

# Building a Python Plugin (QGIS3)

QGIS Tutorials and Tips



Author

Ujaval Gandhi

<http://www.spatialthoughts.com>

# Building a Python Plugin (QGIS3)

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 \(QGIS3\)](#) 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 Designer](#) to design the interface for our plugin.

Download and install the Qt Creator installer from [Qt Offline Installers](#). Make sure you select **Qt Creator** on the download page. Note that you will have to create a free Qt account to install the package.

The screenshot shows the official Qt website's download page. At the top, there's a navigation bar with links for Products, Professional Services, Resources, Customers, Company, a search icon, and a login icon. A prominent green button on the right says "Download. Try. Buy.". Below the navigation, a message says "Tool for changes to a current install." On the left, there's a sidebar with links for Offline Installers, 5.9.x Offline Installers, 5.6.x Offline Installers, and a highlighted "Qt Creator" link, all under the heading "Offline Installers". The main content area discusses Qt Creator 4.8.2 and provides links to download it for various platforms: Windows, Windows 64-bit, Linux 64-bit, and macOS. To the right of the content, there's a vertical green sidebar with a "Contact Us" button.

## 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 `pyrcc5` command-line tool.

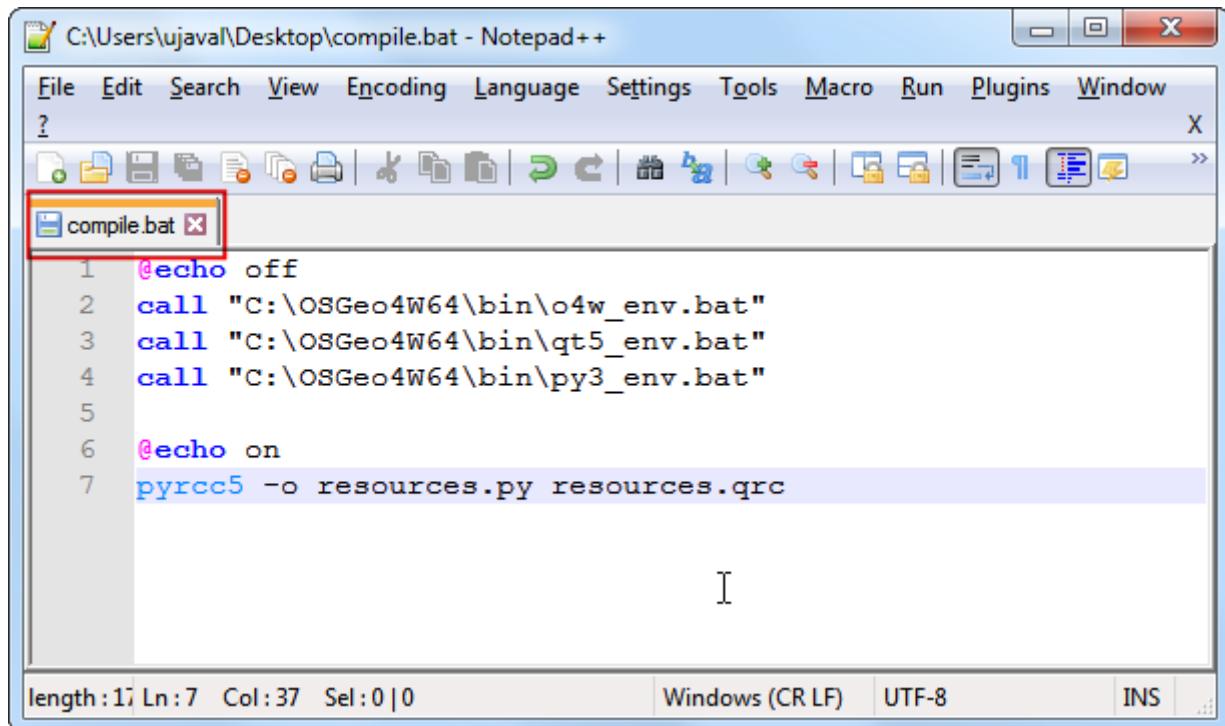
### Windows

Relevant python bindings are included in the QGIS install on Windows. But to use them from the plugin folder, we need to indicate the path to the QGIS install.

Create a Windows Batch file (.bat extension) with the following content and save it on your computer as `compile.bat`. We will later copy this file to the plugin folder. If

you installed QGIS at a different path, replace the C:\OSGeo4W64\bin\ with your path.

```
@echo off  
call "C:\OSGeo4W64\bin\o4w_env.bat"  
call "C:\OSGeo4W64\bin\qt5_env.bat"  
call "C:\OSGeo4W64\bin\py3_env.bat"  
  
@echo on  
pyrcc5 -o resources.py resources.qrc
```



## 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-qt5` package. On Ubuntu and Debian-based distributions, you can run the following command:

```
sudo apt-get install python-qt5
```

### Note

You may find that QGIS has already installed this package.

## 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 go to Settings ▶ Preferences ▶ Tab Settings and enable Replace by space. 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

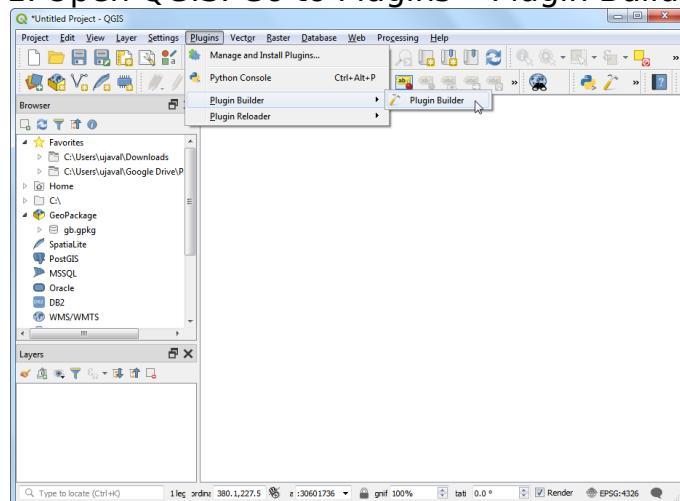
This is another helper plugin which allows iterative development of plugins. Using this plugin, you can change your plugin code and have it reflected in QGIS without having to restart QGIS every time. Find and install the `Plugin Reloader` plugin. See [Using Plugins](#) for more details on how to install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

