

# Building a Python Plugin

QGIS Tutorials and Tips



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# Building a Python Plugin

Plugins are a great way to extend the functionality of QGIS. You can write plugins using Python that can range from adding a simple button to sophisticated toolkits. This tutorial will outline the process involved in setting up your development environment, designing the user interface for a plugin and writing code to interact with QGIS. Please review the [Getting Started With Python Programming](#) tutorial to get familiar with the basics.

## Overview of the Task

We will develop a simple plugin called `Save Attributes` that will allow users to pick a vector layer and write its attributes to a CSV file.

## Get the Tools

### Qt Creator

[Qt](#) is a software development framework that is used to develop applications that run on Windows, Mac, Linux as well as various mobile operating systems. QGIS itself is written using the Qt framework. For plugin development, we will use an application called [Qt Creator](#) to design the interface for our plugin.

Download and install the Qt Creator software from [SourceForge](#)

### Python Bindings for Qt

Since we are developing the plugin in Python, we need to install the python bindings for Qt. The method for installing these will depend on the platform you are using. For building plugins we need the `pyrcc4` command-line tool.

#### Windows

Download the [OSGeo4W network installer](#) and choose Express Desktop Install. Install the package `QGIS`. After installation, you will be able to access the `pyrcc4` tool via the OSGeo4W Shell.

#### Mac

Install the [Homebrew](#) package manager. Install `PyQt` package by running the following command:

```
brew install pyqt
```

#### Linux

Depending on your distribution, find and install the `python-qt4` package. On Ubuntu and Debian-based distributions, you can run the following command:

```
sudo apt-get install python-qt4
```

## A Text Editor or a Python IDE

Any kind of software development requires a good text editor. If you already have a favorite text editor or an IDE (Integrated Development Environment), you may use it for this tutorial. Otherwise, each platform offers a wide variety of free or paid options for text editors. Choose the one that fits your needs.

This tutorial uses Notepad++ editor on Windows.

## Windows

Notepad++ is a good free editor for windows. Download and install the [Notepad++ editor](#).

### Note

If you are using Notepad++, makes sure to check Replace by space at Settings > Preferences > Tab Settings. Python is very sensitive about whitespace and this setting will ensure tabs and spaces are treated properly.

## ***Plugin Builder plugin***

There is a helpful QGIS plugin named `Plugin Builder` which creates all the necessary files and the boilerplate code for a plugin. Find and install the `Plugin Builder` plugin. See [Using Plugins](#) for more details on how to install plugins.

## ***Plugins Reloader plugin***

This is another helper plugin which allows iterative development of plugins. Using this plugin, you can change your plugin code and have it reflected in QGIS without having to restart QGIS every time. Find and install the `Plugin Reloader` plugin. See [Using Plugins](#) for more details on how to install plugins.

### Note

Plugin Reloader is an experimental plugin. Make sure you have checked Show also experimental plugins in Plugin Manager settings if you cannot find it.

## Procedure

1. Open QGIS. Go to Plugins > Plugin Builder > Plugin Builder.



2. You will see the QGIS Plugin Builder dialog with a form. You can fill the form with details relating to our plugin. The Class name will be the name of the Python Class containing the logic of the plugin. This will also be the name of the folder containing all the plugin files. Enter `SaveAttributes` as the class name. The Plugin name is the name under which your plugin will appear in the Plugin Manager. Enter the name as `Save Attributes`. Add a description in the Description field. The Module name will be the name of the main python file for the plugin. Enter it as `save_attributes`. Leave the version numbers as they are. The Text for menu item value will be how the users will find your plugin in QGIS menu. Enter it as `Save Attributes as CSV`. Enter your name and email address in the appropriate fields. The Menu field will decide where your plugin item is added in QGIS. Since our plugin is for vector data, select `Vector`. Check the Flag the plugin as experimental box at the bottom. Click OK.



3. Next, you will be prompted to choose a directory for your plugin. You need to browse to the QGIS python plugin directory on your computer and select Select Folder. Typically, a `.qgis2/` directory is located in your home directory. The plugin folder location will depend on your platform as follows: (Replace `username` with your login name)

### Windows

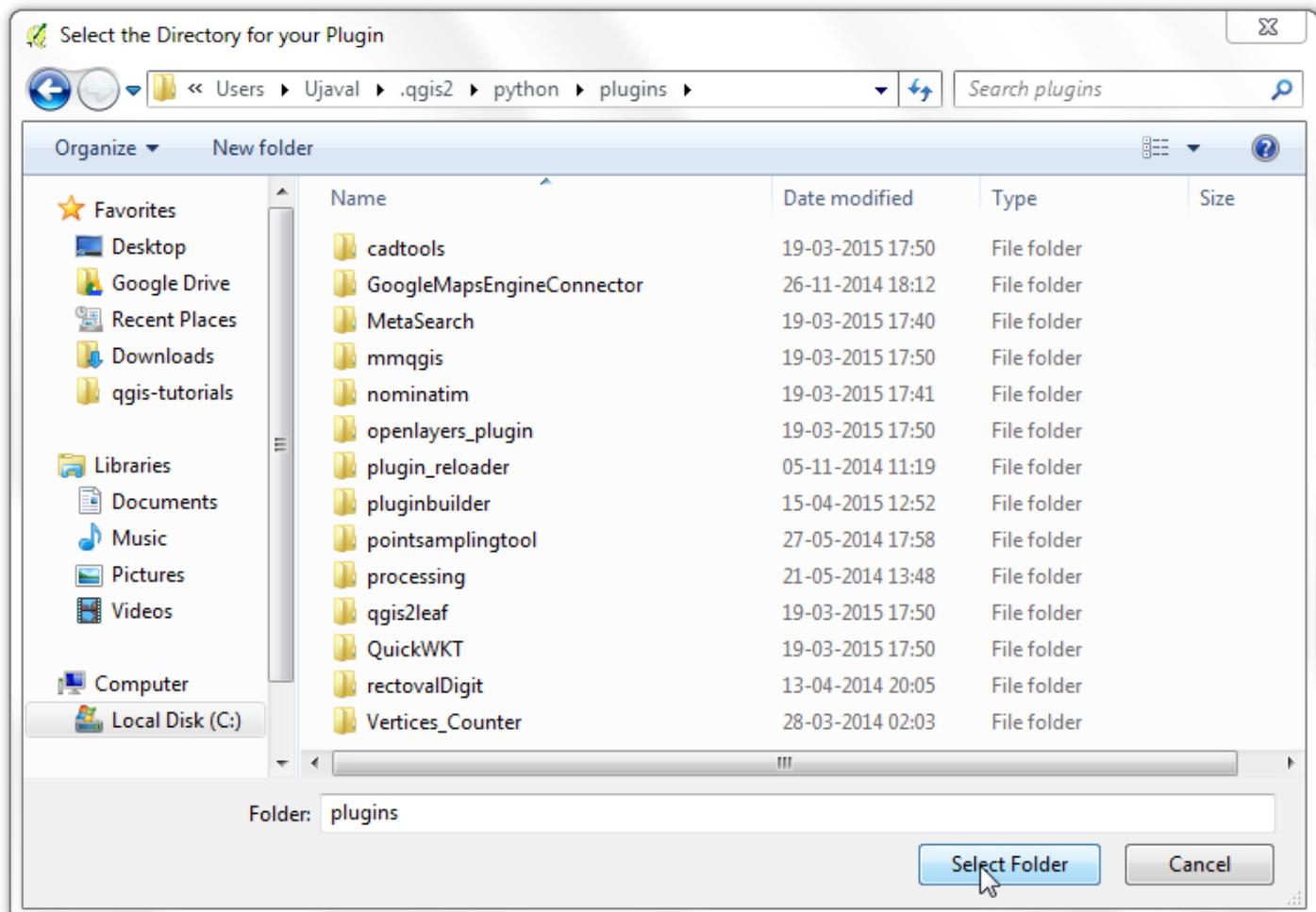
```
c:\Users\username\.qgis2\python\plugins
```

