python-Qt, python-vlc, ...) and some advanced programming constructs such as state engines and how to coordinate asynchronous program flows.

The course is highly practical - we show the concepts by designing a simple media player application which implements all the concepts we teach. To make things more interesting we implement two different UI types, a local GUI and a web GUI.

I'm not the best imaginative namegiver, but for reference, let's call our wonderful product *MyPlayer*. Any ideas for a better name?

Prerequisites

Windows/Linux (advanced user)

Python (basic programming skills: Variables & statements, control structures, functions).

Basic Git usage (Setting up repo, commit, branch)

A lot of perseverance, googling and pushing through! Explanations are sometimes sparse on purpose!

Requirements

Average Laptop / Desktop machine plus peripherals.

OS: Windows (10) or (K)Ubuntu Linux 18

Python 3

Python IDE (PyClipse)

Programmer friendly editor (Windows: Notepad++, Linux: Kate or GEdit)

TortoiseGit (Windows) + deps, Just Git (Linux)

Agenda

1. Installation
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 2. PyClipse
 3. python-qt
 4. python-vlc
 5. Git + friends
2. Program structure
 1. Components and their purpose
3. The GUI
 1. Visual design
 2. Architecture: Delegate pattern
 3. Logic, GUI-Only
4. The controller
 1. State machine
 2. Integrating the GUI
5. The backend
 1. The audiosystem (vlc) - Introduction
 1. Instantiating
 2. Functions
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 2. Integrating vlc into backend
 3. Playlist
6. The controller II
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7. Web GUI, visual design
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9. Integrating WEB GUI
 1. The Javascript library
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Lesson 1: Installation (2019-08)

Objective: Set up the Development environment: Python+libs, git, IDE

Linux

We use KUbuntu, 64 bit, and assume a working system. For the installation you need an open Terminal (emulator). KUbuntu offers you a program for that (aptly named **Konsole**). There you will type everything.

VLC player

That's for your media player backend to play your muzac.

```
~:$ sudo apt install vlc
```

Qt

This is the framework which puts your local GUI on your screen.

```
~:$ sudo apt install qt4-designer
```

git

A source code management system. You need it to keep track of your project.

```
~:$ sudo apt install git  
~:$ sudo apt install git-gui  
~:$ sudo apt install git-man
```

Python + libs

You also need python plus some libs to bind qt and vlc into it.

```
~:$ sudo apt install python3  
~:$ sudo apt install pyside-tool  
~:$ sudo apt install python-qt4  
~:$ sudo apt install python3-pip  
~:$ sudo pip3 install python-vlc
```

Java

Needed for LiClipse. We'll be using the openJDK which ships with KUbuntu. Unfortunately the official Oracle Java8 can't be installed via repository, and it seems OpenJDK is enough. Check whether you have Java installed. On my laptop I get:

```
~:$ java -version
~:$ java version "1.8.0_201"
~:$ Java(TM) SE Runtime Environment (build 1.8.0_201-b09)
Java HotSpot(TM) 64-Bit Server VM (build 25.201-b09, mixed mode)
```

If it tells you it doesn't have java, you need to install it:

```
~:$ sudo apt install default-jdk
```

Your system will download and install the standard Kubuntu JDK

Python IDE (LiClipse)

We'll be using LiClipse. It comes as a trial version with full functionality. After 14 days you will get a tender reminder (popup box) that you really *should* buy a license (software will continue to work though). It will cost \$80, and I'd recommend buying it as it supports the developer (devs do need to eat, too - even if they say that their food is code).

Head over to <https://www.liclipse.com/download.html>. You'll probably have a 64 bit version of KUbuntu, so download the 64 bit version. You will get a file with the ending **.tar.gz** (e.g. **liclipse_5.2.4_linux gtk.x86_64.tar.gz**). For your info - that's a compressed tar archive.

Once the file has downloaded, make yourself a directory **/home/your-user-name/bin/liclipse** and copy the file into that one. Then

- open the folder in Dolphin
- right click it
- choose Extract -> Extract archive here, autodetect subfolder

This will create another sub folder. To start LiClipse **cd** into that sub folder and execute **LiClipse**. (Hint) - you can make that a menu item in your KDE startup menu.

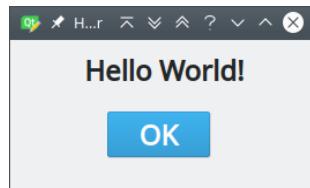
⇒ LiClipse comes with git support inbuilt so you can use git from inside your dev environment. Outside of LiClipse you can use the TortoiseGit features directly inside the Windows explorer, via right click on a (repository) folder.

Windows (10)

Whilst we could install everything directly into Windows there's a better way by setting up a virtual machine with a Kubuntu guest and then to use that as development machine. For the VM environment you can use VMWare (expensive, but if you have it, why not) or Virtualbox. With respect to setting up a VM and installing Linux, this would exceed the scope of this guide. Suffice to say that you should give the VM a harddisk with at least 30 GB and at least 4GB of memory. Also, the VM guest (i.e. VM thing you set up) needs a working connection to the internet and a

working audio output. When you have the base system working, follow the Linux part of this chapter (above) to get your dev environment ready.

Task: Using **QtDesigner** and **pyuic**, make python put a helloworld window onto your screen! Your window should look something like this:



Lesson 2: Program structure

Objective: Show the general structure of the player program.

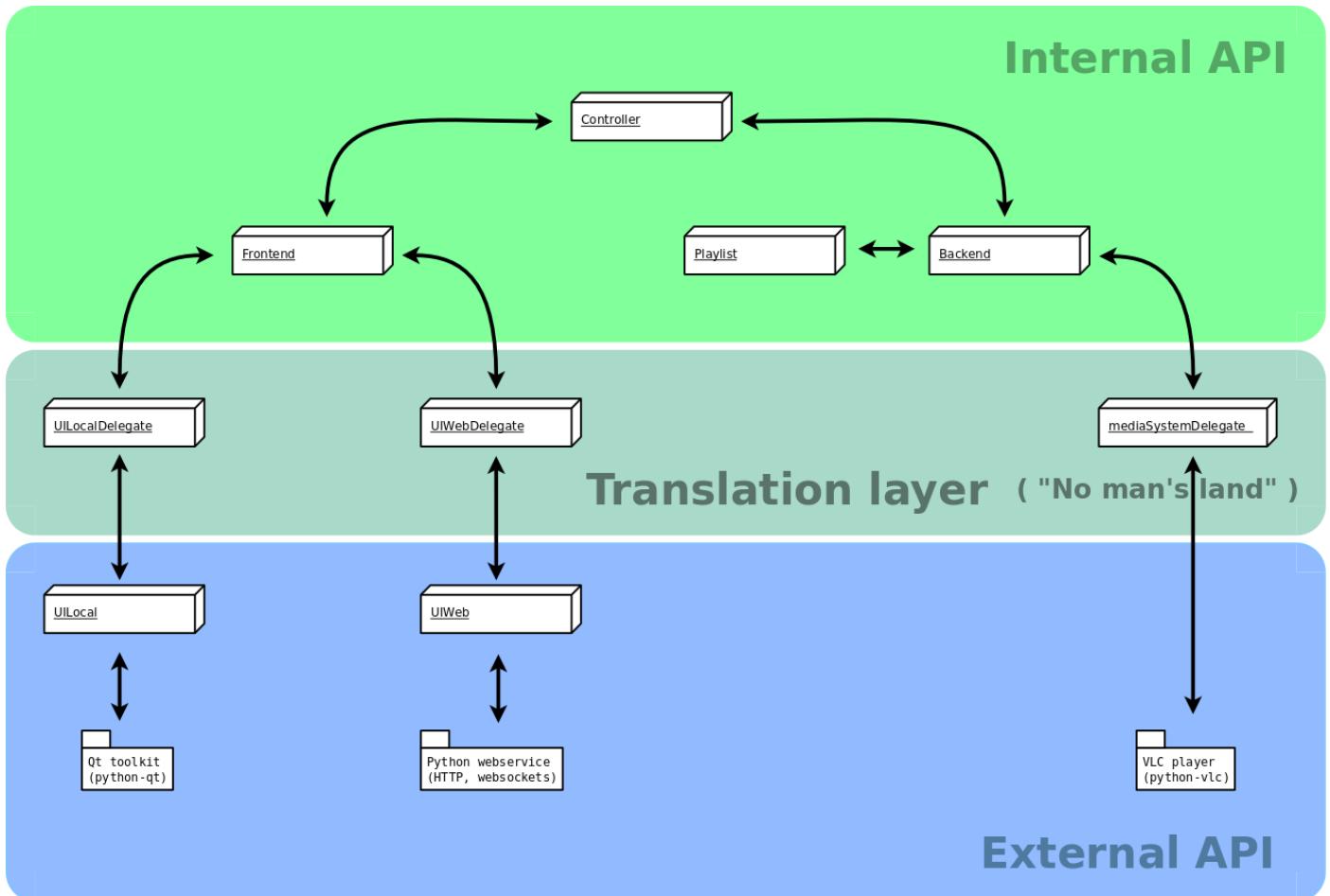


fig 1: Program overview

This chapter is a first get-to-know-me in broad strokes. We present the overall design of our player application. Subsequent chapters will go into much more detail, but this one wants to present the "big picture".

A good program design is hard to get to and needs experience! In today's interconnected world everything is super complicated! Design flaws are hard to beat once the project grows, so it's very important to get things right early! Several principles guide the development of MyPlayer.

- **Separation of concerns.** Example from the real world: A well designed company structure will result in employees who are competent in what they do and communicate well. Software design is similar! We take a big problem, split it up into sub problems then write components that tackle those sub problems independently and work well together. Result: Program works well and can be maintained by dummies!

MyPlayer realizes this principle by splitting up the whole application into smaller independent components. Furthermore, we isolate the components in separate layers. We have a system layer which operates the system parts (Local GUI, web GUI, VLC player), a control layer which represents the player's view of everything (controller, frontend and backend facades) and a translation layer (delegates) which translates what the control

components want to a "language" which the system components understand (and vice versa).

- Talking about "language" - *API, API, and again, API* ! Did I say API? Good separation of concerns is only half the story. What good is the independence if the stuff doesn't talk to each other? We need a well defined interaction between the different components. In programmer's mumbo jumbo such interaction way is called *API (Application programming interface)*. API thinking is all over the application.
 - Each component provides a clean interface - a bunch of methods to set getters and setters (methods that get and set stuff inside the component) and event handlers - which respond to other components wanting something. All methods follow a consistent naming scheme. For example, getters always start with **get**.
 - The components in the system layer all have very different requirements and thus very different methods. To present a more consistent API of the system components we use a layer of delegates that "translate" between the resp. system components and the control components. As a result the control components have a consistent view onto the system components. For example, the two frontends (Local GUI and web GUI) are very different in what they do and how they, but thanks to their respective delegates they look the same to the Frontend facade. This approach reduces complexity so we can pretty much plug any frontend into the running application and access them all same way.

For the media player component (VLC) we also use a delegate; technically this isn't necessary, but we still use it in case we want to use a different media framework. Plus, it's just more consistent - now *any* system component talks to our application via a delegate. This means one less special case and one thing less to consider!

Getting a design right is the hardest part of software design. This setup is just an attempt to make the application easier to understand and maintain. We meet the design challenge by splitting the whole setup into separate components and providing a clearly defined interaction between those components.

Some code to layout

Pardon the weird language, but *layout* is jargonese for the way our source code is organized! In our longish introduction we talked about layers and modules. This reflects directly in how we set up the packages and modules - or in everyday speech - the folder structure and what source files we put there. I'm sure there are more interesting ways of laying out code, but I suggest we organize it somewhat along the layers and modules we presented above. Fig. 2 shows what it looks like.