### Note

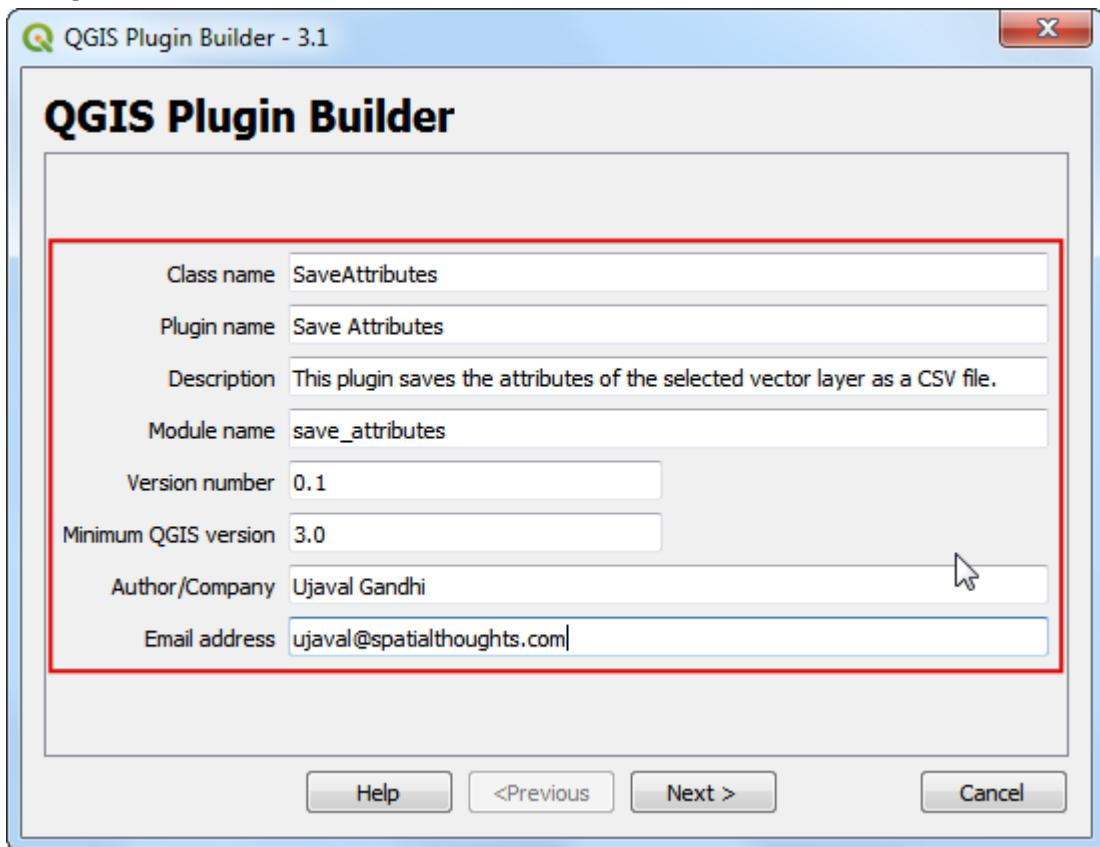
Plugin Reloader is an experimental plugin. Make sure you have checked Show also experimental plugins in Plugin Manager settings if you cannot find it.

## Procedure

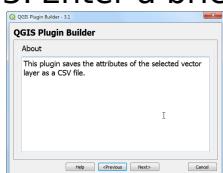
### 1. Open QGIS. Go to Plugins ▶ Plugin Builder ▶ Plugin Builder.



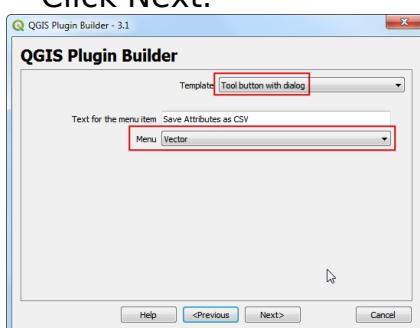
2. You will see the QGIS Plugin Builder dialog with a form. You can fill the form with details relating to our plugin. The Class name will be the name of the Python Class containing the logic of the plugin. This will also be the name of the folder containing all the plugin files. Enter SaveAttributes 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 and enter your name and email address in the appropriate fields. Click Next.



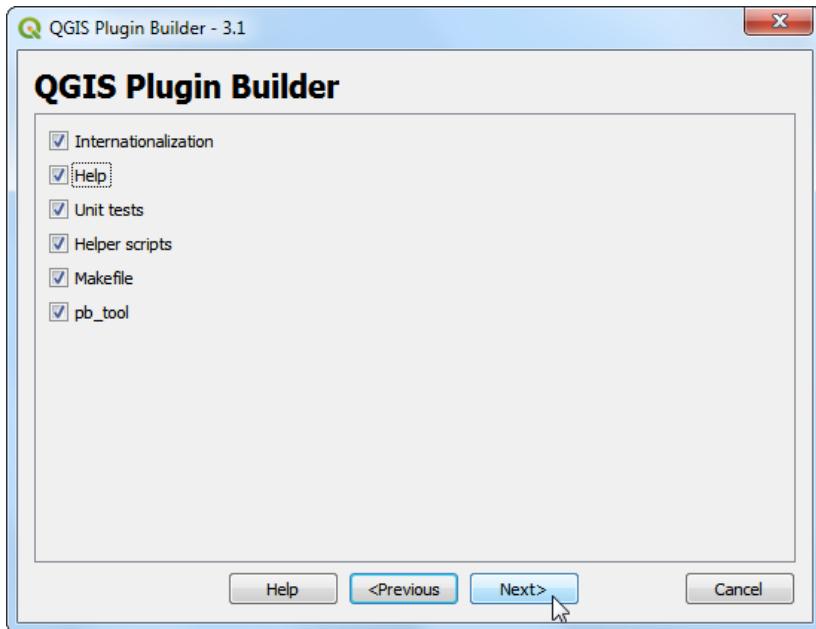
3. Enter a brief description of the plugin for the About dialog and click Next.