### Mac

```
/Users/username/.qgis2/python/plugins
```

## Linux

```
/home/username/.qgis2/python/plugins
```



4. You will see a confirmation dialog once your plugin template is created. Note the path to the plugin folder.



5. Before we can use the newly created plugin, we need to compile the **resources.qrc** file that was created by Plugin Builder. Launch the OSGeo4W Shell on windows or a terminal on Mac or Linux.

```
OSGeo4W Shell
nircmdc      xmlpatterns
ogdi_import  xmlpatternsvalidator
ogdi_info    xmfwf
ogr2ogr      xxmklink

epsg_tr      gdal_fillnodata  ps2pdf12
esri2wkt    gdal_merge        ps2pdf13
gcpss2vec   gdal_polygonize ps2pdf14
gcpss2wld   gdal_proximity   ps2pdfxx
gdal2tiles  gdal_retile     pyuic4
gdal2xyz   gdal_sieve       qgis-browser
gdalchksum  grass64          qgis
gdalcompare gssetgs          rgh2pct
gdalident   make-bat-for-py setup-test
gdalimport  mkgraticule    setup
gdalmove    o-help           udig
gdal_auth   o4w_env
gdal_calc   pct2rgb
gdal_edit   ps2pdf

GDAL 1.11.2, released 2015/02/10
C:\>_
```

6. Browse to the plugin directory where the output of Plugin Builder was created. You can use the `cd` command followed by the path to the directory.

```
cd c:\Users\username\.qgis2\python\plugins\SaveAttributes
```

```
OSGeo4W Shell
ogdi_info      xmfwf
ogr2ogr        xxmklink

epsg_tr      gdal_fillnodata  ps2pdf12
esri2wkt    gdal_merge        ps2pdf13
gcpss2vec   gdal_polygonize ps2pdf14
gcpss2wld   gdal_proximity   ps2pdfxx
gdal2tiles  gdal_retile     pyuic4
gdal2xyz   gdal_sieve       qgis-browser
gdalchksum  grass64          qgis
gdalcompare gssetgs          rgh2pct
gdalident   make-bat-for-py setup-test
gdalimport  mkgraticule    setup
gdalmove    o-help           udig
gdal_auth   o4w_env
gdal_calc   pct2rgb
gdal_edit   ps2pdf

GDAL 1.11.2, released 2015/02/10
C:\>cd Users\Ujaval\.qgis2\python\plugins\SaveAttributes
C:\Users\Ujaval\.qgis2\python\plugins\SaveAttributes>_
```

7. Once you are in the directory, type `make`. This will run the `pyrcc4` command that we had installed as part of Qt bindings for Python.