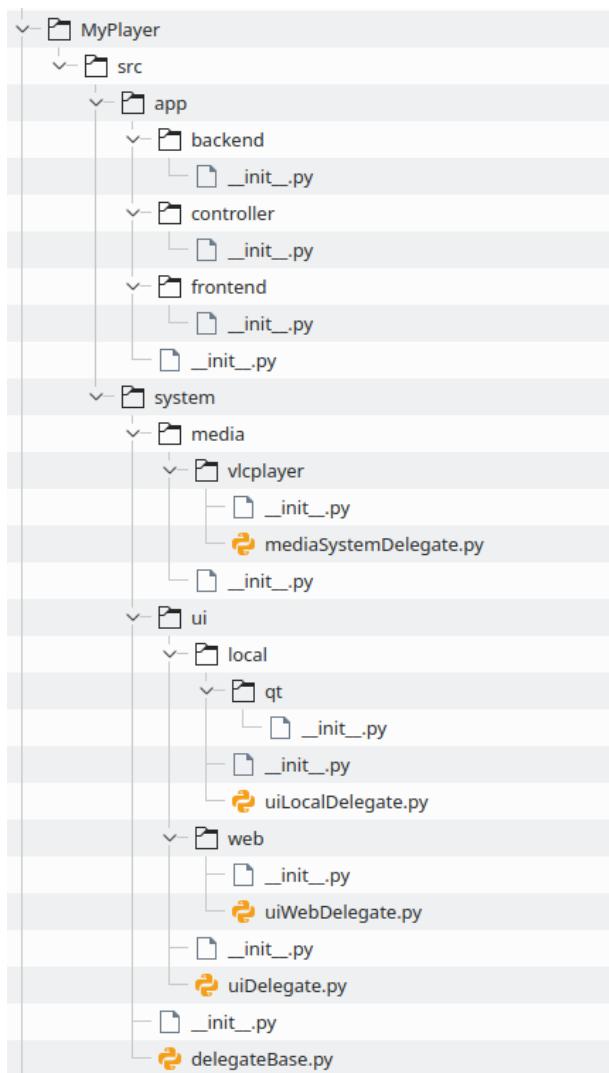


fig 2: Source layout

Noticed something? Blimey, where are those delegates???? If you look closely you will see them lumped with the respective system components! The local GUI has got a **UILocalDelegate**, the web UI has got a **UIWebDelegate** and the VLC driver has got a **MediaSystemDelegate**. The app layer components will use the delegates, and *only* the delegates to use the various system components. We'll see the details of all this later, but for now we note that the app layer talks in appanese with the delegates who translate that stuff into systemese for the system layer (and vice versa). If we pull this off correctly then it will be a breeze to integrate the system components into the app components!

The astute reader will have observed that there's no test code! That's right - but this guide is already demanding enough! Throwing in unit testing would be like adding rocks to your full grain muesli!

Task: In LiClipse, set up the project and create a structure of python modules implementing the program structure we explained.

As a plus, maybe make a GUI and let python execute it.

Using **Konsole**, put the project under git control.

Lesson 3: The GUI

Objective: Design the GUI (visually), build integration into player application and show a simplistic approach to the GUI logic

Let's start with the simple stuff up front. There's always time to complicate, so let's complicate later! We want to design the user interface first¹.

On your dev system (that virtual machine we set up in part 1) start QtDesigner ([Start menu -> Development](#)) and use it to create a user interface like this:

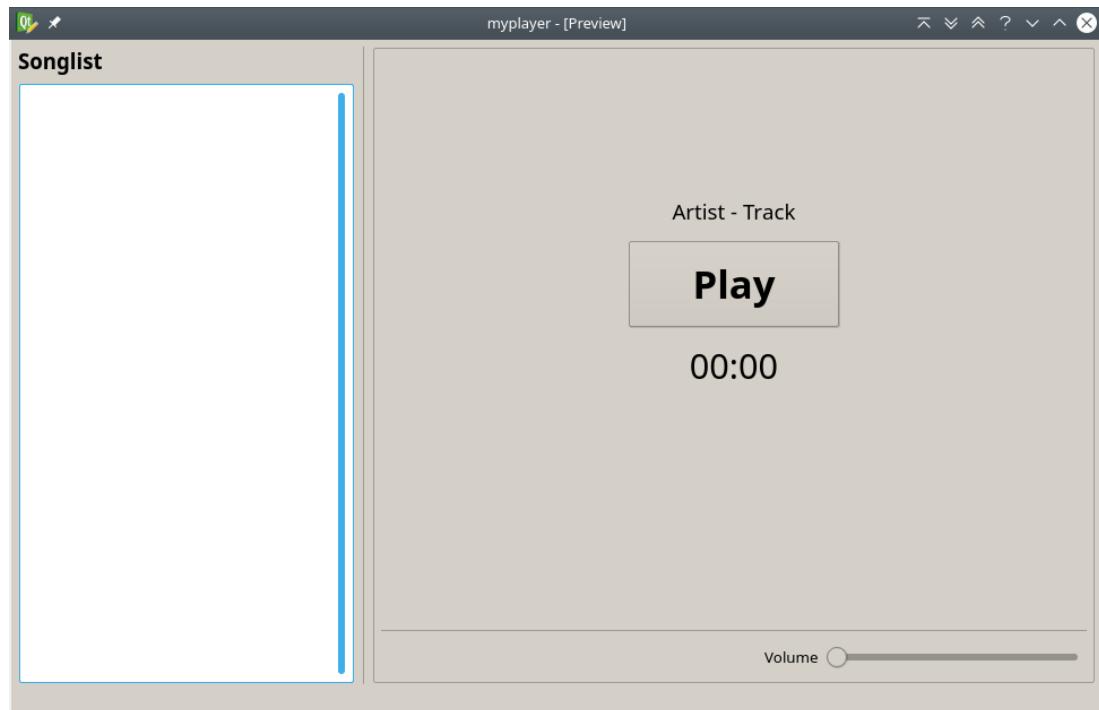


fig 3: GUI (local)

Some of the controls need specific names, so that the GUI works with the code we develop later. You can see those on my designer (fig. 4).

¹ In my own software work I often found that I was *actually* more productive when I designed the GUI first. It sort of was the next best thing to designing my program customer focused.

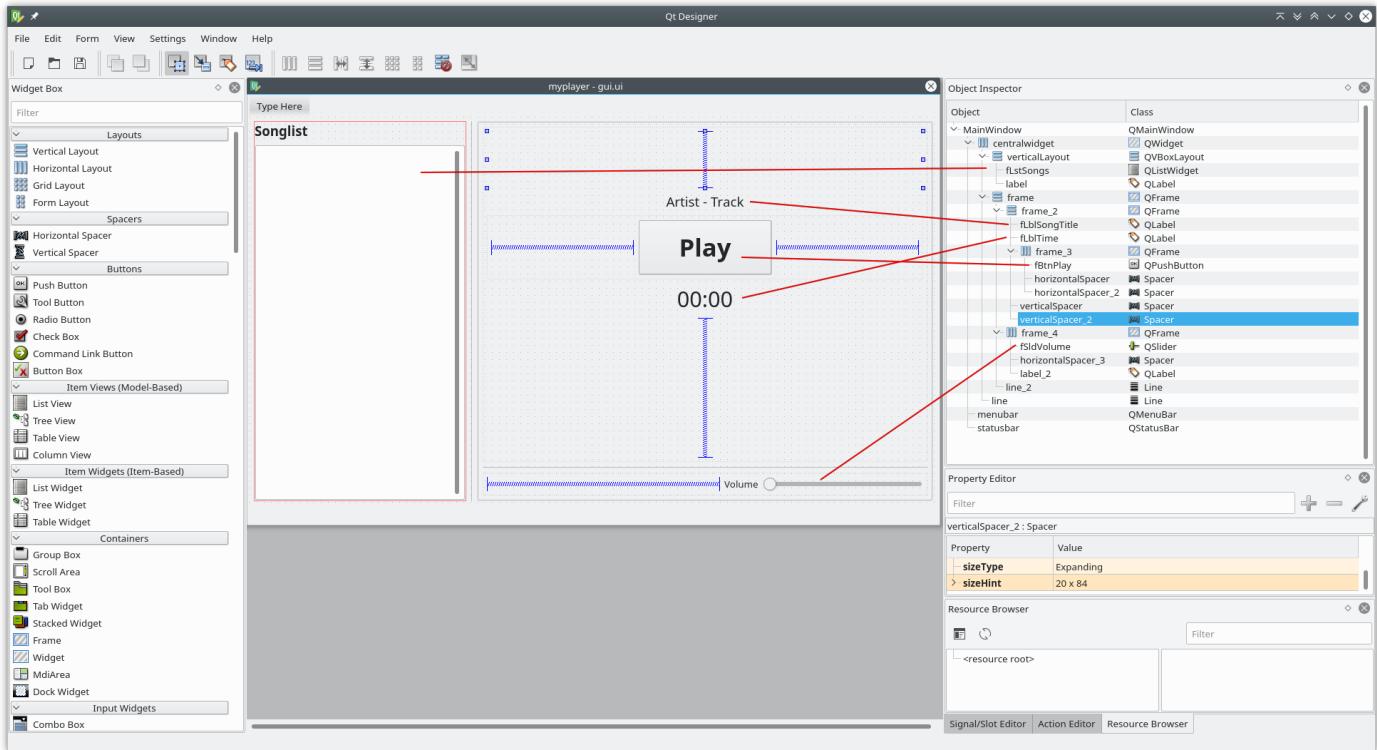


fig 4: Developing UI in QtDesigner

Once you are done with the design you can save the final `.ui` file into your project (I stuffed it into a new directory `MyPlayer/src/app/frontend/_assets`, so let's use that one).

With that done we need to translate the `.ui` file into python code. Open `konsole`, `cd` into that `_assets` directory and do:

```
~:$ pyuic4 -x -o ./gui.py ./gui.ui
```

You can look at the result by listing that directory's contents:

```
~:$ ls -la
total 32
drwxrwxr-x 2 peter peter 4096 Aug 20 18:00 .
drwxrwxr-x 3 peter peter 4096 Aug 20 17:53 ..
-rw-rw-r-- 1 peter peter 9062 Aug 20 18:00 gui.py <---- python file
-rw-rw-r-- 1 peter peter 9792 Aug 20 17:56 gui.ui
```

The new python file is your local GUI. When you run this script you will see MyPlayer's main window². Run it and try out the various controls on it (button, slider,).

There's been an event in China...

As you operated the GUI you noticed ... nothing interesting! Button gets pressed, Slider moves... but nothing much else! What's wrong? GUI's gone on strike? Not really, but in order for stuff to happen you need to write some *event handlers* and connect them with the GUI elements we want

² For the script's source, see Appendix A, Listing: Lesson 3, `gui.py`.

to use. Once connected an event handler will do whatever we program into it when the corresponding GUI element experiences the event. Let's illustrate my skimpy explanation with an example and revisit that homework after lesson 1 (HelloWorld). Like our GUI here the HelloWorld thingy was dead as a Dodo! You could hit that OK button and nothing happens! Let's declare war on lazy GUIs and have it show "How are you?" when we click that OK button!

For starters, let's see the source code generated by my `pyuic` compiler:

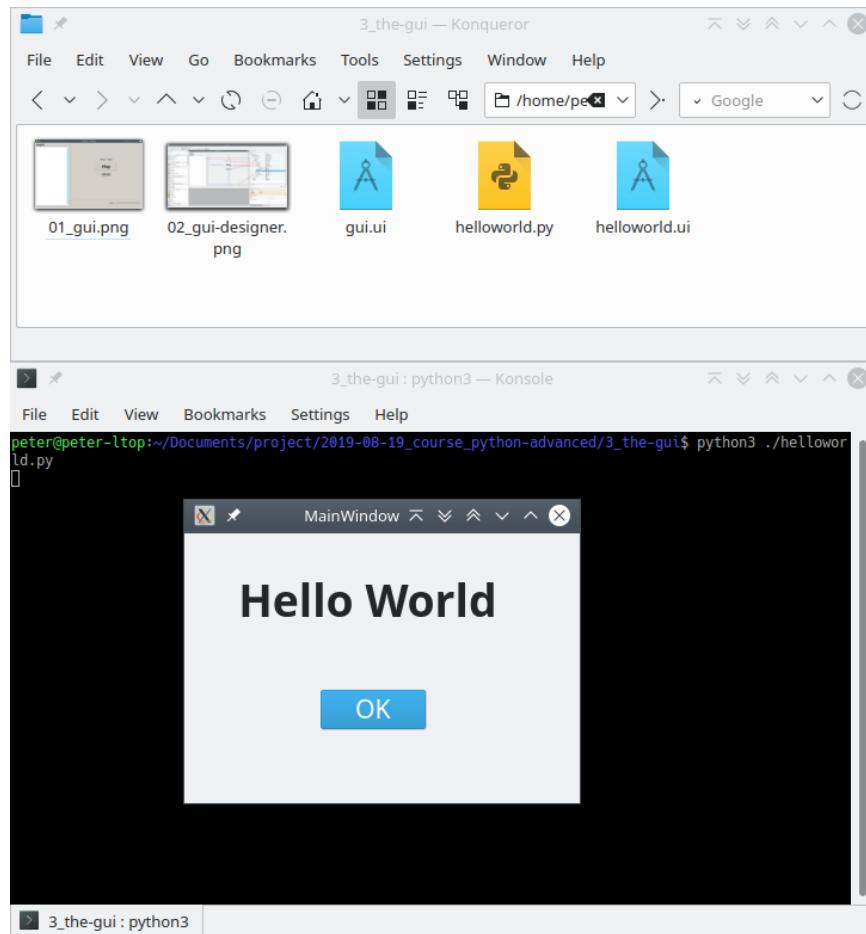
```
1 # -*- coding: utf-8 -*-
2
3 # Form implementation generated from reading ui file './helloworld.ui'
4 #
5 # Created by: PyQt4 UI code generator 4.12.1
6 #
7 # WARNING! All changes made in this file will be lost!
8
9 from PyQt4 import QtCore, QtGui
10
11 try:
12     _fromUtf8 = QtCore.QString.fromUtf8
13 except AttributeError:
14     def _fromUtf8(s):
15         return s
16
17 try:
18     _encoding = QtGui.QApplication.UnicodeUTF8
19     def _translate(context, text, disambig):
20         return QtGui.QApplication.translate(context, text, disambig, _encoding)
21 except AttributeError:
22     def _translate(context, text, disambig):
23         return QtGui.QApplication.translate(context, text, disambig)
24
25 class Ui_MainWindow(object):
26     def setupUi(self, MainWindow):
27         MainWindow.setObjectName(_fromUtf8("MainWindow"))
28         MainWindow.resize(325, 223)
29         self.centralwidget = QtGui.QWidget(MainWindow)
30         self.centralwidget.setObjectName(_fromUtf8("centralwidget"))
31         self.btnOK = QtGui.QPushButton(self.centralwidget)
32         self.btnOK.setGeometry(QtCore.QRect(110, 130, 90, 35))
33         font = QtGui.QFont()
34         font.setPointSize(16)
35         self.btnOK.setFont(font)
36         self.btnOK.setObjectName(_fromUtf8("btnOK"))
37         self.lblMsg = QtGui.QLabel(self.centralwidget)
38         self.lblMsg.setGeometry(QtCore.QRect(20, 30, 261, 51))
39         font = QtGui.QFont()
40         font.setPointSize(28)
41         font.setBold(True)
42         font.setWeight(75)
43         self.lblMsg.setFont(font)
44         self.lblMsg.setAlignment(QtCore.Qt.AlignCenter)
45         self.lblMsg.setObjectName(_fromUtf8("lblMsg"))
46         MainWindow.setCentralWidget(self.centralwidget)
```

```

47
48         self.retranslateUi(MainWindow)
49     QtCore.QMetaObject.connectSlotsByName(MainWindow)
50
51     def retranslateUi(self, MainWindow):
52         MainWindow.setWindowTitle(_translate("MainWindow", "MainWindow", None))
53         self.btnExit.setText(_translate("MainWindow", "OK", None))
54         self.lblMsg.setText(_translate("MainWindow", "Hello World", None))
55
56
57 if __name__ == "__main__":
58     import sys
59     app = QtGui.QApplication(sys.argv)
60     MainWindow = QtGui.QMainWindow()
61     ui = Ui_MainWindow()
62     ui.setupUi(MainWindow)
63     MainWindow.show()
64     sys.exit(app.exec_())