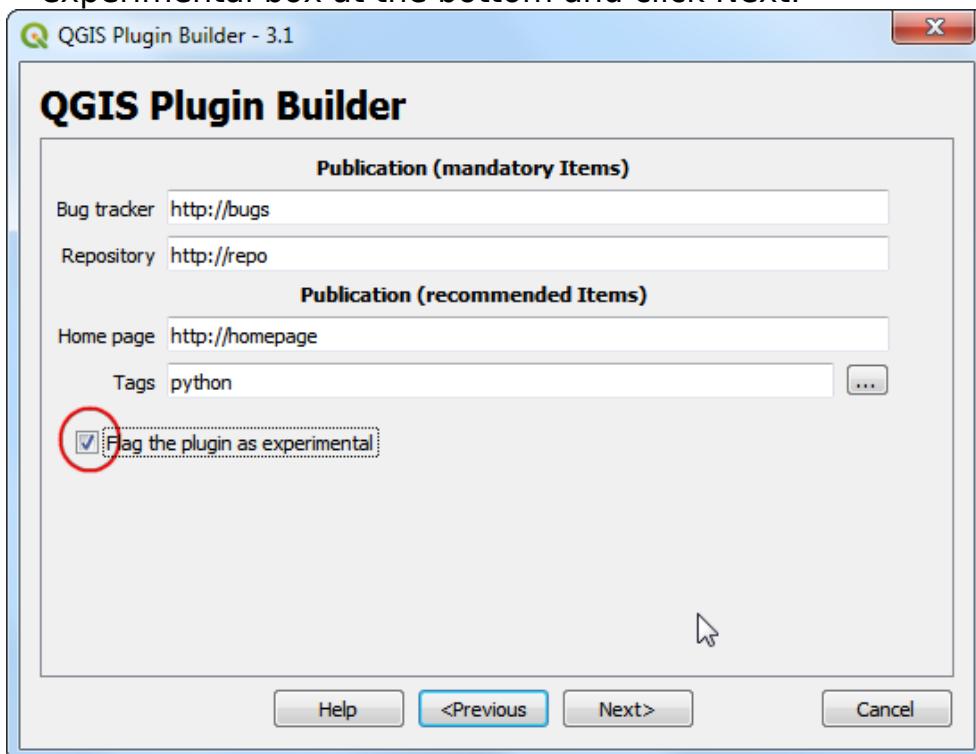
4. Select the Tool button with dialog from the Template selector. The Text for menu item value will be how the users will find your plugin in QGIS menu. Enter it as Save Attributes as CSV. The Menu field will decide where your plugin item is added in QGIS. Since our plugin is for vector data, select Vector. Click Next.



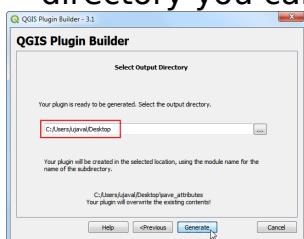
5. Plugin builder will prompt you for the type of files to generate. Keep the default selection and click Next.



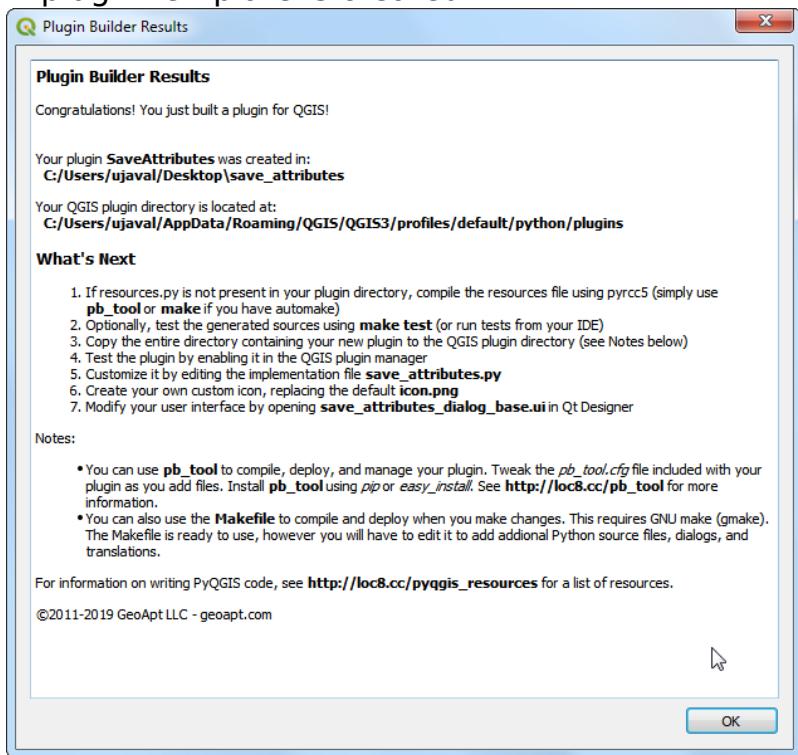
6. As we do not intend to publish the plugin, you may leave the Bug tracker, Repository and Home page values to default. Check the Flag the plugin as experimental box at the bottom and click Next.



7. You will be prompted to choose a directory for your plugin. For now, save it to a directory you can locate easily on your computer and click Generate.



8. Next, press the generate button. You will see a confirmation dialog once your plugin template is created.



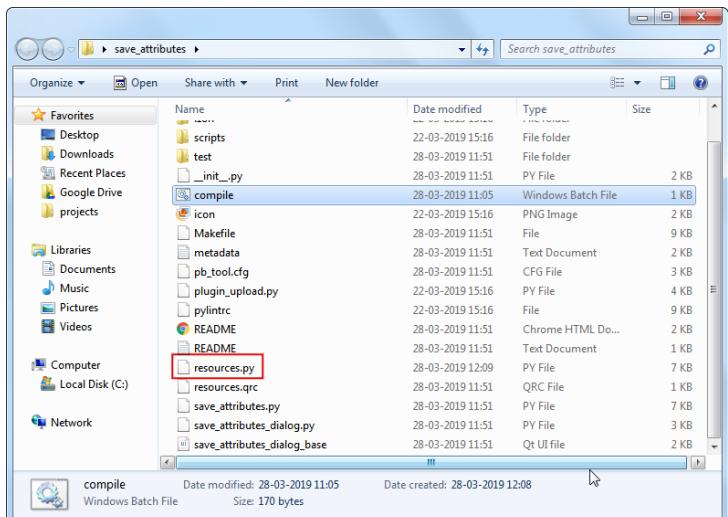
## Note

You may get a prompt saying that pyrcc5 is not found in the path. You can ignore this message.