make

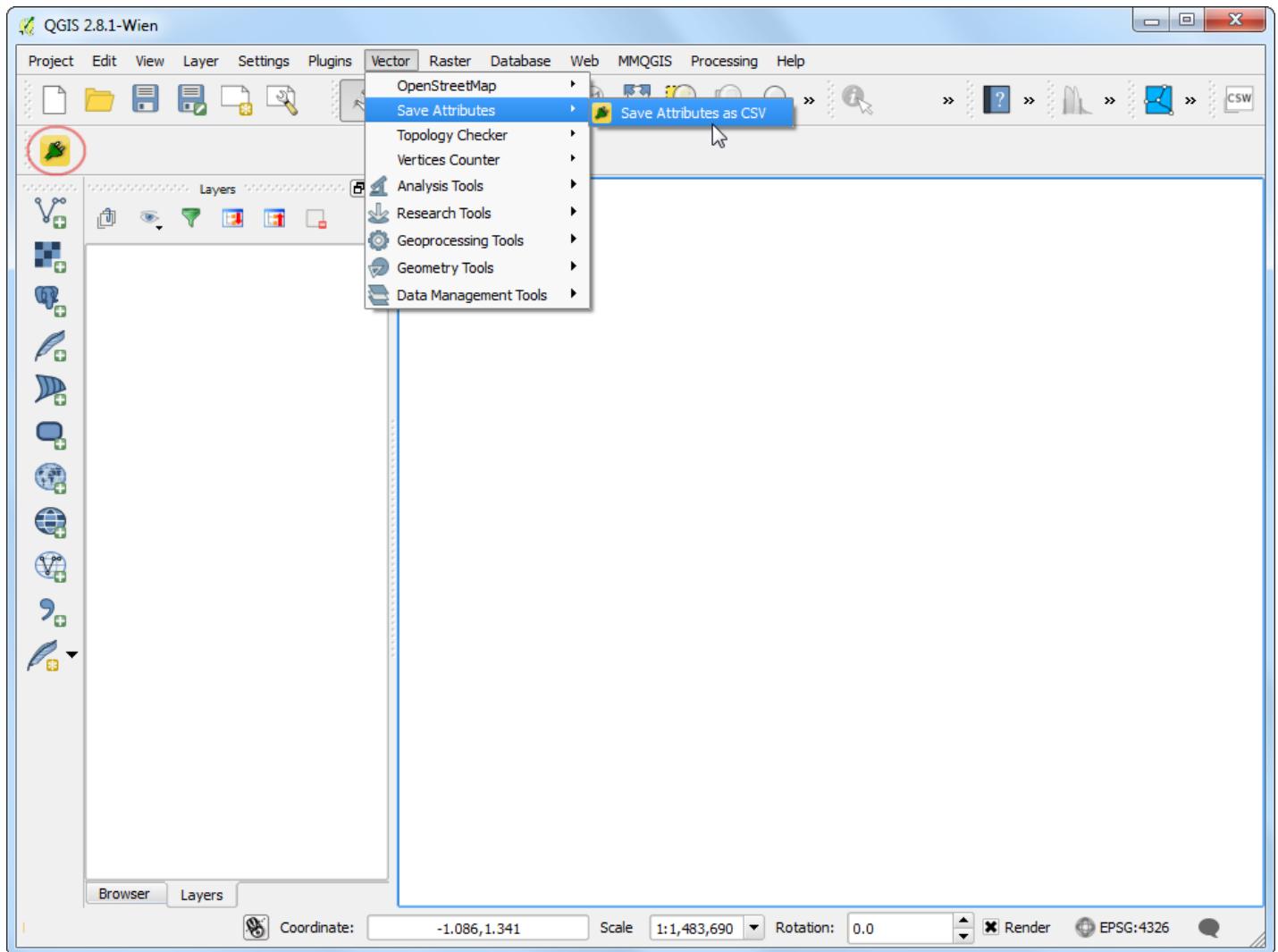


The screenshot shows a Windows command-line interface window titled "OSGeo4W Shell". The window displays the results of a "make" command. At the top, there is a list of GDAL tools:

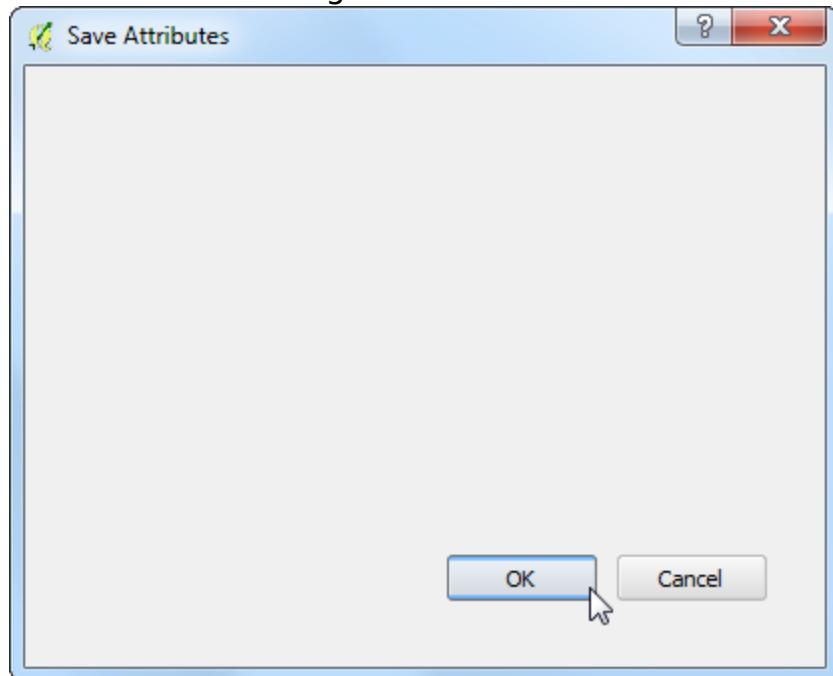
epsg_tr	gdal_fillnodata	ps2pdf12
esri2wkt	gdal_merge	ps2pdf13
gcps2vec	gdal_polygonize	ps2pdf14
gcps2wld	gdal_proximity	ps2pdfxx
gdal2tiles	gdal_retile	pyuic4
gdal2xyz	gdal_sieve	qgis-browser
gdalchksum	grass64	qgis
gdalcompare	gssetgs	rgb2pct
gdalident	make-bat-for-py	setup-test
gdalimport	mkgraticule	setup
gdalmove	o-help	udig
gdal_auth	o4w_env	
gdal_calc	pct2rgb	
gdal_edit	ps2pdf	

Below this, the text "GDAL 1.11.2, released 2015/02/10" is displayed. The command "make" is then run, followed by the command "pyrcc4 -o resources\_rc.py resources.qrc". The entire command "pyrcc4 -o resources\_rc.py resources.qrc" is highlighted with a red rectangle.