```

This code doesn't do anything interesting, apart from showing a pretty window when running it in python. Let's do that:



Apart from a few basics this GUI doesn't do anything when you click on it - The button turns blue when you click on it and the application quits when you click that little cross thingy on the top right corner. But we want the thing to do something interesting when we click that button! Let's say that "something" is: Changing "Hello World" to "How are you?". We need a few things to accomplish that.

Firstly, we need to create an event handler. For that we need to edit the python file which **pyuic** generated (**helloworld.py**). You could do that in LiClipse, but let's keep things simple and use Kate instead (Start button -> Utilities -> Kate). So - open **helloworld.py** in Kate. You may want to delete that offputting warning at the top ("all changes will be lost"). This is relevant when you recreate **helloworld.py** by running **pyuic** again. No worries, we won't do that, so you might as well get rid of that confusing warning.

Then in Kate edit your code so it looks like this:

```
1 # -*- coding: utf-8 -*-
2
3 # Form implementation generated from reading ui file './helloworld.ui'
4 #
5 # Created by: PyQt4 UI code generator 4.12.1
6 #
7
8 from PyQt4 import QtCore, QtGui
9
10 try:
11     _fromUtf8 = QtCore.QString.fromUtf8
12 except AttributeError:
13     def _fromUtf8(s):
14         return s
15
16 try:
17     _encoding = QtGui.QApplication.UnicodeUTF8
18     def _translate(context, text, disambig):
19         return QtGui.QApplication.translate(context, text, disambig, _encoding)
20 except AttributeError:
21     def _translate(context, text, disambig):
22         return QtGui.QApplication.translate(context, text, disambig)
23
24 class Ui_MainWindow(object):
25
26     def Handle_OK_Click():
27         print ("Ouch you clicked me!")
28
29     def setupUi(self, MainWindow):
30         MainWindow.setObjectName(_fromUtf8("MainWindow"))
31         MainWindow.resize(325, 223)
32         self.centralwidget = QtGui.QWidget(MainWindow)
33         self.centralwidget.setObjectName(_fromUtf8("centralwidget"))
34         self.btnOK = QtGui.QPushButton(self.centralwidget)
35         self.btnOK.setGeometry(QtCore.QRect(110, 130, 90, 35))
36         font = QtGui.QFont()
37         font.setPointSize(16)
```

```

38         self.btnOK.setFont(font)
39         self.btnOK.setObjectName(_fromUtf8("btnOK"))
40         self.lblMsg = QtGui.QLabel(self.centralwidget)
41         self.lblMsg.setGeometry(QtCore.QRect(20, 30, 261, 51))
42         font = QtGui.QFont()
43         font.setPointSize(28)
44         font.setBold(True)
45         font.setWeight(75)
46         self.lblMsg.setFont(font)
47         self.lblMsg.setAlignment(QtCore.Qt.AlignCenter)
48         self.lblMsg.setObjectName(_fromUtf8("lblMsg"))
49     MainWindow.setCentralWidget(self.centralwidget)
50
51     self.btnOK.clicked.connect (self.Handle_OK_Click)
52
53     self.retranslateUi(MainWindow)
54     QtCore.QMetaObject.connectSlotsByName(MainWindow)
55
56     def retranslateUi(self, MainWindow):
57         MainWindow.setWindowTitle(_translate("MainWindow", "MainWindow", None))
58         self.btnOK.setText(_translate("MainWindow", "OK", None))
59         self.lblMsg.setText(_translate("MainWindow", "Hello World", None))
60
61
62 if __name__ == "__main__":
63     import sys
64     app = QtGui.QApplication(sys.argv)
65     MainWindow = QtGui.QMainWindow()
66     ui = Ui_MainWindow()
67     ui.setupUi(MainWindow)
68     MainWindow.show()
69     sys.exit(app.exec_())

```

What happens here? In lines 26 and 27 we implemented a function `Handle_OK_Click ()`. Then, in line 51 we connect that function to the OK button so that each time you click that OK button we call the function `Handle_OK_Click ()`. In GUI speak, stuff like a button click is called an *event*. The method `Handle_OK_Click ()` handles that event and has hence become the *event handler* for all clicks on the OK button. There are many different types of events - for example, sliding a slider, selecting a list box entry, setting a checkbox and more galore. Any widget (button, checkbox, listbox, ...) needs an event handler for each type of event we want to handle. As an astute reader you have no doubt noticed that the event handler just prints "Ouch, you clicked me!" onto the terminal... As an exercise, implement the proper behaviour I mentioned above!

And for another example! Suppose you have a form with a text box and a checkbox and want to respond to the user typing into the text box and setting the checkbox,

- You need to provide two event handlers³ (similar to example above in lines 26 and 27):
 - One for handling state changes in the checkbox,
 - the other one for handling text changes in the text box

³ As you don't want to handle anything else you don't need any other event handlers.

- You need to connect each event handler to its widget (similar to example above in line 51):
 - You want one handler to run when the user clicks the button, so you would connect that one to the clicked event of the button.
 - You want the other handler to run when the user changes text in the text box, so you would connect that one to the **textChanged** event of the text box⁴.

Here is our wonder application, sporting a line edit and a checkbox - Ladies and gentlemen, put your hands together for the great Frobrinatorrrrr!

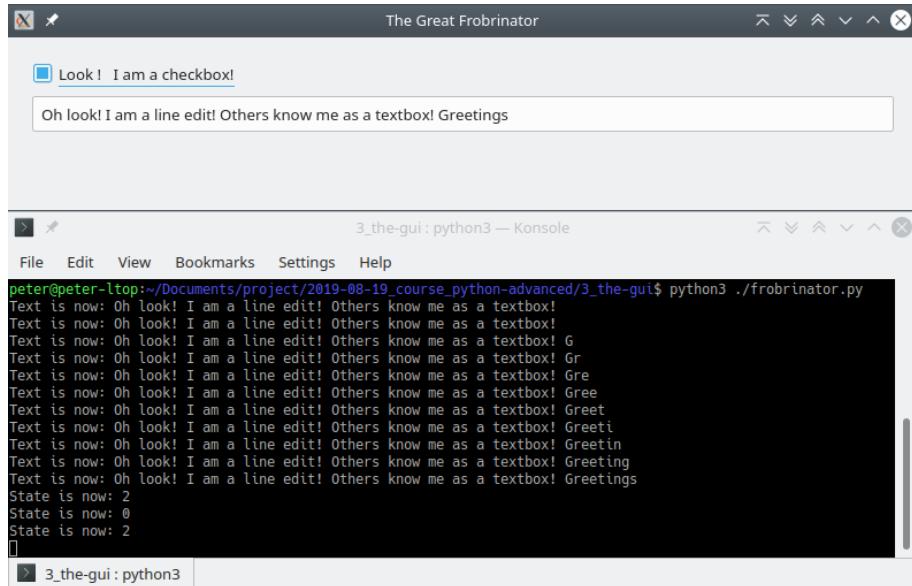


fig 5: The Great Frobri-thing (Hear the sound of applause!)

```

1  # -*- coding: utf-8 -*-
2
3  # Form implementation generated from reading ui file './frobrinator.ui'
4  #
5  # Created by: PyQt4 UI code generator 4.12.1
6
7  from PyQt4 import QtCore, QtGui
8
9  try:
10      _fromUtf8 = QtCore.QString.fromUtf8
11  except AttributeError:
12      def _fromUtf8(s):
13          return s
14
15  try:
16      _encoding = QtGui.QApplication.UnicodeUTF8
17      def _translate(context, text, disambig):
18          return QtGui.QApplication.translate(context, text, disambig, _encoding)
19  except AttributeError:
20      def _translate(context, text, disambig):
21          return QtGui.QApplication.translate(context, text, disambig)
```

⁴ Sorry, I mislead you... in Qt the textbox isn't called a textbox... it's actually called a line edit!

```

22
23 class Ui_MainWindow(object):
24
25     def Handle_LineEdit_TextChanged (self):
26         print ("Text is now: %s" % self.lineEdit.text ())
27
28     def Handle_CheckBox_Toggled (self, state):
29         print ("State is now: %s" % state)
30
31     def setupUi(self, MainWindow):
32         MainWindow.setObjectName(_fromUtf8("MainWindow"))
33         MainWindow.resize(790, 147)
34         self.centralwidget = QtGui.QWidget(MainWindow)
35         self.centralwidget.setObjectName(_fromUtf8("centralwidget"))
36         self.checkBox = QtGui.QCheckBox(self.centralwidget)
37         self.checkBox.setGeometry(QtCore.QRect(20, 20, 181, 23))
38         self.checkBox.setObjectName(_fromUtf8("checkBox"))
39         self.lineEdit = QtGui.QLineEdit(self.centralwidget)
40         self.lineEdit.setGeometry(QtCore.QRect(20, 50, 751, 33))
41         self.lineEdit.setObjectName(_fromUtf8("lineEdit"))
42         MainWindow.setCentralWidget(self.centralwidget)
43         self.menuBar = QtGui.QMenuBar(MainWindow)
44         self.menuBar.setGeometry(QtCore.QRect(0, 0, 790, 31))
45         self.menuBar.setObjectName(_fromUtf8("menuBar"))
46         MainWindow.setMenuBar(self.menuBar)
47         self.statusBar = QtGui.QStatusBar(MainWindow)
48         self.statusBar.setObjectName(_fromUtf8("statusbar"))
49         MainWindow.setStatusBar(self.statusBar)
50
51         self.lineEdit.textChanged.connect (self.Handle_LineEdit_TextChanged)
52         self.checkBox.stateChanged.connect (self.Handle_CheckBox_Toggled)
53
54         self.retranslateUi(MainWindow)
55         QtCore.QMetaObject.connectSlotsByName(MainWindow)
56
57     def retranslateUi(self, MainWindow):
58         MainWindow.setWindowTitle(
59             _translate("MainWindow", "The Great Frobrinator", None))
60         self.checkBox.setText(
61             _translate("MainWindow", "Look ! I am a checkbox!", None))
62         self.lineEdit.setText(
63             _translate(
64                 "MainWindow",
65                 "Oh look! I am a line edit! Others know me as a textbox!",
66                 None
67             )
68         )
69
70 if __name__ == "__main__":
71     import sys
72     app = QtGui.QApplication(sys.argv)
73     MainWindow = QtGui.QMainWindow()
74     ui = Ui_MainWindow()

```

```

75     ui.setupUi(MainWindow)
76     MainWindow.show()
77     sys.exit(app.exec_())

```

What can you put into the event handlers? Your imagination is the limit... you could set the form's color to yellow when you click the button or minimize it when you type "hello" into the text box! Our example above is boring - all it does is to print a message onto the terminal!