9. Before we can use the newly created plugin, we need to compile the resources.qrc file that was created by Plugin Builder. This file is part of the [Qt Resource System](#) which references all binary files used in the plugin. For this plugin, it will only have the plugin icon. Compiling this file generates application code that can be used in the plugin independent which platform the plugin is being run. Follow the platform specific instruction for this step.

## Windows

You can now copy the `compile.bat` file (created during the *Python Bindings for Qt* section at the start) to the plugin folder. Once copied, double-click the file to run it. If the run was successful, you will see a new file called `resources.py` in the folder.



## Note

If this step fails, you can launch `cmd.exe` and browse to the plugin folder using `cd` command. Run the Batch file by running `compile.bat` to see the error.

## Mac and Linux

You will need to install `pb_tool` first. Open a Terminal and install it via pip.

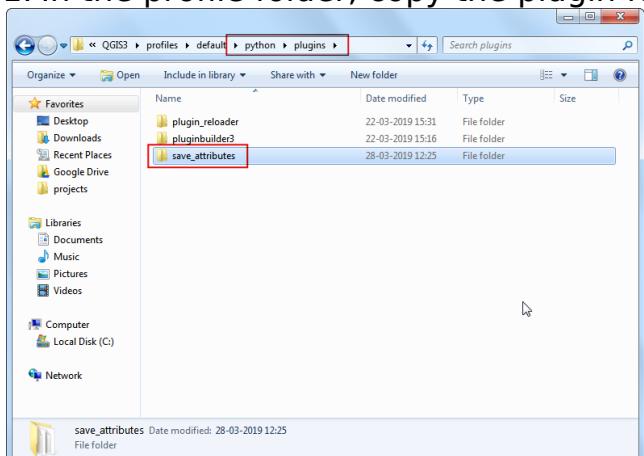
```
sudo pip3 install pb_tool
```

Open a Terminal and go to the plugin directory and type `pb_tool compile`. This will run the `pyrcc5` command that we had installed as part *Python Bindings for Qt* section.

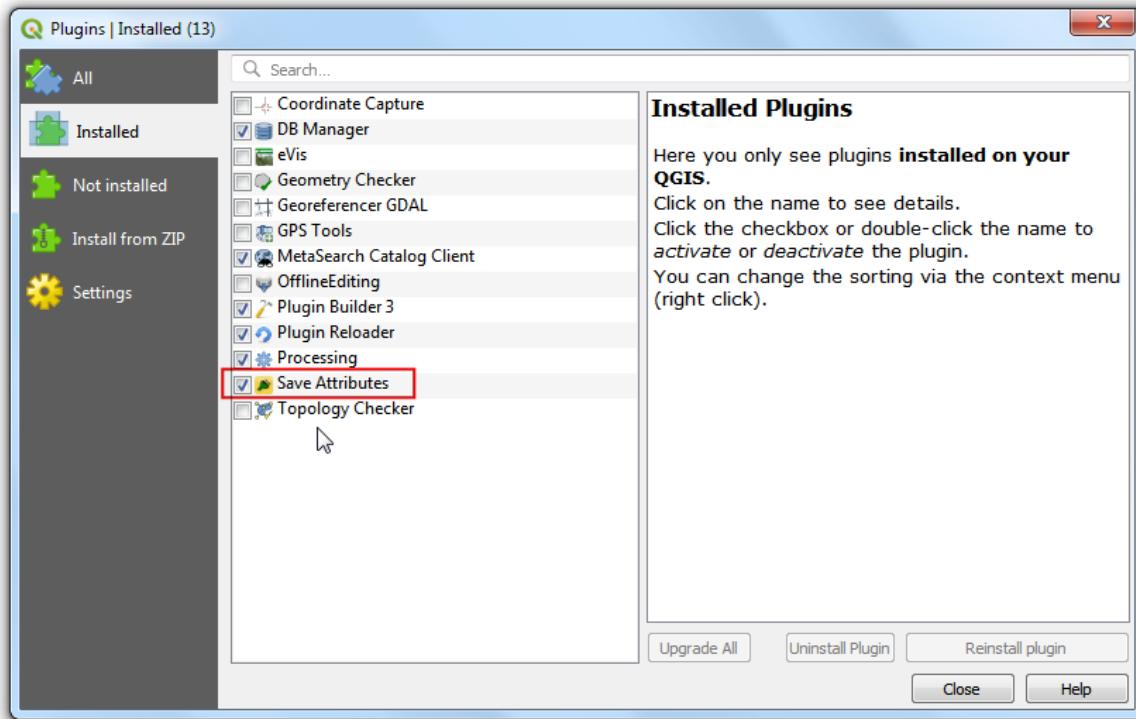
```
pb_tool compile
```

10. Plugins in QGIS are stored in a special folder. We must copy our plugin directory to that folder before it can be used. In QGIS, locate your current profile folder by going to **Settings > User Profiles > Open Active Profile Folder**.

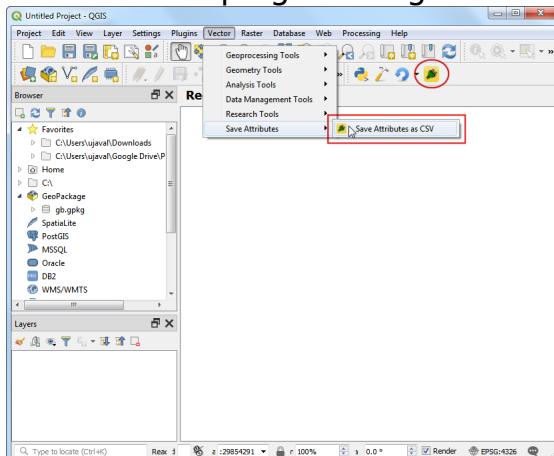
11. In the profile folder, copy the plugin folder to **python > plugins** subfolder.