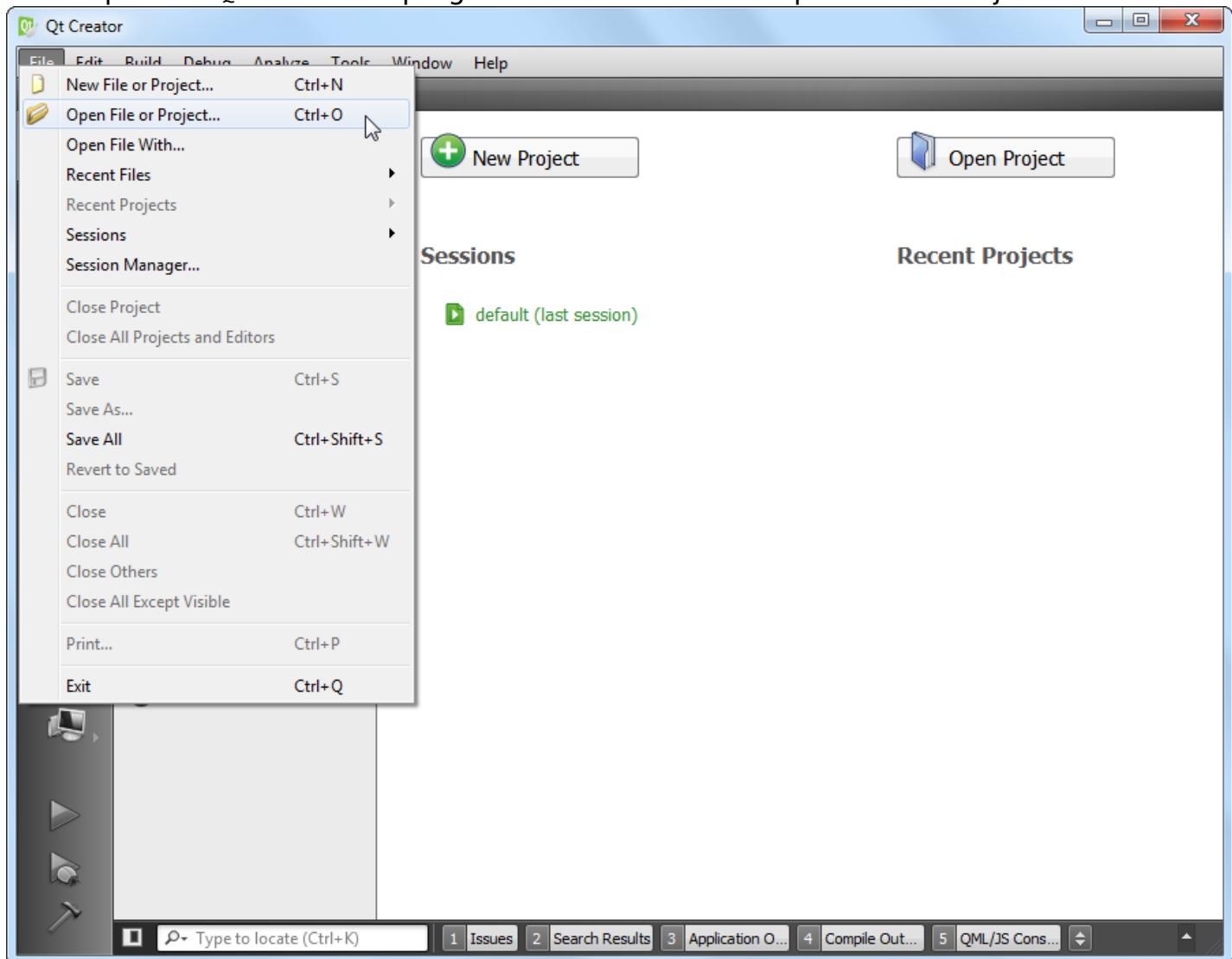
8. Now we are ready to have a first look at the brand new plugin we created. Close QGIS and launch it again. Go to Plugins > Manage and Install plugins and enable the Save Attributes plugin in the Installed tab. You will notice that there is a new icon in the toolbar and a new menu entry under Vector > Save Attributes > Save Attributes as CSV` . Select it to launch the plugin dialog.



9. You will notice a new blank dialog named Save Attributes. Close this dialog.



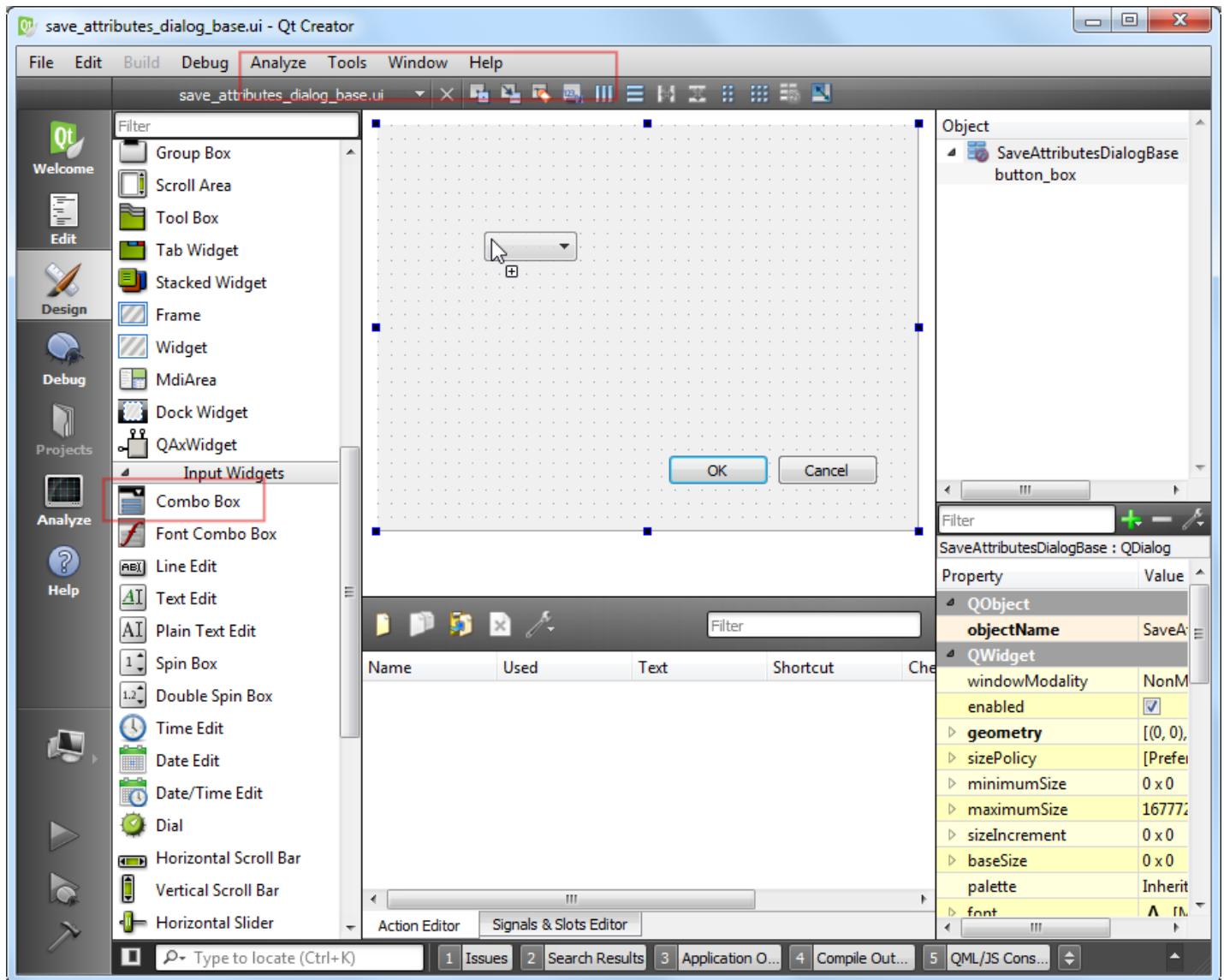
10. We will now design our dialog box and add some user interface elements to it. Open the Qt Creator program and go to File --> Open File or Project....



11. Browse to the plugin directory and select the `save_attributes_dialog_base.ui` file. Click Open.



12. You will see the blank dialog from the plugin. You can drag-and-drop elements from the left-hand panel on the dialog. We will add a Combo Box type of Input Widget. Drag it to the plugin dialog.