So... we didn't really have an event in China (Admit you found the heading kool, otherwise I will attach an event handler to your left earlobe!), but we have plenty of events on our forms, and you are the expert when it comes to handle them! To recap -

- On your GUI you place various widgets,
- Each widget can send events, depending on what the user does with it
- To give your GUI life you have to create event handlers (each handler a function) and connect those to the form's widgets.
- You only need to create (and connect) those handlers you need

Our GUI

After all that long fluff, let's turn our attention back to the GUI we use. We presented the looks at the beginning of this chapter. Here is the source code as created by pyuic (I removed a lot of the generated code, because I want to show our parts):

```

1  from PyQt4 import QtCore, QtGui
2
3  ... snip ...
4
5  class Ui_MainWindow(object):
6      def setupUi(self, MainWindow):
7          ... snip ...
8
9      def retranslateUi(self, MainWindow):
10         ... snip ...
11
12 if __name__ == "__main__":
13     import sys
14     ... snip ...

```

Firstly, we need some event handlers that make the form alive. We need three event handlers (meaning: functions):

- An event handler which captures mouse (left) clicks on the Play button,
- An event handler which captures item selections on the left hand playlist,
- An event handler which captures value changes on the volume slider (i.e. user moves the slider).

We implement these functions as methods of the **Ui_MainWindow** class, and we mark them as private by putting an underscore in front of them⁵:

⁵ It's just a convention saying to others "Please don't use". In current python every method is (really) public.

```

1  from PyQt4 import QtCore, QtGui
2
3  ... snip ...
4
5  class Ui_MainWindow(object):
6      """
7          The local GUI.
8      """
9      def _Handle.BtnPlay_Click (self):
10         """
11             Event handler: User clicked "Play" button.
12         """
13         ... to be added later ...
14
15     def _Handle.LstPlaylist_Select (self, item):
16         """
17             Event handler: User selected a song on the playlist.
18         """
19         ... to be added later ...
20
21     def _Handle.SldVolume_Move (self, currentValue):
22         """
23             Event handler: User changed volume setting.
24         """
25         ... to be added later ...
26
27     def setupUi(self, MainWindow):
28         ... snip ...
29
30         self.fBtnPlay.clicked.connect      (self._Handle.BtnPlay_Click)
31         self.fLstPlaylist.itemClicked.connect (self._Handle.LstPlaylist_Select)
32         self.fSldVolume.sliderMoved.connect (self._Handle.SldVolume_Move)
33
34     def retranslateUi(self, MainWindow):
35         ... snip ...
36
37 if __name__ == "__main__":
38     import sys
39     ... snip ...

```

As you see, we have three little event handlers and their evil little sisters (connection statements in `setupUI()`). Note that from here forthwith we do some better source commenting. This is going to be the standard. Good source commenting makes code much much more readable - even to yourself after five years!

For the full code of our GUI, see Appendix A, Listing 1.

Task: Implement some behaviour in the new GUI:

- At application startup have the program load three items into the left hand playlist and set the Play button disabled.
- When you click an item in the playlist set the Play button enabled. Then write the text of what you clicked into the terminal (via `print(...)`).
- When you click the (enabled) Play button, and it has "Play" written on it, change its text to "Pause".
- When you click the (enabled) Play button, and it has "Pause" written on it, change its text to "Play".
- When you move the slider, have it write its current value to the terminal (via `print(...)`).

The GUI reloaded

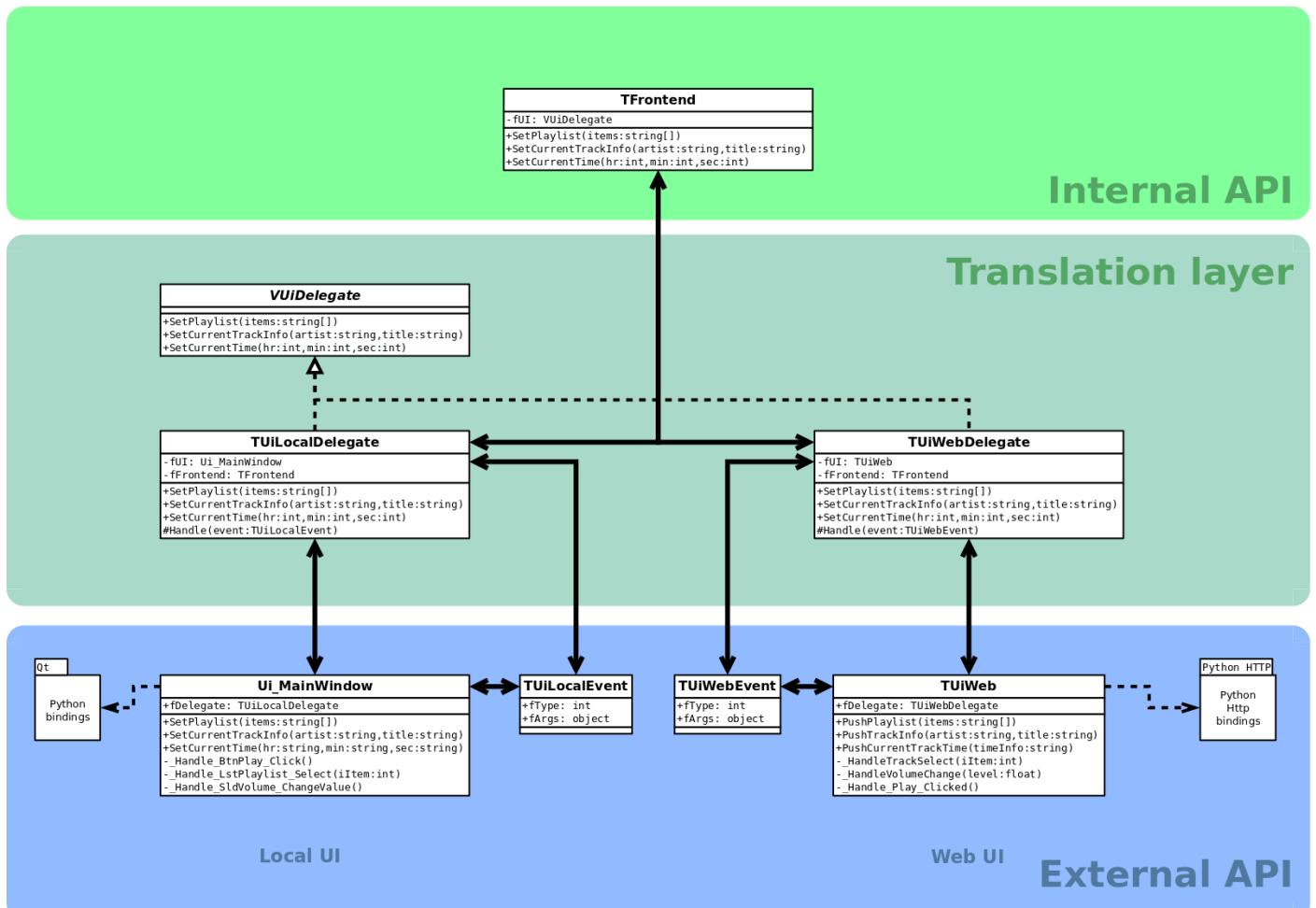
So far our GUI stands by itself. The GUI is the app! As you did your last task you will have noticed that the code grew more and more complex! You may get a hunch that this will become much more complex as you go on. For example, you could bind the vlc part into the GUI and then integrate everything, so you hear the music you select. It's a fast way of getting some results, and it's good to test something quickly or do some prototype. But if we want to develop this further (and we will) then we should really not cram everything into the GUI code - it would become a bloated unmanageable mess! The mistake we'd make would be quite simply that we are trying to integrate the application into the GUI! What we should do instead is to integrate the GUI into our application! This little reversal means a lot for the GUI code as it will mean a much smaller and tidier code - making the thing manageable and maintainable! And it opens a world of opportunities what else we could integrate into our application! For example, as you have seen in chapter 2 there is also another, web based UI to come!

The first step to a good GUI is that we give it a voice that speaks in a large application. What was that code word again, back in chapter 2? Wasn't there something about APIs?

APIs, delegates and singleness

As you will see, our GUI is a highly specialized thing. Its main purpose is to interact with the user by capturing user actions (events: clicks, slides, ...) and changing its appearance (changing some text, coloring some element blue, ...). Because it's so specialized it needs a special set of functions to express that. Unfortunately we cannot allow this special-ness to spread to the entire application! Especially, if we also integrate another UI (that web based one) which is highly specialized as well! That's why we provide each of these special components with a *delegate* - that is a class which makes them both appear the same to our application. We call it a delegate because it represents the specialized UI components, so both of them present the same API to our application! The result will be an *enormously* more readable and maintainable code!

Enough with the preface, let's do it! Here's what I mean:



Here we put some flesh and bones on the big picture we presented back in lesson 2. Basically, we have the external API (UI components), the internal API (our program) and the delegates as the glue between the two. You can see that the components in the external API use their own specialized set of methods. For example, you would call **SetPlaylist** to fill the playlist in the local UI whilst you would call **PushPlaylist** in the web UI.

Meanwhile, the Delegates provide identical methods for filling the playlist, namely **SetPlaylist**. This means that whatever UI we use, from our internal API calls **SetPlaylist**. This concept can scale indefinitely - we can add as many different UIs as we want, and thanks to the Delegates we always call **SetPlaylist** to fill the playlist widget.

To enforce consistency we provide a *base class* - **VUIDelegate** - and have all delegates *inherit from* this class. **VUIDelegate** contains nothing but method stubs, and each delegate must implement the methods prescribed by it. You will notice that **VUIDelegate** provides only setters (**SetPlaylist**, **SetCurrentTrackInfo**, **SetCurrentTime**), but none of the **Handle** methods. This is because the setters are called from our application whilst the handlers are called by the resp. frontends. The handlers are as specialized as the frontends which call them. The handlers can still talk to our application by calling the appropriate method in the **TFrontend** class.

Let's talk about **TFrontend**! We now have a unified view on *all* UIs, so why not bundle the whole access via one object? When the application runs we will provide a single, application wide, object of type **TFrontend** which channels all our wishes to whatever UI is running at the moment. To the application (internal API) the single **TFrontend** object becomes our *facade* of the the whole UI framework. The internal API does not need to know what kind of UI it operates, it just tells the facade what it wants done on the UI. For example, if our application wants to set the title and artist of the current track it calls frontend's method **SetCurrentTrackInfo** which then calls **SetCurrentTrackInfo** of the current delegate which then calls the appropriate method(s) in the current UI.

TFrontend is the last step to make UI access easy as we now have one object via which we talk to any UI. Note the difference - I said, "one *object*", not just "one class". Application wide, there is one and *only* one object (meaning - instance of a class) that we use for our UI work. This pattern is called *singleton pattern* (singleton being that one object), and it makes the whole UI access *insanely* easy for our application!

Lesson 4: The controller

Objective: Show the concept of a state machine and integrate the GUI into it. Demonstrate how the state machine controls the GUI.

So far we have implemented the program's logic in the GUI. This has several drawbacks, most notably that it is inflexible (as we are bound to a single GUI only) and makes the program convoluted, i.e hard to maintain. The way forward is to follow the "separation of concerns" principle by exporting the program's logic into its own part. We shall explore a viable route by introducing a controller which utilizes a state engine at its core. A state machine is usually shown as the diagram in fig 6.