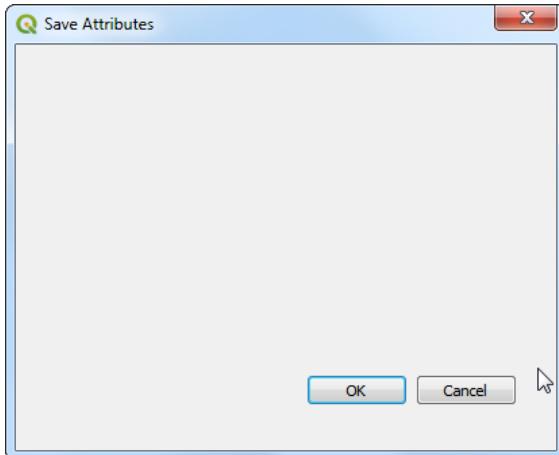
12. Now we are ready to have a first look at the brand new plugin we created. Close QGIS and launch it again. Go to Plugins > Manage and Install plugins and enable the Save Attributes plugin in the Installed tab.



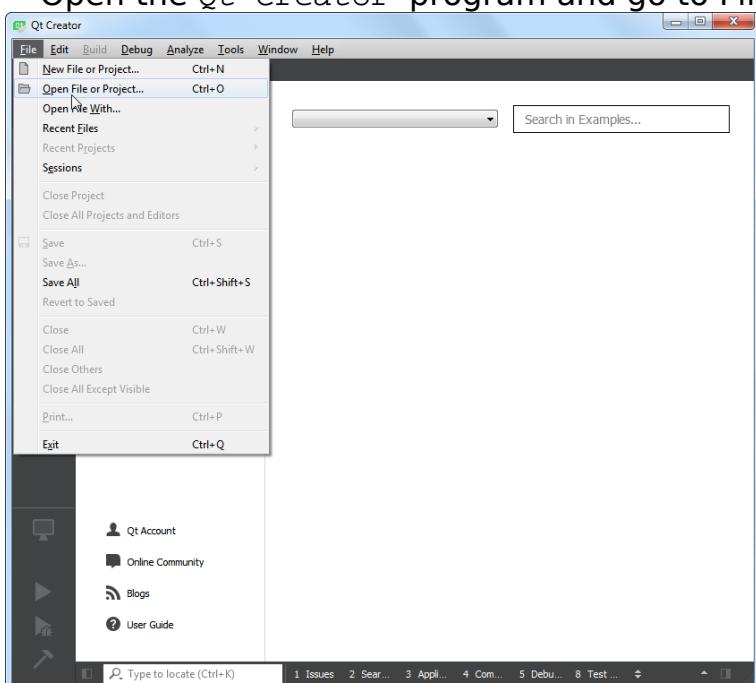
13. You will notice that there is a new icon in the plugin toolbar and a new menu entry under Vector > Save Attributes > Save Attributes as CSV. Select it to launch the plugin dialog.



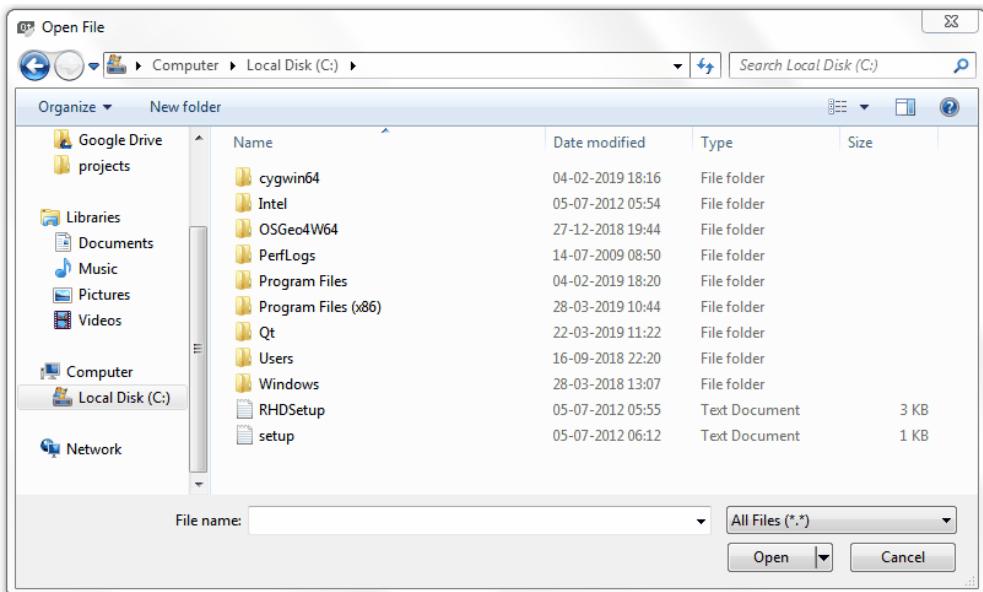
14. You will notice a new blank dialog named Save Attributes. Close this dialog.



15. 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.



16. Browse to the plugin directory and select the save\_attributes\_dialog\_base.ui file. Click Open.



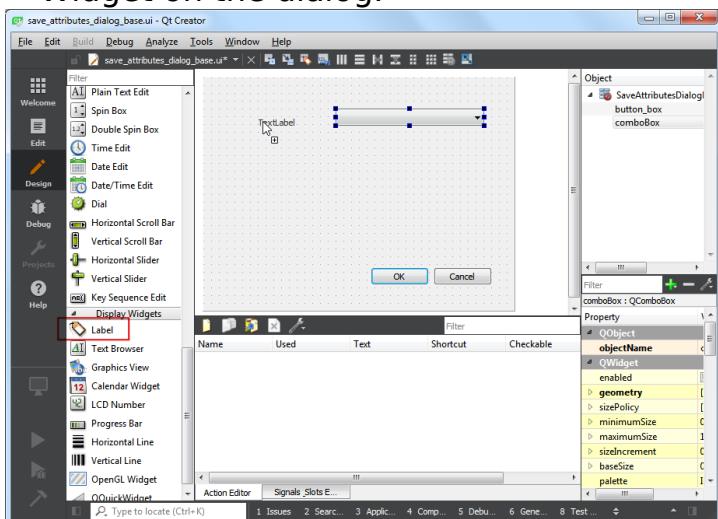
## Note

Windows hides the AppData folder so you may not see it in the file selector dialog. You can enter AppData in the File name prompt from its parent directory to open it.

17. 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 Widgets. Drag it to the plugin dialog.