13. Resize the combo box and adjust its size. Now drag a Label type Display Widget on the dialog.



14. Click on the label text and enter Select a layer.



15. Save this file by going to File > Save save\_attributes\_dialog\_base.ui. Note the name of the combo box object is comboBox. To interact with this object using python code, we will have to refer to it by this name.



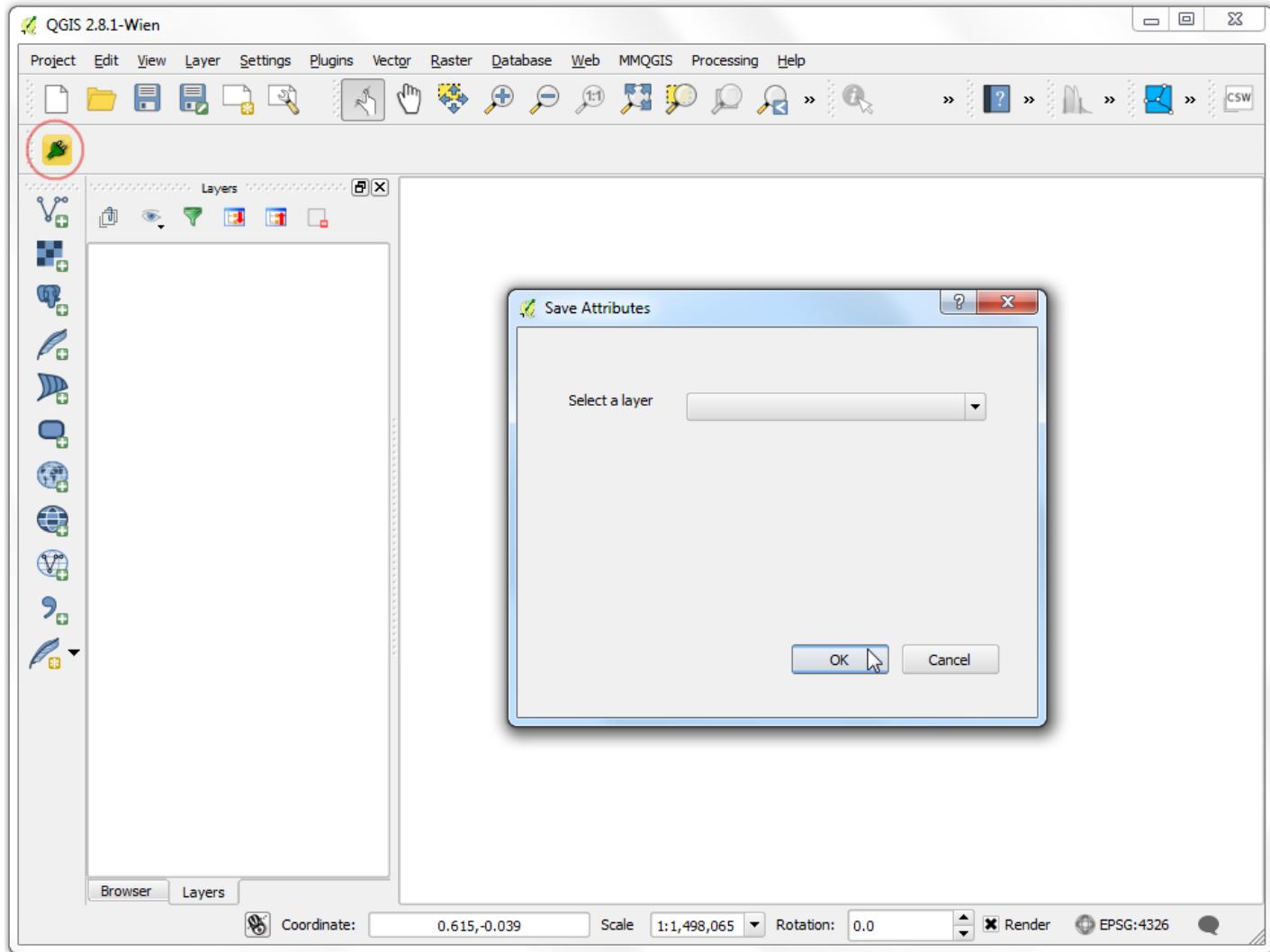
16. Let's reload our plugin so we can see the changes in the dialog window. Go to **Plugin > Plugin Reloader > Choose a plugin to be reloaded.**



17. Select SaveAttributes in the Configure Plugin reloader dialog.



18. Now click the Save Attributes as CSV button. You will see the newly designed dialog box.



19. Let's add some logic to the plugin that will populate the combo box with the layers loaded in QGIS. Go to the plugin directory and load the file `save_attributes.py` in a text editor. Scroll down and find the `run(self)` method. This method will be called when you click the toolbar button or select the plugin menu item. Add the following code at the beginning of the method. This code gets the layers loaded in QGIS and adds it to the `comboBox` object from the plugin dialog.

```
layers = self iface.legendInterface().layers()
layer_list = []
for layer in layers:
    layer_list.append(layer.name())
    self dlg.comboBox.addItem(layer_list)
```