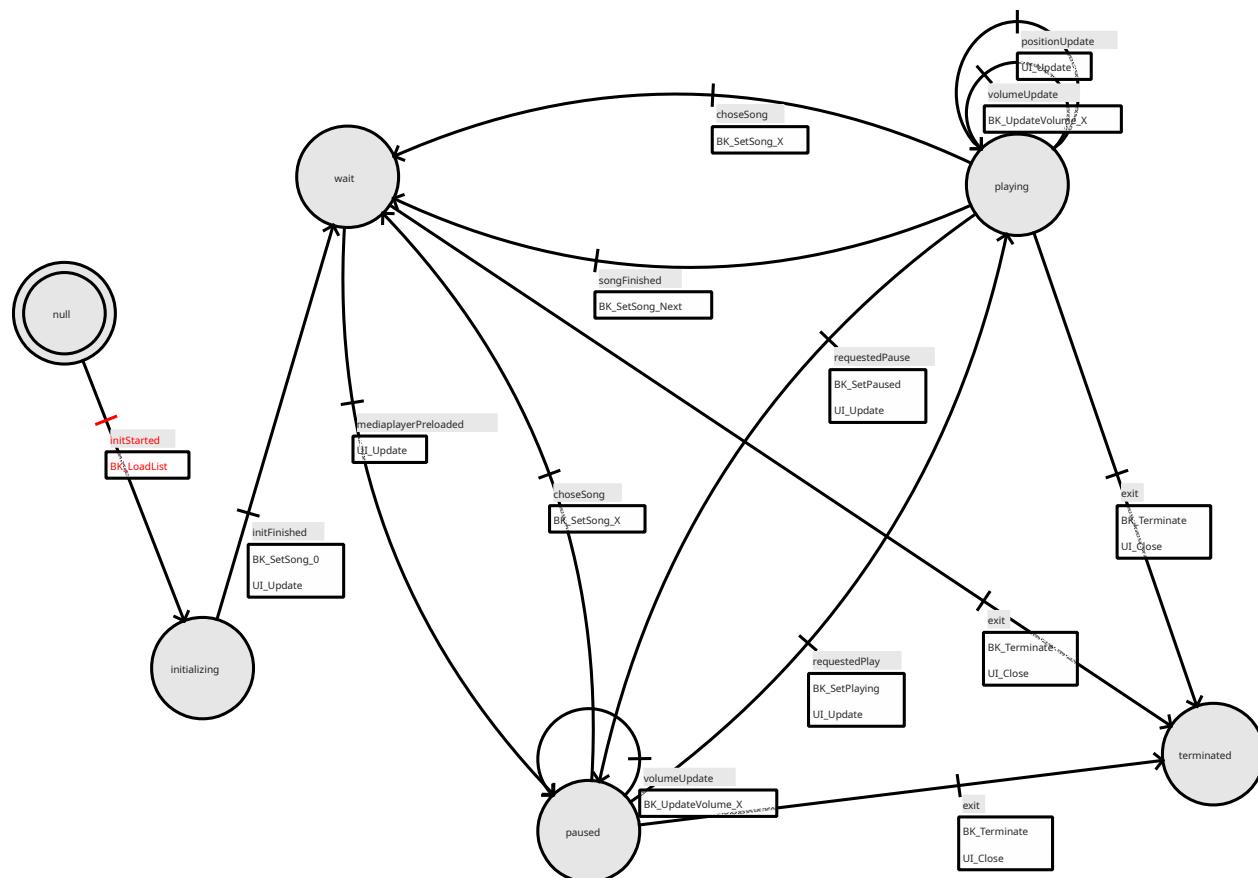
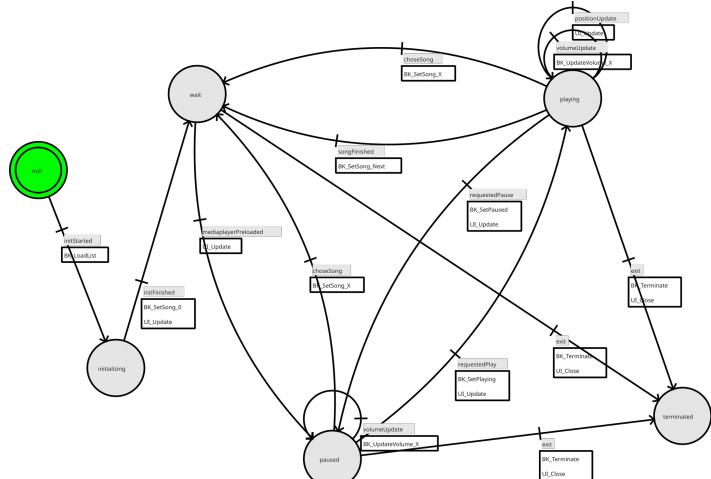


fig 6: state machine

A state machine provides fine grained control of complex applications, also with asynchronous processes. Our media player uses plenty of those! Here is a hypothetical program run and how the state engine controls the player.

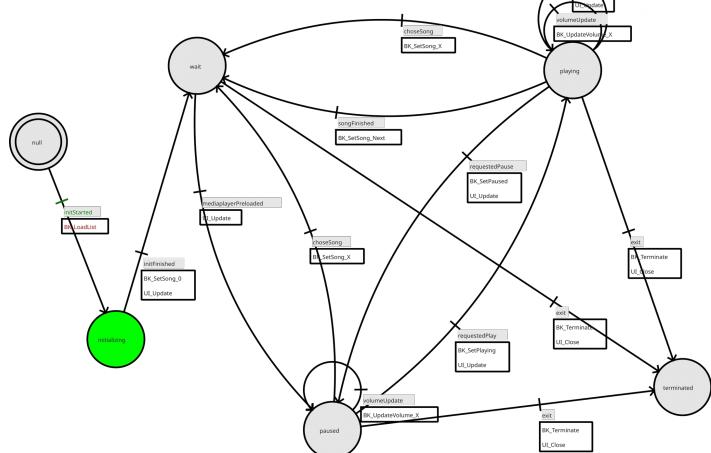
At program start we set the state engine to state **null**.



We issue event **initStarted**.

This sets the engine into state **initializing**.

State machine calls **BK_LoadList ()** to load the songs into the playlist.

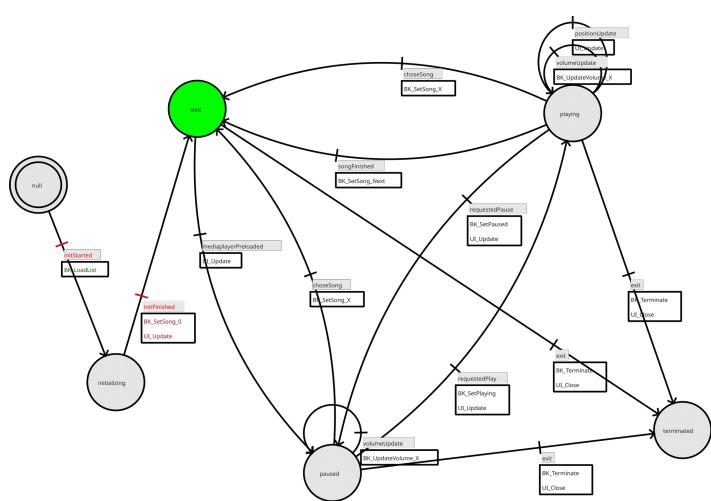


List has loaded. We issue event **initFinished**.

This sets the state machine into state **wait**.

State machine calls **BK_SetSong (0)** to have the backend load the first song into the media layer.

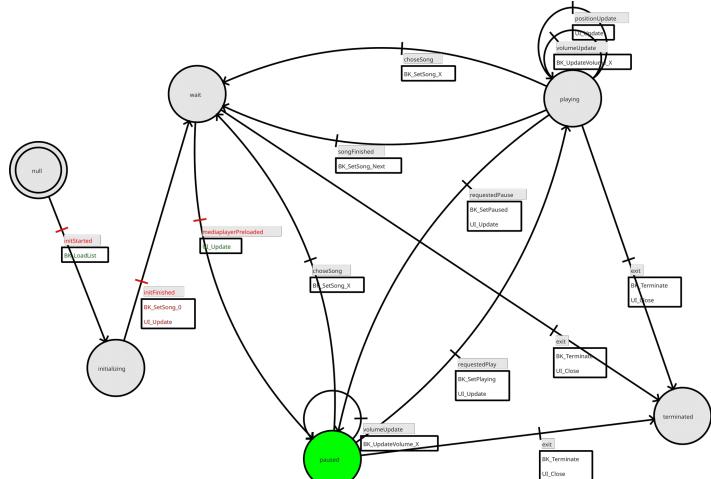
Song loading is asynchronous, i.e. we wait for another event from the backend when the media layer has actually loaded the song.



Media layer has loaded the song.
Backend issues the event **mediaplayerPreload**.

This sets the state engine into state **paused**.

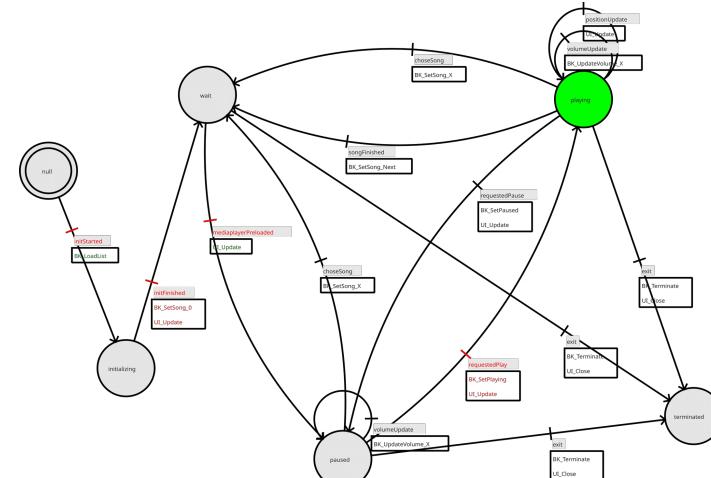
State machine calls **UI_Update ()** to update the frontend (UI).



User clicked the big Play button which issues a **requestPlay** event.

This sets the state engine into state **playing**.

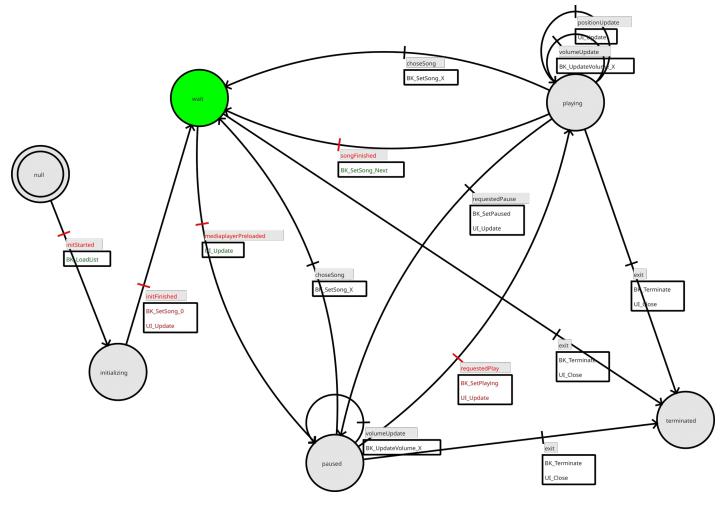
State machine first calls **BK_SetPlaying ()** (media layer plays track), then **UI_Update ()** to update the Frontend (UI).



Song has finished, so the backend layer issues a **songFinished** event.

This sets the state machine into state **wait**.

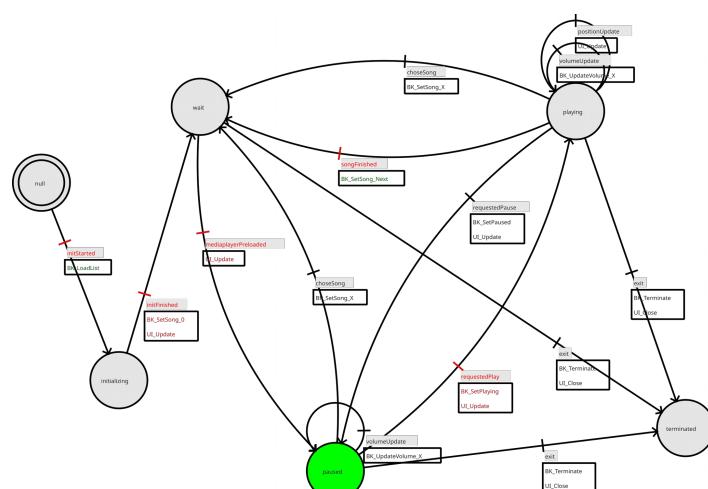
State machine calls **BK_SetSong_Next()** to have the backend load the next song into the media layer.



Media layer has loaded the next song. Backend issues the event **mediaplayerPreload**.

This sets the state engine into state **paused**.

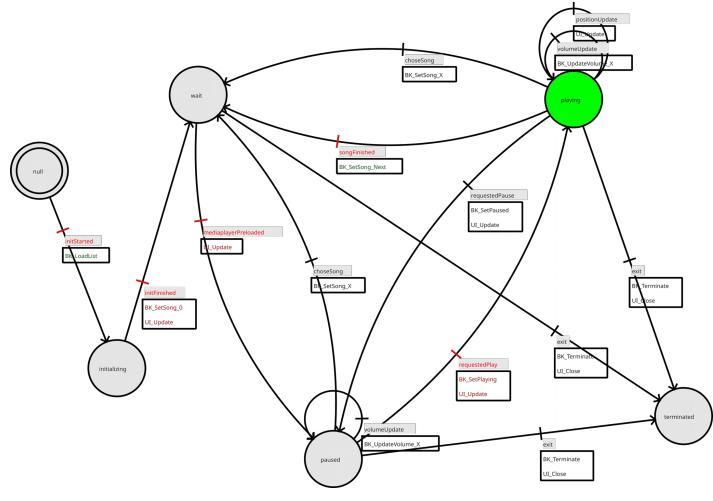
State machine calls **UI_Update()** to update the frontend (UI).