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



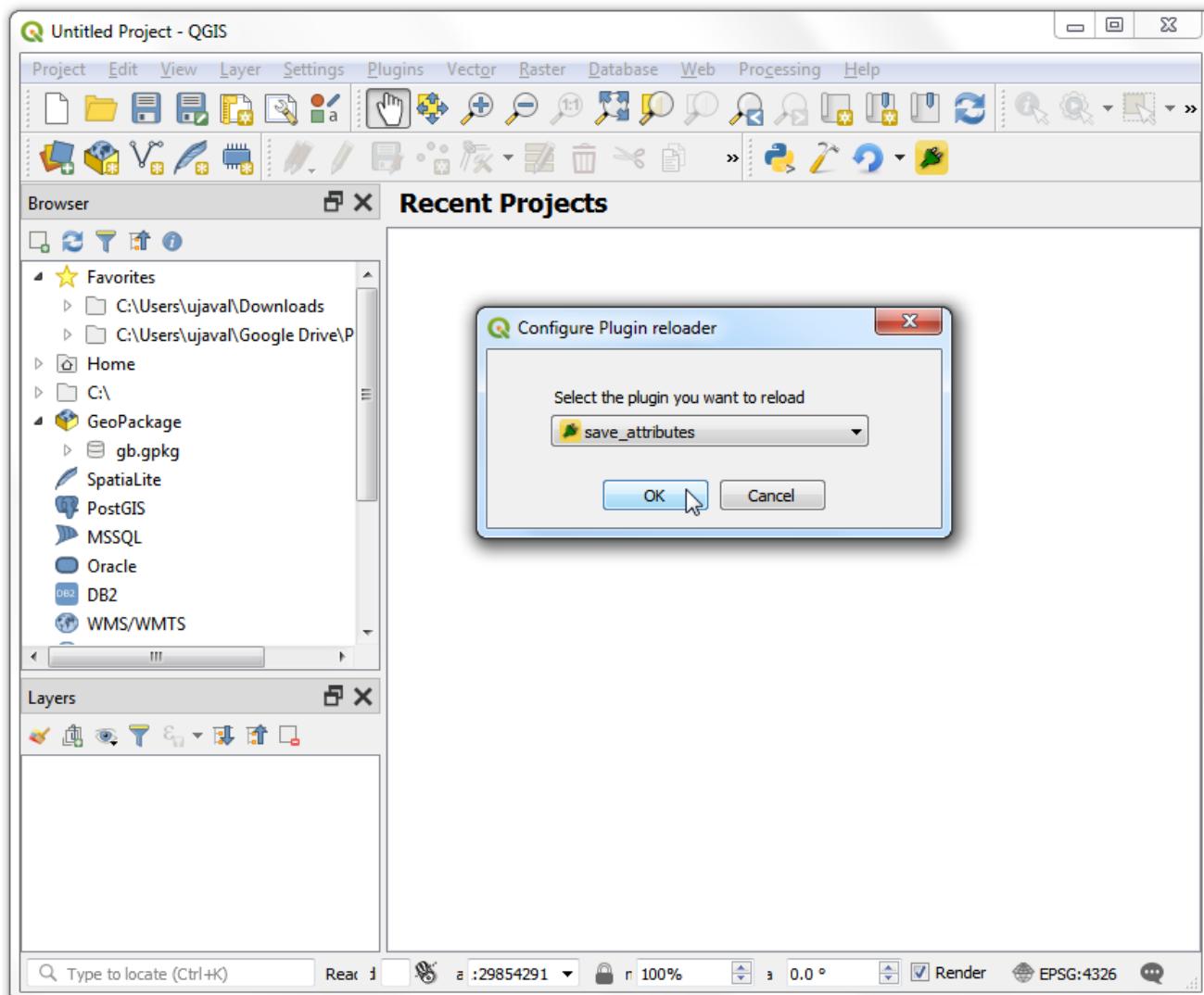
19. Click on the label text and enter Select a layer.



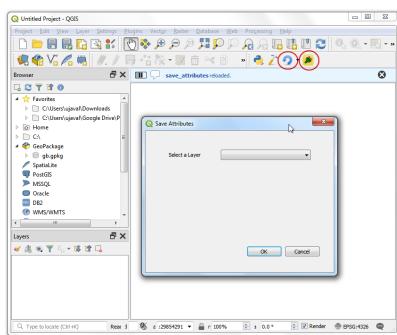
20. Save this file by going to File > Save save\_attributes\_dialog\_base.ui. Note the name of the combo box object is `comboBox`. To interact with this object using python code, we will have to refer to it by this name.

...

21. Let's reload our plugin so we can see the changes in the dialog window. Go to Plugin > Plugin Loader > Choose a plugin to be reloaded. Select SaveAttributes in the Configure Plugin loader dialog.



22. Click the Reload plugin button to load the latest version of the plugin. Click the Save Attributes as CSV button to open the newly designed dialog box.



23. 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. First, insert at the top of the file with the other imports:

```
from qgis.core import QgsProject
```

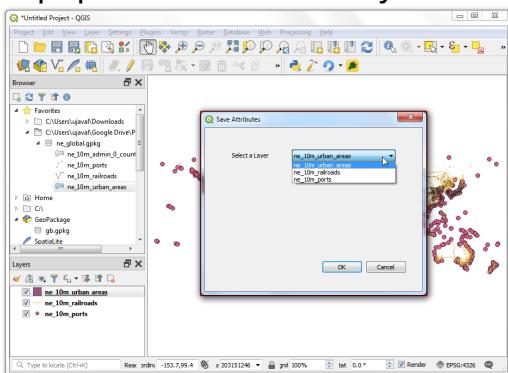
Then scroll down to the end and find the `run(self)` method. This method will be called when you click the toolbar button or select the plugin menu item. Add the following code at the beginning of the method. This code gets the layers loaded in QGIS and adds it to the `comboBox` object from the plugin dialog.

```
# Fetch the currently loaded layers
layers = QgsProject.instance().layerTreeRoot().children()
# Clear the contents of the comboBox from previous runs
self.dlg.comboBox.clear()
# Populate the comboBox with names of all the loaded layers
self.dlg.comboBox.addItems([layer.name() for layer in layers])
```