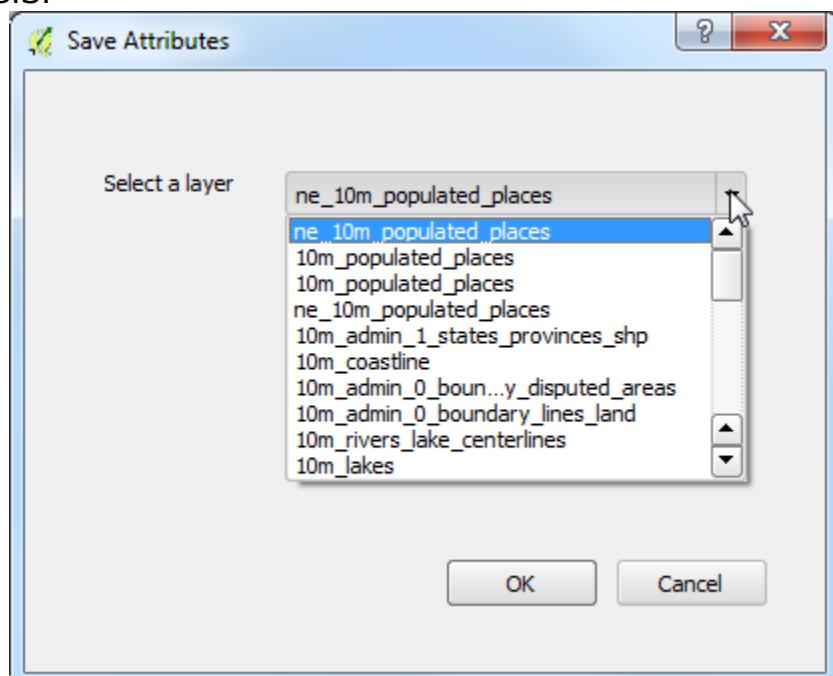
The screenshot shows a Notepad++ window with the file 'save\_attributes.py' open. The code is written in Python and defines two methods: 'unload' and 'run'. The 'run' method retrieves a list of layers from the legend interface and adds their names to a combo box in a dialog. A red box highlights the code for adding items to the combo box.

```
169
170
171     def unload(self):
172         """Removes the plugin menu item and icon from QGIS GUI."""
173         for action in self.actions():
174             self.iface.removePluginVectorMenu(
175                 self.tr(u'&Save Attributes'),
176                 action)
177             self.iface.removeToolBarIcon(action)
178         # remove the toolbar
179         del self.toolbar
180
181
182     def run(self):
183         """Run method that performs all the real work"""
184         layers = self.iface.legendInterface().layers()
185         layer_list = []
186         for layer in layers:
187             layer_list.append(layer.name())
188
189         self.dlg.comboBox.addItems(layer_list)
190
191         # show the dialog
192         self.dlg.show()
193         # Run the dialog event loop
```

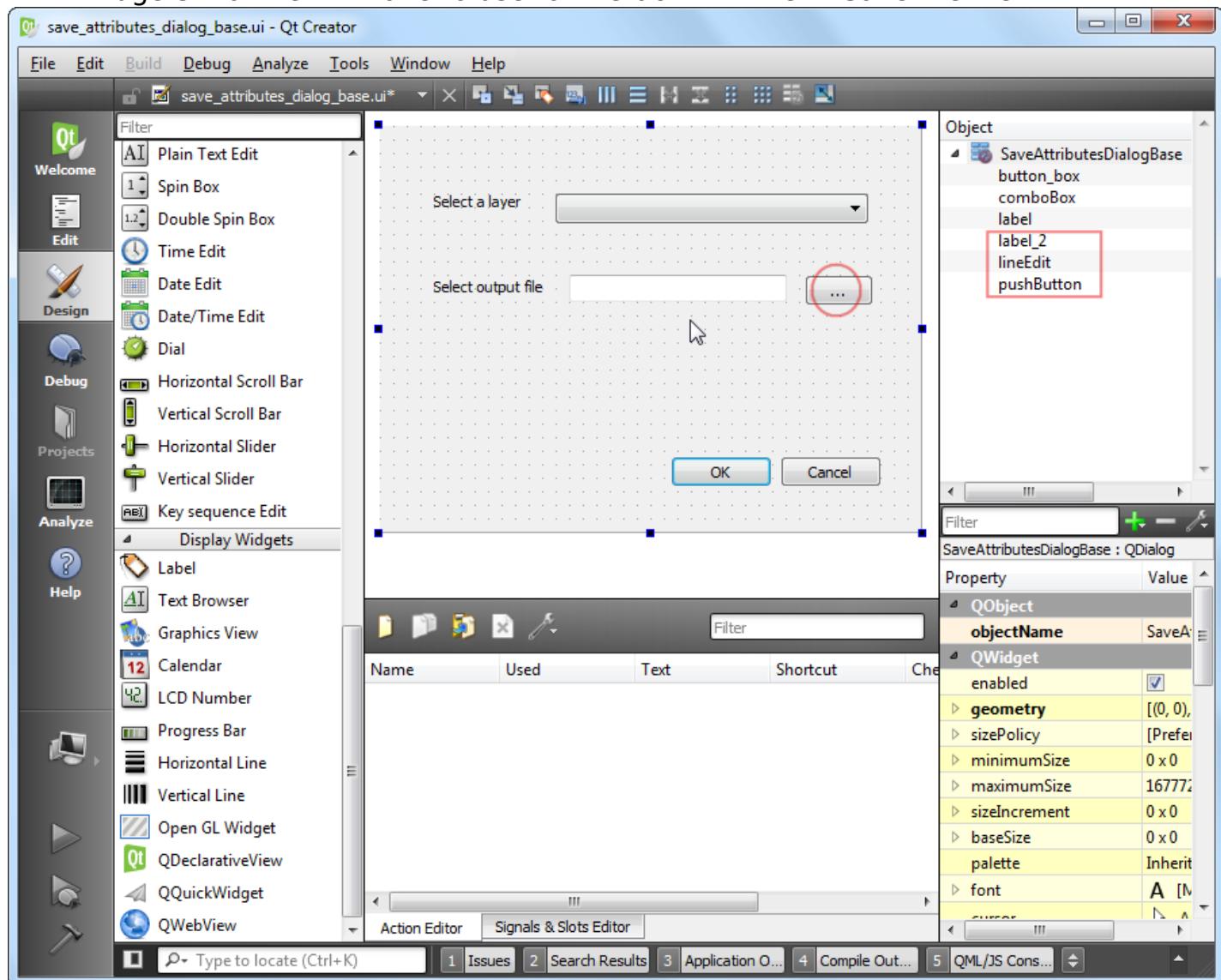
20. Back in the main QGIS window, reload the plugin by going to Plugins > Plugin Reloader > Reload plugin: SaveAttributes. Alternatively, you can just press F5. To test this new functionality, we must load some layers in QGIS. After you load some data, launch the plugin by going to Vector > Save Attributes > Save Attributes as CSV.



21. You will see that our combo box is now populated with the layer names that are loaded in QGIS.



22. Let's add remaining user interface elements. Switch back to Qt Creator and load the `save_attributes_dialog_base.ui` file. Add a Label Display Widget and change the text to Select output file. Add a LineEdit type Input Widget that will show the output file path that the user has chosen. Next, add a Push Button type Button and change the button label to .... Note the object names of the widgets that we will have to use to interact with them. Save the file.