User clicked the Play button which issues a **requestPlay** event.

This sets the state engine into state **playing**.

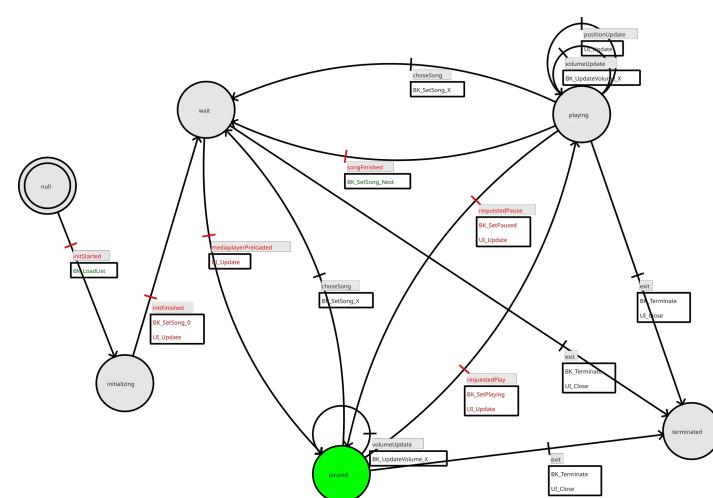
State machine first calls **BK_SetPlaying ()** (media layer plays track), then **UI_Update ()** to update the Frontend (UI).



User clicked the Pause button which issues a **requestPause** event.

This sets the state engine into state **paused**.

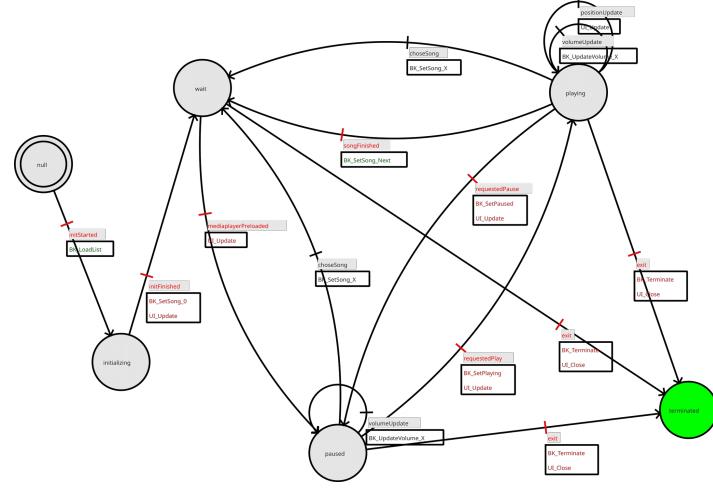
State machine first calls **BK_SetPaused ()** (media layer plays track), then **UI_Update ()** to update the Frontend (UI).



User closed the application which issues an **exit** event.

This sets the state engine into state **terminated**.

State machine first calls **BK_Terminate ()** which cleans up any traces (close audio streams etc.) and updates the frontend (UI) so it shows that we exit.



Lesson 5: The backend

Objective: We build the backend layer which controls audio system and provides a simple playlist management.

Lesson 6: The controller II

Objective: We integrate controller and audio backend and connect it with the GUI.

Lesson 7: WEB GUI, visual design

Objective: We design a simple web GUI (HTML + CSS).

Lesson 8: Player, web service

Objective: We design the player's web backend (Web + web socket server + delegate).

Lesson 9: Integrating web GUI and web service.

Objective: We design a javascript library which communicates with the player's web service to send user requests (track choice, volume updates, ...), receive server information (track infos, track position, volume, ...) and update the web GUI

Appendix A (Source code)

Listing 1:

```
1  # -*- coding: utf-8 -*-
2
3  # Form implementation generated from reading ui file './gui.ui'
4  #
5  # Created by: PyQt4 UI code generator 4.12.1
6
7  from PyQt4 import QtCore, QtGui
8
9  try:
10      _fromUtf8 = QtCore.QString.fromUtf8
11 except AttributeError:
12     def _fromUtf8(s):
13         return s
14
15 try:
16     _encoding = QtGui.QApplication.UnicodeUTF8
17     def _translate(context, text, disambig):
18         return QtGui.QApplication.translate(context, text, disambig, _encoding)
19 except AttributeError:
20     def _translate(context, text, disambig):
21         return QtGui.QApplication.translate(context, text, disambig)
22
23 class Ui_MainWindow(object):
24     def _Handle.BtnPlay_Click (self):
25         """
26             Event handler: User clicked "Play" button.
27         """
28         ... to be added later ...
29
30     def _Handle.LstPlaylist_Select (self, item):
31         """
32             Event handler: User selected a song on the playlist.
33         """
34         ... to be added later ...
35
36     def _Handle.SldVolume_Move (self, currentValue):
37         """
38             Event handler: User changed volume setting.
39         """
40         ... to be added later ...
41
42     def setupUi(self, MainWindow):
43         MainWindow.setObjectName(_fromUtf8("MainWindow"))
44         MainWindow.resize(965, 600)
45         self.centralwidget = QtGui.QWidget(MainWindow)
46         self.centralwidget.setObjectName(_fromUtf8("centralwidget"))
47         self.horizontalLayout = QtGui.QHBoxLayout(self.centralwidget)
```

```

48         self.horizontalLayout.setObjectName(_fromUtf8("horizontalLayout"))
49         self.verticalLayout = QtGui.QVBoxLayout()
50         self.verticalLayout.setSizeConstraint(QtGui.QLayout.SetDefaultConstraint)
51     )
52         self.verticalLayout.setContentsMargins(0, 0, 0, -1)
53         self.verticalLayout.setObjectName(_fromUtf8("verticalLayout"))
54         self.label = QtGui.QLabel(self.centralwidget)
55         font = QtGui.QFont()
56         font.setPointSize(14)
57         font.setBold(True)
58         font.setWeight(75)
59         self.label.setFont(font)
60         self.label.setTextFormat(QtCore.Qt.PlainText)
61         self.label.setObjectName(_fromUtf8("label"))
62         self.verticalLayout.addWidget(self.label)
63         self.fLstSongs = QtGui.QListWidget(self.centralwidget)
64         font = QtGui.QFont()
65         font.setPointSize(14)
66         font.setBold(True)
67         font.setWeight(75)
68         self.fLstSongs.setFont(font)
69         self.fLstSongs.setVerticalScrollBarPolicy(QtCore.Qt.ScrollBarAlwaysOn)
70         self.fLstSongs.setHorizontalScrollBarPolicy(QtCore.Qt.ScrollBarAlwaysOff)
71     )
72         self.fLstSongs.setUniformItemSizes(False)
73         self.fLstSongs.setSelectionRectVisible(True)
74         self.fLstSongs.setObjectName(_fromUtf8("fLstSongs"))
75         self.verticalLayout.addWidget(self.fLstSongs)
76         self.horizontalLayout.addLayout(self.verticalLayout)
77         self.line = QtGui.QFrame(self.centralwidget)
78         self.line.setFrameShape(QtGui.QFrame.VLine)
79         self.line.setFrameShadow(QtGui.QFrame.Sunken)
80         self.line.setObjectName(_fromUtf8("line"))
81         self.horizontalLayout.addWidget(self.line)
82         self.frame = QtGui.QFrame(self.centralwidget)
83         sizePolicy = QtGui.QSizePolicy(
84             QtGui.QSizePolicy.Minimum, QtGui.QSizePolicy.Preferred)
85         sizePolicy.setHorizontalStretch(0)
86         sizePolicy.setVerticalStretch(0)
87         sizePolicy.setHeightForWidth(
88             self.frame.sizePolicy().hasHeightForWidth())
89         self.frame.setSizePolicy(sizePolicy)
90         self.frame.setMinimumSize(QtCore.QSize(640, 0))
91         self.frame.setFrameShape(QtGui.QFrame.StyledPanel)
92         self.frame.setFrameShadow(QtGui.QFrame.Raised)
93         self.frame.setLineWidth(0)
94         self.frame.setObjectName(_fromUtf8("frame"))
95         self.verticalLayout_3 = QtGui.QVBoxLayout(self.frame)
96         self.verticalLayout_3.setObjectName(_fromUtf8("verticalLayout_3"))
97         self.frame_2 = QtGui.QFrame(self.frame)
98         self.frame_2.setFrameShape(QtGui.QFrame.NoFrame)

```

```

99         self.verticalLayout_2 = QtGui.QVBoxLayout(self.frame_2)
100        self.verticalLayout_2.setObjectName(_fromUtf8("verticalLayout_2"))
101        spacerItem = QtGui.QSpacerItem(
102            20, 84, QtGui.QSizePolicy.Minimum, QtGui.QSizePolicy.Expanding)
103        self.verticalLayout_2.addItem(spacerItem)
104        self.fLblSongTitle = QtGui.QLabel(self.frame_2)
105        font = QtGui.QFont()
106        font.setPointSize(14)
107        self.fLblSongTitle.setFont(font)
108        self.fLblSongTitle.setAlignment(QtCore.Qt.AlignCenter)
109        self.fLblSongTitle.setObjectName(_fromUtf8("fLblSongTitle"))
110        self.verticalLayout_2.addWidget(self.fLblSongTitle)
111        self.frame_3 = QtGui.QFrame(self.frame_2)
112        self.frame_3 setFrameShape(QtGui.QFrame.NoFrame)
113        self.frame_3 setFrameShadow(QtGui.QFrame.Raised)
114        self.frame_3.setObjectName(_fromUtf8("frame_3"))
115        self.horizontalLayout_2 = QtGui.QHBoxLayout(self.frame_3)
116        self.horizontalLayout_2.setObjectName(_fromUtf8("horizontalLayout_2"))
117        spacerItem1 = QtGui.QSpacerItem(
118            197, 20, QtGui.QSizePolicy.Expanding, QtGui.QSizePolicy.Minimum)
119        self.horizontalLayout_2.addItem(spacerItem1)
120        self.fBtnPlay = QtGui.QPushButton(self.frame_3)
121        self.fBtnPlay.setMinimumSize(QtCore.QSize(188, 78))
122        font = QtGui.QFont()
123        font.setPointSize(26)
124        font.setBold(True)
125        font.setWeight(75)
126        self.fBtnPlay.setFont(font)
127        self.fBtnPlay.setCheckable(False)
128        self.fBtnPlay.setObjectName(_fromUtf8("fBtnPlay"))
129        self.horizontalLayout_2.addWidget(self.fBtnPlay)
130        spacerItem2 = QtGui.QSpacerItem(
131            197, 20, QtGui.QSizePolicy.Expanding, QtGui.QSizePolicy.Minimum)
132        self.horizontalLayout_2.addItem(spacerItem2)
133        self.verticalLayout_2.addWidget(self.frame_3)
134        self.fLblTime = QtGui.QLabel(self.frame_2)
135        font = QtGui.QFont()
136        font.setPointSize(23)
137        self.fLblTime.setFont(font)
138        self.fLblTime.setAlignment(QtCore.Qt.AlignCenter)
139        self.fLblTime.setObjectName(_fromUtf8("fLblTime"))
140        self.verticalLayout_2.addWidget(self.fLblTime)
141        spacerItem3 = QtGui.QSpacerItem(
142            20, 200, QtGui.QSizePolicy.Minimum, QtGui.QSizePolicy.Expanding)
143        self.verticalLayout_2.addItem(spacerItem3)
144        self.verticalLayout_3.addWidget(self.frame_2)
145        self.line_2 = QtGui.QFrame(self.frame)
146        self.line_2 setFrameShape(QtGui.QFrame.HLine)
147        self.line_2 setFrameShadow(QtGui.QFrame.Sunken)
148        self.line_2.setObjectName(_fromUtf8("line_2"))
149        self.verticalLayout_3.addWidget(self.line_2)
150        self.frame_4 = QtGui.QFrame(self.frame)
151        self.frame_4 setFrameShape(QtGui.QFrame.NoFrame)