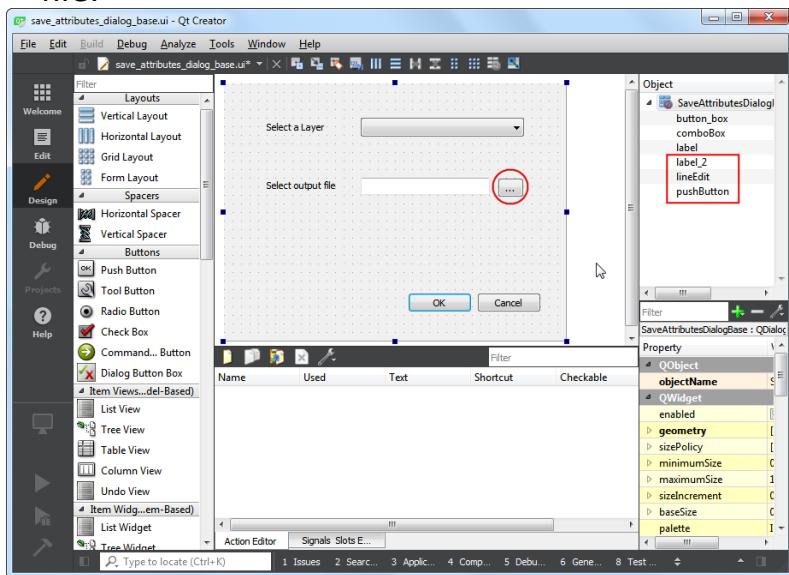
```
16  *
17  * This program is free software; you can redistribute it and/or modify
18  * it under the terms of the GNU General Public License as published by
19  * the Free Software Foundation; either version 2 of the License, or
20  * (at your option) any later version.
21  *
22  ****
23  """
24  from PyQt5.QtCore import QSettings, QTranslator, qVersion, QCoreApplication
25  from PyQt5.QtGui import QIcon
26  from PyQt5.QtWidgets import QAction
27  from qgis.core import QgsProject
28
29  # Initialize Qt resources from file resources.py
30  from resources import *
```

```
184
185
186 def run(self):
187     """Run method that performs all the real work"""
188
189     # Create the dialog with elements (after translation) and keep
190     # reference
191     # Only create GUI ONCE in callback, so that it will only load when
192     # the plugin is started
193     if self.first_start == True:
194         self.first_start = False
195         self.dig = SaveAttributesDialog()
196
197         # Fetch the currently loaded layers
198         layers = QgsProject.instance().layerTreeRoot().children()
199         # Clear the contents of the comboBox from previous runs
200         self.dig.comboBox.clear()
201         # Populate the comboBox with names of all the loaded layers
202         self.dig.comboBox.addItems([layer.name() for layer in layers])
203
204         # show the dialog
205         self.dig.show()
```

24. Back in the main QGIS window, reload the plugin by clicking on the Reload plugin button. To test this new functionality, we must load some layers in QGIS. After you have loaded some layers, launch the plugin by going to Vector > Save Attributes > Save Attributes as CSV. You will see that our combo box is now populated with the layer names that are loaded in QGIS.



25. Let's add the 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.



26. 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 `QtWidgets` list of imports at the top of the file.

```

7   Generated by Plugin Builder: http://g-sherman.github.io/Ogis-Plugin-Builder/
8
9     begin           : 2019-03-28
10    git sha        : $Format:$H$G
11    copyright      : (C) 2019 by Ujaval Gandhi
12    email          : ujaval@spatialthoughts.com
13
14
15  ****
16  *
17  * This program is free software; you can redistribute it and/or modify
18  * it under the terms of the GNU General Public License as published by
19  * the Free Software Foundation; either version 2 of the License, or
20  * (at your option) any later version.
21  *
22  ****
23 """
24 from PyQt5.QtCore import QSettings, QTranslator, qVersion, QApplication
25 from PyQt5.QtGui import QIcon
26 from PyQt5.QtWidgets import QAction, QFileDialog
27 from qgis.core import QgsProject
28
29 # Initialize Qt resources from file resources.py

```

27. 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. Note, how `getSaveFileName` returns a tuple with the filename and the filter used.

```

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

```



28. Now we need to add code so that when the ... button is clicked, `select_output_file` method is called. Scroll down to the `run` method and add the following line in the block where the dialog is initialized. This code will connect the `select_output_file` method to the `clicked` signal of the push button widget.

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

```

175
176
177     def unload(self):
178         """Removes the plugin menu item and icon from QGIS GUI."""
179         for action in self.actions:
180             self.iface.removePluginVectorMenu(
181                 self.tr(u'&Save Attributes'),
182                 action)
183             self.iface.removeToolBarIcon(action)
184
185     def select_output_file(self):
186         filename, _filter = QFileDialog.getSaveFileName(
187             self.dlg, "Select output file","", '*.csv')
188         self.dlg.lineEdit.setText(filename)
189
190     def run(self):
191         """Run method that performs all the real work"""
192
193         # Create the dialog with elements (after translation) and keep
194         # reference
195         # Only create GUI ONCE in callback, so that it will only load when
196         # the plugin is started
197         if self.first_start == True:
198             self.first_start = False
199             self.dlg = SaveAttributesDialog()
200             self.dlg.pushButton.clicked.connect(self.select_output_file)

```

29. Back in QGIS, reload the plugin and run it. If all went fine, you will be able to click the ... button and select an output text file from your disk.



30. 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 (QGIS3)*.

```
filename = self.dlg.lineEdit.text()
with open(filename, 'w') as output_file:
    selectedLayerIndex = self.dlg.comboBox.currentIndex()
    selectedLayer = layers[selectedLayerIndex].layer()
    fieldnames = [field.name() for field in selectedLayer.fields()]
    # write header
    line = ','.join(name for name in fieldnames) + '\n'
    output_file.write(line)
    # write feature attributes
    for f in selectedLayer.getFeatures():
        line = ','.join(str(f[name]) for name in fieldnames) + '\n'
        output_file.write(line)
```

```
198
199
200
201     self.dlg.pushButton.clicked.connect(self.select_output_file)
202
203     # Fetch the currently loaded layers
204     layers = QgsProject.instance().layerTreeRoot().children()
205     # Clear the contents of the comboBox from previous runs
206     self.dlg.comboBox.clear()
207     # Populate the comboBox with names of all the loaded layers
208     self.dlg.comboBox.addItems([layer.name() for layer in layers])
209
210     # show the dialog
211     self.dlg.show()
212     # Run the dialog event loop
213     result = self.dlg.exec_()
214     # See if OK was pressed
215     if result:
216         filename = self.dlg.lineEdit.text()
217         with open(filename, 'w') as output_file:
218             selectedLayerIndex = self.dlg.comboBox.currentIndex()
219             selectedLayer = layers[selectedLayerIndex].layer()
220             fieldnames = [field.name() for field in selectedLayer.fields()]
221             # write header
222             line = ','.join(name for name in fieldnames) + '\n'
223             output_file.write(line)
224             # write feature attributes
225             for f in selectedLayer.getFeatures():
226                 line = ','.join(str(f[name]) for name in fieldnames) + '\n'
227                 output_file.write(line)
```