23. We will now add python code to open a file browser when the user clicks the ... push button and show the select path in the line edit widget. Open the `save_attributes.py` file in a text editor. Add `QFileDialog` to our list of imports at the top of the file.

```
*C:\Users\Ujaval\qgis2\python\plugins\SaveAttributes\save_attributes.py - Notepad++
File Edit Search View Encoding Language Settings Macro Run Plugins Window ?
save_attributes.py
1  # -*- coding: utf-8 -*-
2  """
3  *****
4  SaveAttributes
5  |           A QGIS plugin
6  | This plugin saves the attribute of the selected vector layer as a CSV file.
7  |
8  | begin          : 2015-04-20
9  | git sha        : $Format:%H$
10 | copyright      : (C) 2015 by Ujaval Gandhi
11 | email          : ujal@spatialthoughts.com
12 *****/
13
14 *****
15 *
16 *   This program is free software; you can redistribute it and/or modify
17 *   it under the terms of the GNU General Public License as published by
18 *   the Free Software Foundation; either version 2 of the License, or
19 *   (at your option) any later version.
20 *
21 *****/
22 """
23 from PyQt4.QtCore import QSettings, QTranslator, qVersion, QCoreApplication
24 from PyQt4.QtGui import QAction, QIcon, QFileDialog
25 # Initialize Qt resources from file resources.py
26 import resources_rc
"""
Python file length : 7149  lines : 203    Ln:24  Col:52  Sel:0|0    UNIX    UTF-8 w/o BOM    INS
```

24. Add a new method called `select_output_file` with the following code. This code will open a file browser and populate the line edit widget with the path of the file that the user chose.

```
def select_output_file(self):
    filename = QFileDialog.getSaveFileName(self.dlg, "Select output file","", "*.txt")
    self.dlg.lineEdit.setText(filename)
```

```
C:\Users\Ujava\qgis2\python\plugins\SaveAttributes\save_attributes.py - Notepad++
File Edit Search View Encoding Language Settings Macro Run Plugins Window ?
save_attributes.py x
173     for action in self.actions:
174         self.iface.removePluginVectorMenu(
175             self.tr(u'&Save Attributes'),
176             action)
177         self.iface.removeToolBarIcon(action)
178     # remove the toolbar
179     del self.toolbar
180
181 def select_output_file(self):
182     filename = QFileDialog.getSaveFileName(self.dlg, "Select output file","", '*.txt')
183     self.dlg.lineEdit.setText(filename)
184
185 def run(self):
186     """Run method that performs all the real work"""
187     layers = self.iface.legendInterface().layers()
188     layer_list = []
189     for layer in layers:
190         layer_list.append(layer.name())
191
192     self.dlg.comboBox.addItems(layer_list)
193
194     # show the dialog
195     self.dlg.show()
196     # Run the dialog event loop
197     result = self.dlg.exec_()
198     # See if OK was pressed
199     if result:
200
Python file length: 7151 lines: 203 Ln:183 Col:44 Sel:0 | 0 UNIX UTF-8 w/o BOM INS
```

25. Now we need to add code so that when the ... button is clicked, `select_output_file` method is called. Scroll up to the `__init__` method and add the following lines at the bottom. This code will clear the previously loaded text (if any) in the line edit widget and also connect the `select_output_file` method to the `clicked` signal of the push button widget.

```
self.dlg.lineEdit.clear()
self.dlg.pushButton.clicked.connect(self.select_output_file)
```

The screenshot shows a Notepad++ window with the following details:

- Title Bar:** C:\Users\Ujava\qgis2\python\plugins\SaveAttributes\save\_attributes.py - Notepad++
- Menu Bar:** File Edit Search View Encoding Language Settings Macro Run Plugins Window ?
- Toolbar:** Standard file operations like Open, Save, Print, Find, Replace, etc.
- Code Editor:** The main area contains Python code for a QGIS plugin. A red box highlights the following code block:

```
    self.dlg.lineEdit.clear()
    self.dlg.pushButton.clicked.connect(self.select_output_file)
```
- Code Completion:** A tooltip for the `self.select_output_file` method is visible at the bottom of the editor.
- Status Bar:** Shows the file path as "C:\Users\Ujava\qgis2\python\plugins\SaveAttributes\save\_attributes.py", length: 7272, lines: 207, Ln: 69, Col: 35, Sel: 0 | 0, and encodings UNIX, UTF-8 w/o BOM, INS.

26. Back in QGIS, reload the plugin and open the Save Attributes` dialog. If all went fine, you will be able to click the ... button and select an output text file from your disk.



27. When you click OK on the plugin dialog, nothing happens. That is because we have not added the logic to pull attribute information from the layer and write it to the text file. We now have all the pieces in place to do just that. Find the place in the run method where it says pass. Replace it with the code below. The explanation for this code can be found in *Getting Started With Python Programming*.

```
filename = self.dlg.lineEdit.text()
output_file = open(filename, 'w')

selectedLayerIndex = self.dlg.comboBox.currentIndex()
selectedLayer = layers[selectedLayerIndex]
fields = selectedLayer.pendingFields()
fieldnames = [field.name() for field in fields]

for f in selectedLayer.getFeatures():
    line = ','.join(unicode(f[x]) for x in fieldnames) + '\n'
    unicode_line = line.encode('utf-8')
    output_file.write(unicode_line)
output_file.close()
```

The screenshot shows a Notepad++ window with the file 'save\_attributes.py' open. The code is a Python script for a QGIS plugin. It defines a 'run' method that lists all layers, shows a dialog, and then writes the attributes of the selected layer to a file. A red box highlights the section where the file is opened and attributes are written.

```
189     def run(self):
190         """Run method that performs all the real work"""
191         layers = self iface.legendInterface().layers()
192         layer_list = []
193         for layer in layers:
194             layer_list.append(layer.name())
195
196         self dlg.comboBox.addItems(layer_list)
197         # show the dialog
198         self dlg.show()
199         # Run the dialog event loop
200         result = self dlg.exec_()
201         # See if OK was pressed
202         if result:
203             # Do something useful here - delete the line containing pass and
204             # substitute with your code.
205             filename = self dlg.lineEdit.text()
206             output_file = open(filename, 'w')
207
208             selectedLayerIndex = self dlg.comboBox.currentIndex()
209             selectedLayer = layers[selectedLayerIndex]
210             fields = selectedLayer.pendingFields()
211             fieldnames = [field.name() for field in fields]
212
213             for f in selectedLayer.getFeatures():
214                 line = ','.join(unicode(f[x]) for x in fieldnames) + '\n'
215                 unicode_line = line.encode('utf-8')
216                 output_file.write(unicode_line)
217             output_file.close()
```

28. Now our plugin is ready. Reload the plugin and try it out. You will find that the output text file you chose will have the attributes from the vector layer. You can zip the plugin directory and share it with your users. They can unzip the contents to their plugin directory and try out your plugin. If this was a real plugin, you would upload it to the [QGIS Plugin Repository](#) so that all QGIS users will be able to find and download your plugin.