```

```

152         self.frame_4.setFrameShadow(QtGui.QFrame.Raised)
153         self.frame_4.setObjectName(_fromUtf8("frame_4"))
154         self.horizontalLayout_3 = QtGui.QHBoxLayout(self.frame_4)
155         self.horizontalLayout_3.setObjectName(_fromUtf8("horizontalLayout_3"))
156         spacerItem4 = QtGui.QSpacerItem(
157             40, 20, QtGui.QSizePolicy.Expanding, QtGui.QSizePolicy.Minimum)
158         self.horizontalLayout_3.addItem(spacerItem4)
159         self.label_2 = QtGui.QLabel(self.frame_4)
160         self.label_2.setObjectName(_fromUtf8("label_2"))
161         self.horizontalLayout_3.addWidget(self.label_2)
162         self.fSldVolume = QtGui.QSlider(self.frame_4)
163         sizePolicy = QtGui.QSizePolicy(
164             QtGui.QSizePolicy.Fixed, QtGui.QSizePolicy.Fixed)
165         sizePolicy.setHorizontalStretch(0)
166         sizePolicy.setVerticalStretch(0)
167         sizePolicy.setHeightForWidth(
168             self.fSldVolume.sizePolicy().hasHeightForWidth())
169         self.fSldVolume.setSizePolicy(sizePolicy)
170         self.fSldVolume.setMinimumSize(QtCore.QSize(225, 0))
171         self.fSldVolume.setBaseSize(QtCore.QSize(0, 0))
172         self.fSldVolume.setAcceptDrops(False)
173         self.fSldVolume.setTracking(True)
174         self.fSldVolume.setOrientation(QtCore.Qt.Horizontal)
175         self.fSldVolume.setInvertedAppearance(False)
176         self.fSldVolume.setInvertedControls(False)
177         self.fSldVolume.setObjectName(_fromUtf8("fSldVolume"))
178         self.horizontalLayout_3.addWidget(self.fSldVolume)
179         self.verticalLayout_3.addWidget(self.frame_4)
180         self.horizontalLayout.addWidget(self.frame)
181         MainWindow.setCentralWidget(self.centralwidget)
182         self.menuBar = QtGui.QMenuBar(MainWindow)
183         self.menuBar.setGeometry(QtCore.QRect(0, 0, 965, 31))
184         self.menuBar.setObjectName(_fromUtf8("menuBar"))
185         MainWindow.setMenuBar(self.menuBar)
186         self.statusBar = QtGui.QStatusBar(MainWindow)
187         self.statusBar.setObjectName(_fromUtf8("statusBar"))
188         MainWindow.setStatusBar(self.statusBar)
189
190         self.fBtnPlay.clicked.connect      (self._Handle_BtnPlay_Click)
191         self.fLstPlaylist.itemClicked.connect (self._Handle_LstPlaylist_Select)
192         self.fSldVolume.sliderMoved.connect (self._Handle_SldVolume_Move)
193
194         QtCore.QMetaObject.connectSlotsByName(MainWindow)
195
196
197
198     def retranslateUi(self, MainWindow):
199         MainWindow.setWindowTitle(_translate("MainWindow", "myplayer", None))
200         self.label.setText(_translate("MainWindow", "Songlist", None))
201         self.fLblSongTitle.setText(
202             _translate("MainWindow", "Artist - Track", None))
203         self.fBtnPlay.setText(_translate("MainWindow", "Play", None))
204         self.fLblTime.setText(_translate("MainWindow", "00:00", None))

```

```

205         self.label_2.setText(_translate("MainWindow", "Volume", None))
206
207
208     if __name__ == "__main__":
209         import sys
210         app = QtGui.QApplication(sys.argv)
211         MainWindow = QtGui.QMainWindow()
212         ui = Ui_MainWindow()
213         ui.setupUi(MainWindow)
214         MainWindow.show()
215         sys.exit(app.exec_())

```

Listing 2: Lesson 3, gui.py

```

216 # -*- coding: utf-8 -*-
217
218 # Form implementation generated from reading ui file './gui.ui'
219 #
220
221 from PyQt4 import QtCore, QtGui
222
223 try:
224     _fromUtf8 = QtCore.QString.fromUtf8
225 except AttributeError:
226     def _fromUtf8(s):
227         return s
228
229 try:
230     _encoding = QtGui.QApplication.UnicodeUTF8
231     def _translate(context, text, disambig):
232         return QtGui.QApplication.translate(context, text, disambig,
233 _encoding)
234     except AttributeError:
235         def _translate(context, text, disambig):
236             return QtGui.QApplication.translate(context, text, disambig)
237
238 class Ui_MainWindow(object):
239     def setupUi(self, MainWindow):
240         MainWindow.setObjectName(_fromUtf8("MainWindow"))
241         MainWindow.resize(965, 600)
242         self.centralwidget = QtGui.QWidget(MainWindow)
243         self.centralwidget.setObjectName(_fromUtf8("centralwidget"))
244         self.horizontalLayout = QtGui.QHBoxLayout(self.centralwidget)
245         self.horizontalLayout.setObjectName(_fromUtf8("horizontalLayout"))
246         self.verticalLayout = QtGui.QVBoxLayout()
247         self.verticalLayout.setSizeConstraint(QtGui.QLayout.SetDefaultConstra
int)
248         self.verticalLayout.setContentsMargins(0, 0, 0, -1)
249         self.verticalLayout.setObjectName(_fromUtf8("verticalLayout"))
250         self.label = QtGui.QLabel(self.centralwidget)
251         font = QtGui.QFont()
252         font.setPointSize(14)

```

```

252         font.setBold(True)
253         font.setWeight(75)
254         self.label.setFont(font)
255         self.label.setTextFormat(QtCore.Qt.PlainText)
256         self.label.setObjectName(_fromUtf8("label"))
257         self.verticalLayout.addWidget(self.label)
258         self.fLstSongs = QtGui.QListWidget(self.centralwidget)
259         font = QtGui.QFont()
260         font.setPointSize(14)
261         font.setBold(True)
262         font.setWeight(75)
263         self.fLstSongs.setFont(font)
264         self.fLstSongs.setVerticalScrollBarPolicy(QtCore.Qt.ScrollBarAlwaysOn
265 )
265         self.fLstSongs.setHorizontalScrollBarPolicy(QtCore.Qt.ScrollBarAlways
266 Off)
266         self.fLstSongs.setUniformItemSizes(False)
267         self.fLstSongs.setSelectionRectVisible(True)
268         self.fLstSongs.setObjectName(_fromUtf8("fLstSongs"))
269         self.verticalLayout.addWidget(self.fLstSongs)
270         self.horizontalLayout.addLayout(self.verticalLayout)
271         self.line = QtGui.QFrame(self.centralwidget)
272         self.line setFrameShape(QtGui.QFrame.VLine)
273         self.line setFrameShadow(QtGui.QFrame.Sunken)
274         self.line.setObjectName(_fromUtf8("line"))
275         self.horizontalLayout.addWidget(self.line)
276         self.frame = QtGui.QFrame(self.centralwidget)
277             sizePolicy = QtGui.QSizePolicy(QtGui.QSizePolicy.Minimum,
278 QtGui.QSizePolicy.Preferred)
278             sizePolicy.setHorizontalStretch(0)
279             sizePolicy.setVerticalStretch(0)
280             sizePolicy.setHeightForWidth(self.frame.sizePolicy().hasHeightForWidt
280 h())
281             self.frame.setSizePolicy(sizePolicy)
282             self.frame.setMinimumSize(QtCore.QSize(640, 0))
283             self.frame setFrameShape(QtGui.QFrame.StyledPanel)
284             self.frame setFrameShadow(QtGui.QFrame.Raised)
285             self.frame.setLineWidth(0)
286             self.frame.setObjectName(_fromUtf8("frame"))
287             self.verticalLayout_3 = QtGui.QVBoxLayout(self.frame)
288             self.verticalLayout_3.setObjectName(_fromUtf8("verticalLayout_3"))
289             self.frame_2 = QtGui.QFrame(self.frame)
290             self.frame_2 setFrameShape(QtGui.QFrame.NoFrame)
291             self.frame_2 setFrameShadow(QtGui.QFrame.Raised)
292             self.frame_2.setObjectName(_fromUtf8("frame_2"))
293             self.verticalLayout_2 = QtGui.QVBoxLayout(self.frame_2)
294             self.verticalLayout_2.setObjectName(_fromUtf8("verticalLayout_2"))
295                 spacerItem = QtGui.QSpacerItem(20, 84, QtGui.QSizePolicy.Minimum,
295 QtGui.QSizePolicy.Expanding)
296                 self.verticalLayout_2.addItem(spacerItem)
297                 self.fLblSongTitle = QtGui.QLabel(self.frame_2)
298                 font = QtGui.QFont()
299                 font.setPointSize(14)

```

```

300         self.fLblSongTitle.setFont(font)
301         self.fLblSongTitle.setAlignment(QtCore.Qt.AlignCenter)
302         self.fLblSongTitle.setObjectName(_fromUtf8("fLblSongTitle"))
303         self.verticalLayout_2.addWidget(self.fLblSongTitle)
304         self.frame_3 = QtGui.QFrame(self.frame_2)
305         self.frame_3.setFrameShape(QtGui.QFrame.NoFrame)
306         self.frame_3.setFrameShadow(QtGui.QFrame.Raised)
307         self.frame_3.setObjectName(_fromUtf8("frame_3"))
308         self.horizontalLayout_2 = QtGui.QHBoxLayout(self.frame_3)
309         self.horizontalLayout_2.setObjectName(_fromUtf8("horizontalLayout_2"))
310     )
311     spacerItem1 = QtGui.QSpacerItem(197, 20, QtGui.QSizePolicy.Expanding,
312                                     QtGui.QSizePolicy.Minimum)
313     self.horizontalLayout_2.addItem(spacerItem1)
314     self.fBtnPlay = QtGui.QPushButton(self.frame_3)
315     self.fBtnPlay.setMinimumSize(QtCore.QSize(188, 78))
316     font = QtGui.QFont()
317     font.setPointSize(26)
318     font.setBold(True)
319     font.setWeight(75)
320     self.fBtnPlay.setFont(font)
321     self.fBtnPlay.setCheckable(False)
322     self.fBtnPlay.setObjectName(_fromUtf8("fBtnPlay"))
323     self.horizontalLayout_2.addWidget(self.fBtnPlay)
324     spacerItem2 = QtGui.QSpacerItem(197, 20, QtGui.QSizePolicy.Expanding,
325                                     QtGui.QSizePolicy.Minimum)
326     self.horizontalLayout_2.addItem(spacerItem2)
327     self.verticalLayout_2.addWidget(self.frame_3)
328     self.fLblTime = QtGui.QLabel(self.frame_2)
329     font = QtGui.QFont()
330     font.setPointSize(23)
331     self.fLblTime.setFont(font)
332     self.fLblTime.setAlignment(QtCore.Qt.AlignCenter)
333     self.fLblTime.setObjectName(_fromUtf8("fLblTime"))
334     self.verticalLayout_2.addWidget(self.fLblTime)
335     spacerItem3 = QtGui.QSpacerItem(20, 200, QtGui.QSizePolicy.Minimum,
336                                     QtGui.QSizePolicy.Expanding)
337     self.verticalLayout_2.addItem(spacerItem3)
338     self.verticalLayout_3.addWidget(self.frame_2)
339     self.line_2 = QtGui.QFrame(self.frame)
340     self.line_2.setFrameShape(QtGui.QFrame.HLine)
341     self.line_2.setFrameShadow(QtGui.QFrame.Sunken)
342     self.line_2.setObjectName(_fromUtf8("line_2"))
343     self.verticalLayout_3.addWidget(self.line_2)
344     self.frame_4 = QtGui.QFrame(self.frame)
345     self.frame_4.setFrameShape(QtGui.QFrame.NoFrame)
346     self.frame_4.setFrameShadow(QtGui.QFrame.Raised)
347     self.frame_4.setObjectName(_fromUtf8("frame_4"))
348     self.horizontalLayout_3 = QtGui.QHBoxLayout(self.frame_4)
349     self.horizontalLayout_3.setObjectName(_fromUtf8("horizontalLayout_3"))
350   )
351   spacerItem4 = QtGui.QSpacerItem(40, 20, QtGui.QSizePolicy.Expanding,
352                                     QtGui.QSizePolicy.Minimum)