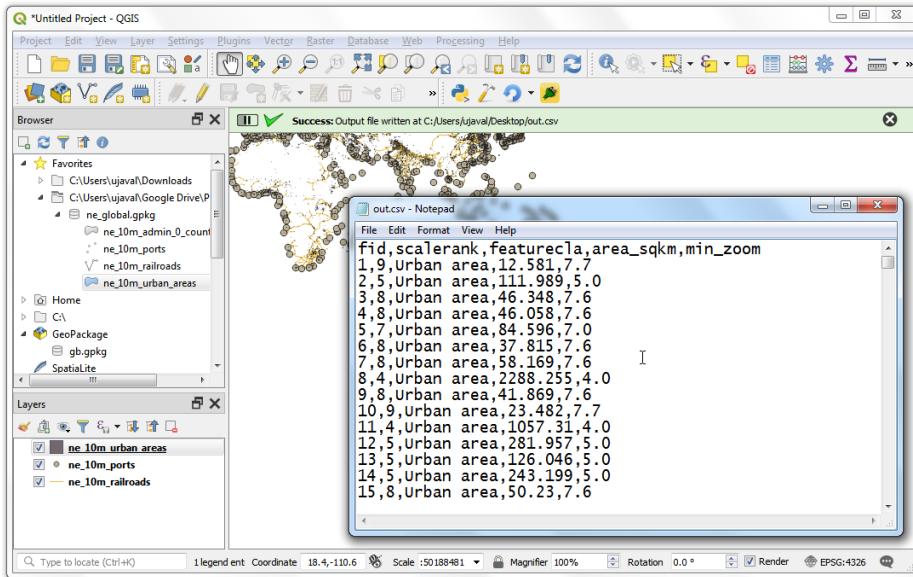
31. We have one last thing to add. When the operation finishes successfully, we should indicate the same to the user. The preferred way to give notifications to the user in QGIS is via the `self iface.messageBar().pushMessage()` method. Add `Qgis` to `qgis.core` list of imports at the top of the file and add the code below at the end of the `run` method.

```
self iface.messageBar().pushMessage(
    "Success", "Output file written at " + filename,
    level=Qgis.Success, duration=3)
```

```
18
19     * the Free Software Foundation; either version 2 of the License, or
20     * (at your option) any later version.
21     *
22     ****
23 """
24 from PyQt5.QtCore import QSettings, QTranslator, qVersion, QCoreApplication
25 from PyQt5.QtGui import QIcon
26 from PyQt5.QtWidgets import QAction, QFileDialog
27 from qgis.core import QgsProject, Qgis
28
29 # Initialize Qt resources from file resources.py
30 from .resources import *
```

Success

32. 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.



33. 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
    A QGIS plugin
This plugin saves the attributes of the selected vector layer as a CSV file.
Generated by Plugin Builder: http://g-sherman.github.io/Qgis-Plugin-Builder/
-----
begin : 2019-03-28
git sha : $Format:%H$
copyright : (C) 2019 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 PyQt5.QtCore import QSettings, QTranslator, qVersion, QCoreApplication
from PyQt5.QtGui import QIcon
from PyQt5.QtWidgets import QAction, QFileDialog
from qgis.core import QgsProject, Qgis

# Initialize Qt resources from file resources.py
from .resources import *
# 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)

        # Declare instance attributes
        self.actions = []
        self.menu = self.tr(u'&Save Attributes')

        # Check if plugin was started the first time in current QGIS session
        # Must be set in initGui() to survive plugin reloads
        self.first_start = None

    # 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
        """
        return QCoreApplication.translate('SaveAttributes', message)

```

```

"""
# 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:
        # Adds plugin icon to Plugins toolbar
        self iface.addToolBarIcon(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/save_attributes/icon.png'
    self.addAction(
        icon_path,
        text=self.tr(u'Save Attributes as CSV'),
        callback=self.run,
        parent=self iface mainWindow())

    # will be set False in run()
    self.first_start = True

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)

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

def run(self):
    """Run method that performs all the real work"""

    # Create the dialog with elements (after translation) and keep reference
    # Only create GUI ONCE in callback, so that it will only load when the plugin is st
    if self.first_start == True:
        self.first_start = False
        self.dlg = SaveAttributesDialog()
        self.dlg.pushButton.clicked.connect(self.select_output_file)

    # Fetch the currently loaded layers
    layers = QgsProject.instance().layerTreeRoot().children()
    # Clear the contents of the comboBox and lineEdit from previous runs
    self.dlg.comboBox.clear()
    self.dlg.lineEdit.clear()

```

```
# Populate the comboBox with names of all the loaded layers
self.dlg.comboBox.addItems([layer.name() for layer in layers])

# show the dialog
self.dlg.show()
# Run the dialog event loop
result = self.dlg.exec_()
# See if OK was pressed
if result:
    filename = self.dlg.lineEdit.text()
    with open(filename, 'w') as output_file:
        selectedLayerIndex = self.dlg.comboBox.currentIndex()
        selectedLayer = layers[selectedLayerIndex].layer()
        fieldnames = [field.name() for field in selectedLayer.fields()]
        # write header
        line = ','.join(name for name in fieldnames) + '\n'
        output_file.write(line)
        # write feature attributes
        for f in selectedLayer.getFeatures():
            line = ','.join(str(f[name]) for name in fieldnames) + '\n'
            output_file.write(line)
    self iface.messageBar().pushMessage(
        "Success", "Output file written at " + filename,
        level=Qgis.Success, duration=3)
```