### Note

This plugin is for demonstration purpose only. Do not publish this plugin or upload it to the QGIS plugin repository.

Below is the full `save_attributes.py` file as a reference.

```
# -*- coding: utf-8 -*-
"""
```

```

/*
***** SaveAttributes *****

SaveAttributes
A QGIS plugin
This plugin saves the attribute of the selected vector layer as a CSV file.

-----
begin          : 2015-04-20
git sha        : $Format:%H$ 
copyright      : (C) 2015 by Ujaval Gandhi
email          : ujaval@spatialthoughts.com
***** */

/*
* This program is free software; you can redistribute it and/or modify
* it under the terms of the GNU General Public License as published by
* the Free Software Foundation; either version 2 of the License, or
* (at your option) any later version.
*
***** */

"""
from PyQt4.QtCore import QSettings, QTranslator, qVersion, QCoreApplication
from PyQt4.QtGui import QAction, QIcon, QFileDialog
# Initialize Qt resources from file resources.py
import resources_rc
# Import the code for the dialog
from save_attributes_dialog import SaveAttributesDialog
import os.path

class SaveAttributes:
    """QGIS Plugin Implementation."""

    def __init__(self, iface):
        """Constructor.

        :param iface: An interface instance that will be passed to this class
                      which provides the hook by which you can manipulate the QGIS
                      application at run time.
        :type iface: QgsInterface
        """
        # Save reference to the QGIS interface
        self.iface = iface
        # initialize plugin directory
        self.plugin_dir = os.path.dirname(__file__)
        # initialize locale
        locale = QSettings().value('locale/userLocale')[0:2]
        locale_path = os.path.join(
            self.plugin_dir,
            'i18n',
            'SaveAttributes_{}.qm'.format(locale))

        if os.path.exists(locale_path):
            self.translator = QTranslator()
            self.translator.load(locale_path)

            if qVersion() > '4.3.3':
                QCoreApplication.installTranslator(self.translator)

```

```

# Create the dialog (after translation) and keep reference
self.dlg = SaveAttributesDialog()

# Declare instance attributes
self.actions = []
self.menu = self.tr(u'&Save Attributes')
# TODO: We are going to let the user set this up in a future iteration
self.toolbar = self.iface.addToolBar(u'SaveAttributes')
self.toolbar.setObjectName(u'SaveAttributes')

self.dlg.lineEdit.clear()
self.dlg.pushButton.clicked.connect(self.select_output_file)

# noinspection PyMethodMayBeStatic
def tr(self, message):
    """Get the translation for a string using Qt translation API.

    We implement this ourselves since we do not inherit QObject.

    :param message: String for translation.
    :type message: str, QString

    :returns: Translated version of message.
    :rtype: QString
    """

# noinspection PyTypeChecker,PyArgumentList,PyCallByClass
return QCoreApplication.translate('SaveAttributes', message)

def add_action(
    self,
    icon_path,
    text,
    callback,
    enabled_flag=True,
    add_to_menu=True,
    add_to_toolbar=True,
    status_tip=None,
    whats_this=None,
    parent=None):
    """Add a toolbar icon to the toolbar.

    :param icon_path: Path to the icon for this action. Can be a resource
        path (e.g. ':/plugins/foo/bar.png') or a normal file system path.
    :type icon_path: str

    :param text: Text that should be shown in menu items for this action.
    :type text: str

    :param callback: Function to be called when the action is triggered.
    :type callback: function

    :param enabled_flag: A flag indicating if the action should be enabled
        by default. Defaults to True.
    :type enabled_flag: bool

```

```

:param add_to_menu: Flag indicating whether the action should also
    be added to the menu. Defaults to True.
:type add_to_menu: bool

:param add_to_toolbar: Flag indicating whether the action should also
    be added to the toolbar. Defaults to True.
:type add_to_toolbar: bool

:param status_tip: Optional text to show in a popup when mouse pointer
    hovers over the action.
:type status_tip: str

:param parent: Parent widget for the new action. Defaults None.
:type parent: QWidget

:param whats_this: Optional text to show in the status bar when the
    mouse pointer hovers over the action.

:returns: The action that was created. Note that the action is also
    added to self.actions list.
:rtype: QAction
"""

icon = QIcon(icon_path)
action = QAction(icon, text, parent)
action.triggered.connect(callback)
action.setEnabled(enabled_flag)

if status_tip is not None:
    action.setStatusTip(status_tip)

if whats_this is not None:
    action.setWhatsThis(whats_this)

if add_to_toolbar:
    self.toolbar.addAction(action)

if add_to_menu:
    self.iface.addPluginToVectorMenu(
        self.menu,
        action)

self.actions.append(action)

return action

def initGui(self):
    """Create the menu entries and toolbar icons inside the QGIS GUI."""

icon_path = ':/plugins/SaveAttributes/icon.png'
self.addAction(
    icon_path,
    text=self.tr(u'Save Attributes as CSV'),
    callback=self.run,
    parent=self.iface mainWindow())

```

```

def unload(self):
    """Removes the plugin menu item and icon from QGIS GUI."""
    for action in self.actions:
        self.iface.removePluginVectorMenu(
            self.tr(u'&Save Attributes'),
            action)
        self.iface.removeToolBarIcon(action)
    # remove the toolbar
    del self.toolbar

def select_output_file(self):
    filename = QFileDialog.getSaveFileName(self.dlg, "Select output file","", '*.txt')
    self.dlg.lineEdit.setText(filename)

def run(self):
    """Run method that performs all the real work"""
    layers = self.iface.legendInterface().layers()
    layer_list = []
    for layer in layers:
        layer_list.append(layer.name())

    self.dlg.comboBox.clear()
    self.dlg.comboBox.addItems(layer_list)
    # show the dialog
    self.dlg.show()
    # Run the dialog event loop
    result = self.dlg.exec_()
    # See if OK was pressed
    if result:
        # Do something useful here - delete the line containing pass and
        # substitute with your code.
        filename = self.dlg.lineEdit.text()
        output_file = open(filename, 'w')

        selectedLayerIndex = self.dlg.comboBox.currentIndex()
        selectedLayer = layers[selectedLayerIndex]
        fields = selectedLayer.pendingFields()
        fieldnames = [field.name() for field in fields]

        for f in selectedLayer.getFeatures():
            line = ','.join(unicode(f[x]) for x in fieldnames) + '\n'
            unicode_line = line.encode('utf-8')
            output_file.write(unicode_line)
        output_file.close()

```