```

```

347         self.horizontalLayout_3.addItem(spacerItem4)
348         self.label_2 = QtGui.QLabel(self.frame_4)
349         self.label_2.setObjectName(_fromUtf8("label_2"))
350         self.horizontalLayout_3.addWidget(self.label_2)
351         self.fSldVolume = QtGui.QSlider(self.frame_4)
352             sizePolicy = QtGui.QSizePolicy(QtGui.QSizePolicy.Fixed,
353                                         QtGui.QSizePolicy.Fixed)
353             sizePolicy.setHorizontalStretch(0)
354             sizePolicy.setVerticalStretch(0)
355             sizePolicy.setHeightForWidth(self.fSldVolume.sizePolicy().hasHeightFor
356                                         rWidth())
356         self.fSldVolume.setSizePolicy(sizePolicy)
357         self.fSldVolume.setMinimumSize(QtCore.QSize(225, 0))
358         self.fSldVolume.setBaseSize(QtCore.QSize(0, 0))
359         self.fSldVolume.setAcceptDrops(False)
360         self.fSldVolume.setTracking(True)
361         self.fSldVolume.setOrientation(QtCore.Qt.Horizontal)
362         self.fSldVolume.setInvertedAppearance(False)
363         self.fSldVolume.setInvertedControls(False)
364         self.fSldVolume.setObjectName(_fromUtf8("fSldVolume"))
365         self.horizontalLayout_3.addWidget(self.fSldVolume)
366         self.verticalLayout_3.addWidget(self.frame_4)
367         self.horizontalLayout.addWidget(self.frame)
368         MainWindow.setCentralWidget(self.centralwidget)
369         self.menubar = QtGui.QMenuBar(MainWindow)
370         self.menubar.setGeometry(QtCore.QRect(0, 0, 965, 31))
371         self.menubar.setObjectName(_fromUtf8("menubar"))
372         MainWindow.setMenuBar(self.menubar)
373         self.statusbar = QtGui.QStatusBar(MainWindow)
374         self.statusbar.setObjectName(_fromUtf8("statusbar"))
375         MainWindow.setStatusBar(self.statusbar)

376
377         self.retranslateUi(MainWindow)
378         QtCore.QMetaObject.connectSlotsByName(MainWindow)
379

380     def retranslateUi(self, MainWindow):
381         MainWindow.setWindowTitle(_translate("MainWindow", "myplayer", None))
382         self.label.setText(_translate("MainWindow", "Songlist", None))
383         self.fLblSongTitle.setText(_translate("MainWindow", "Artist - Track",
384                                         None))
384         self.fBtnPlay.setText(_translate("MainWindow", "Play", None))
385         self.fLblTime.setText(_translate("MainWindow", "00:00", None))
386         self.label_2.setText(_translate("MainWindow", "Volume", None))
387

388     if __name__ == "__main__":
389         import sys
390         app = QtGui.QApplication(sys.argv)
391         MainWindow = QtGui.QMainWindow()
392         ui = Ui_MainWindow()
393         ui.setupUi(MainWindow)
394         MainWindow.show()
395         sys.exit(app.exec_())

```

Listing: Lesson 3, gui.py with event handlers

```
397  # -*- coding: utf-8 -*-
398
399  # Form implementation generated from reading ui file './gui.ui'
400  #
401
402  import sys
403
404  from PyQt5 import QtCore, QtGui, QtWidgets
405
406  class TUILocal:
407      def __init__ (self, delegate):
408          self.fApp      = None
409          self.fDelegate = delegate
410          self.fWndMain  = None
411
412      def Handle_List_Click (self, item):
413          pass
414
415      def Handle_Play_Click (self):
416          pass
417
418      def Handle_Volume_Moved (self, currentValue):
419          pass
420
421      def UIStart (self):
422          self.fDelegate.Handle_HasInitStarted ()
423          self.fApp      = QtWidgets.QApplication (sys.argv)
424          self.fWndMain  = QtWidgets.QMainWindow ()
425          self._setupUi (self.fWndMain)
426          self.fWndMain.show ()
427          self.fDelegate.Handle_HasInitFinished ()
428          self.fApp.exec ()
429
430      def _setupUi(self, mainWindow):
431          mainWindow.setObjectName("MainWindow")
432          mainWindow.resize(965, 600)
433          self.centralwidget = QtWidgets.QWidget(mainWindow)
434          self.centralwidget.setObjectName("centralwidget")
435          self.horizontalLayout = QtWidgets.QHBoxLayout(self.centralwidget)
436          self.horizontalLayout.setObjectName("horizontalLayout")
437          self.verticalLayout = QtWidgets.QVBoxLayout()
438          self.verticalLayout.setSizeConstraint(QtWidgets.QLayout.SetDefaultCon
straint)
439          self.verticalLayout.setContentsMargins(0, 0, 0, -1)
440          self.verticalLayout.setObjectName("verticalLayout")
441          self.label = QtWidgets.QLabel(self.centralwidget)
442          font = QtGui.QFont()
443          font.setPointSize(14)
444          font.setBold(True)
445          font.setWeight(75)
446          self.label.setFont(font)
```

```

447         self.label.setTextFormat(QtCore.Qt.PlainText)
448         self.label.setObjectName("label")
449         self.verticalLayout.addWidget(self.label)
450         self.fLstSongs = QtWidgets.QListWidget(self.centralwidget)
451         font = QtGui.QFont()
452         font.setPointSize(14)
453         font.setBold(True)
454         font.setWeight(75)
455         self.fLstSongs.setFont(font)
456         self.fLstSongs.setVerticalScrollBarPolicy(QtCore.Qt.ScrollBarAlwaysOn
457 )
458         self.fLstSongs.setHorizontalScrollBarPolicy(QtCore.Qt.ScrollBarAlways
459 Off)
460         self.fLstSongs.setUniformItemSizes(False)
461         self.fLstSongs.setSelectionRectVisible(True)
462         self.fLstSongs.setObjectName("fLstSongs")
463         self.verticalLayout.addWidget(self.fLstSongs)
464         self.horizontalLayout.addLayout(self.verticalLayout)
465         self.line = QtWidgets.QFrame(self.centralwidget)
466         self.line.setFrameShape(QtWidgets.QFrame.VLine)
467         self.line.setFrameShadow(QtWidgets.QFrame.Sunken)
468         self.line.setObjectName("line")
469         self.horizontalLayout.addWidget(self.line)
470         self.frame = QtWidgets.QFrame(self.centralwidget)
471             sizePolicy = QtWidgets.QSizePolicy(QtWidgets.QSizePolicy.Minimum,
472 QtWidgets.QSizePolicy.Preferred)
473             sizePolicy.setHorizontalStretch(0)
474             sizePolicy.setVerticalStretch(0)
475             sizePolicy.setHeightForWidth(self.frame.sizePolicy().hasHeightForWidt
476 h())
477             self.frame.setSizePolicy(sizePolicy)
478             self.frame.setMinimumSize(QtCore.QSize(640, 0))
479             self.frame.setFrameShape(QtWidgets.QFrame.StyledPanel)
480             self.frame.setFrameShadow(QtWidgets.QFrame.Raised)
481             self.frame.setLineWidth(0)
482             self.frame.setObjectName("frame")
483             self.verticalLayout_3 = QtWidgets.QVBoxLayout(self.frame)
484             self.verticalLayout_3.setObjectName("verticalLayout_3")
485             self.frame_2 = QtWidgets.QFrame(self.frame)
486             self.frame_2.setFrameShape(QtWidgets.QFrame.NoFrame)
487             self.frame_2.setFrameShadow(QtWidgets.QFrame.Raised)
488             self.frame_2.setObjectName("frame_2")
489             self.verticalLayout_2 = QtWidgets.QVBoxLayout(self.frame_2)
490             self.verticalLayout_2.setObjectName("verticalLayout_2")
491                 spacerItem = QtWidgets.QSpacerItem(20,     84,
492 QtWidgets.QSizePolicy.Minimum, QtWidgets.QSizePolicy.Expanding)
493                 self.verticalLayout_2.addItem(spacerItem)
494                 self.fLblSongTitle = QtWidgets.QLabel(self.frame_2)

```

```

495         self.verticalLayout_2.addWidget(self.fLblSongTitle)
496         self.frame_3 = QtWidgets.QFrame(self.frame_2)
497         self.frame_3.setFrameShape(QtWidgets.QFrame.NoFrame)
498         self.frame_3.setFrameShadow(QtWidgets.QFrame.Raised)
499         self.frame_3.setObjectName("frame_3")
500         self.horizontalLayout_2 = QtWidgets.QHBoxLayout(self.frame_3)
501         self.horizontalLayout_2.setObjectName("horizontalLayout_2")
502             spacerItem1 = QtWidgets.QSpacerItem(197, 20,
503                                         QtWidgets.QSizePolicy.Expanding, QtWidgets.QSizePolicy.Minimum)
504             self.horizontalLayout_2.addItem(spacerItem1)
505             self.fBtnPlay = QtWidgets.QPushButton(self.frame_3)
506             self.fBtnPlay.setMinimumSize(QtCore.QSize(188, 78))
507             font = QtGui.QFont()
508             font.setPointSize(26)
509             font.setBold(True)
510             font.setWeight(75)
511             self.fBtnPlay.setFont(font)
512             self.fBtnPlay.setFocusPolicy(QtCore.Qt.NoFocus)
513             self.fBtnPlay.setCheckable(False)
514             self.fBtnPlay.setObjectName("fBtnPlay")
515             self.horizontalLayout_2.addWidget(self.fBtnPlay)
516             spacerItem2 = QtWidgets.QSpacerItem(197, 20,
517                                         QtWidgets.QSizePolicy.Expanding, QtWidgets.QSizePolicy.Minimum)
518             self.horizontalLayout_2.addItem(spacerItem2)
519             self.verticalLayout_2.addWidget(self.frame_3)
520             self.fLblTime = QtWidgets.QLabel(self.frame_2)
521             font = QtGui.QFont()
522             font.setPointSize(23)
523             self.fLblTime.setFont(font)
524             self.fLblTime.setAlignment(QtCore.Qt.AlignCenter)
525             self.fLblTime.setObjectName("fLblTime")
526             self.verticalLayout_2.addWidget(self.fLblTime)
527             spacerItem3 = QtWidgets.QSpacerItem(20, 200,
528                                         QtWidgets.QSizePolicy.Minimum, QtWidgets.QSizePolicy.Expanding)
529             self.verticalLayout_2.addItem(spacerItem3)
530             self.verticalLayout_3.addWidget(self.frame_2)
531             self.line_2 = QtWidgets.QFrame(self.frame)
532             self.line_2.setFrameShape(QtWidgets.QFrame.HLine)
533             self.line_2.setFrameShadow(QtWidgets.QFrame.Sunken)
534             self.line_2.setObjectName("line_2")
535             self.verticalLayout_3.addWidget(self.line_2)
536             self.frame_4 = QtWidgets.QFrame(self.frame)
537             self.frame_4.setFrameShape(QtWidgets.QFrame.NoFrame)
538             self.frame_4.setFrameShadow(QtWidgets.QFrame.Raised)
539             self.frame_4.setObjectName("frame_4")
540             self.horizontalLayout_3 = QtWidgets.QHBoxLayout(self.frame_4)
541             self.horizontalLayout_3.setObjectName("horizontalLayout_3")
542             spacerItem4 = QtWidgets.QSpacerItem(40, 20,
543                                         QtWidgets.QSizePolicy.Expanding, QtWidgets.QSizePolicy.Minimum)
544             self.horizontalLayout_3.addItem(spacerItem4)
545             self.label_2 = QtWidgets.QLabel(self.frame_4)
546             self.label_2.setObjectName("label_2")
547             self.horizontalLayout_3.addWidget(self.label_2)

```

```

544         self.fSldVolume = QtWidgets.QSlider(self.frame_4)
545             sizePolicy = QtWidgets.QSizePolicy(QtWidgets.QSizePolicy.Fixed,
546                                         QtWidgets.QSizePolicy.Fixed)
546             sizePolicy.setHorizontalStretch(0)
547             sizePolicy.setVerticalStretch(0)
548             sizePolicy.setHeightForWidth(self.fSldVolume.sizePolicy().hasHeightFor
      rWidth())
549         self.fSldVolume.setSizePolicy(sizePolicy)
550         self.fSldVolume.setMinimumSize(QtCore.QSize(225, 0))
551         self.fSldVolume.setBaseSize(QtCore.QSize(0, 0))
552         self.fSldVolume.setAcceptDrops(False)
553         self.fSldVolume.setTracking(True)
554         self.fSldVolume.setOrientation(QtCore.Qt.Horizontal)
555         self.fSldVolume.setInvertedAppearance(False)
556         self.fSldVolume.setInvertedControls(False)
557         self.fSldVolume.setObjectName("fSldVolume")
558         self.horizontalLayout_3.addWidget(self.fSldVolume)
559         self.verticalLayout_3.addWidget(self.frame_4)
560         self.horizontalLayout.addWidget(self.frame)
561         mainWindow.setCentralWidget(self.centralwidget)
562         self.menubar = QtWidgets.QMenuBar(mainWindow)
563         self.menubar.setGeometry(QtCore.QRect(0, 0, 965, 30))
564         self.menubar.setObjectName("menubar")
565         mainWindow.setMenuBar(self.menubar)
566         self.statusbar = QtWidgets.QStatusBar(mainWindow)
567         self.statusbar.setObjectName("statusbar")
568         mainWindow.setStatusBar(self.statusbar)
569
570         self.fBtnPlay.clicked.connect          (self.Handle_Play_Click      )
571         self.fSldVolume.sliderMoved.connect  (self.Handle_Volume_Moved   )
572         self.fLstSongs.itemClicked.connect   (self.Handle_List_Click     )
573
574         mainWindow.setWindowTitle           ("myplayer")
575         self.label.setText                  ("Songlist")
576             self.fLblSongTitle.setText        ("Ivan Torrent - Beyond
      love")
577         self.fBtnPlay.setText                ("Play")
578         self.fLblTime.setText               ("00:00")
579         self.label_2.setText                ("Volume")
580
581         QtCore.QMetaObject.connectSlotsByName(mainWindow)

```

