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PyQGIS developer cookbook

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QGIS Project

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CHAPTER 1

Introducción

This document is intended to work both as a tutorial and a reference guide. While it does not list all possible use cases, it should give a good overview of the principal functionality.

Starting from 0.9 release, QGIS has optional scripting support using Python language. We've decided for Python as it's one of the most favourite languages for scripting. PyQGIS bindings depend on SIP and PyQt4. The reason for using SIP instead of more widely used SWIG is that the whole QGIS code depends on Qt libraries. Python bindings for Qt (PyQt) are done also using SIP and this allows seamless integration of PyQGIS with PyQt.

TODO: Getting PyQGIS to work (Manual compilation, Troubleshooting)

There are several ways how to use QGIS python bindings, they are covered in detail in the following sections:

- automatically run Python code when QGIS starts
- issue commands in Python console within QGIS
- create and use plugins in Python
- create custom applications based on QGIS API

There is a complete QGIS API reference that documents the classes from the QGIS libraries. Pythonic QGIS API is nearly identical to the API in C++.

There are some resources about programming with PyQGIS on QGIS blog. See QGIS tutorial ported to Python for some examples of simple 3rd party apps. A good resource when dealing with plugins is to download some plugins from plugin repository and examine their code. Also, the `python/plugins/` folder in your QGIS installation contains some plugin that you can use to learn how to develop such plugin and how to perform some of the most common tasks

1.1 Run Python code when QGIS starts

There are two distinct methods to run Python code every time QGIS starts.

1.1.1 PYQGIS_STARTUP environment variable

You can run Python code just before QGIS initialization completes by setting the `PYQGIS_STARTUP` environment variable to the path of an existing Python file.

This method is something you will probably rarely need, but worth mentioning here because it is one of the several ways to run Python code within QGIS and because this code will run before QGIS initialization is complete. This method is very useful for cleaning sys.path, which may have undesireable paths, or for isolating/loading the initial environ without requiring a virt env, e.g. homebrew or MacPorts installs on Mac.

1.1.2 The `startup.py` file

Every time QGIS starts, the user's Python home directory (usually: `.qgis2/python`) is searched for a file named `startup.py`, if that file exists, it is executed by the embedded Python interpreter.

1.2 Python Console

For scripting, it is possible to take advantage of integrated Python console. It can be opened from menu: *Plugins* → *Python Console*. The console opens as a non-modal utility window:

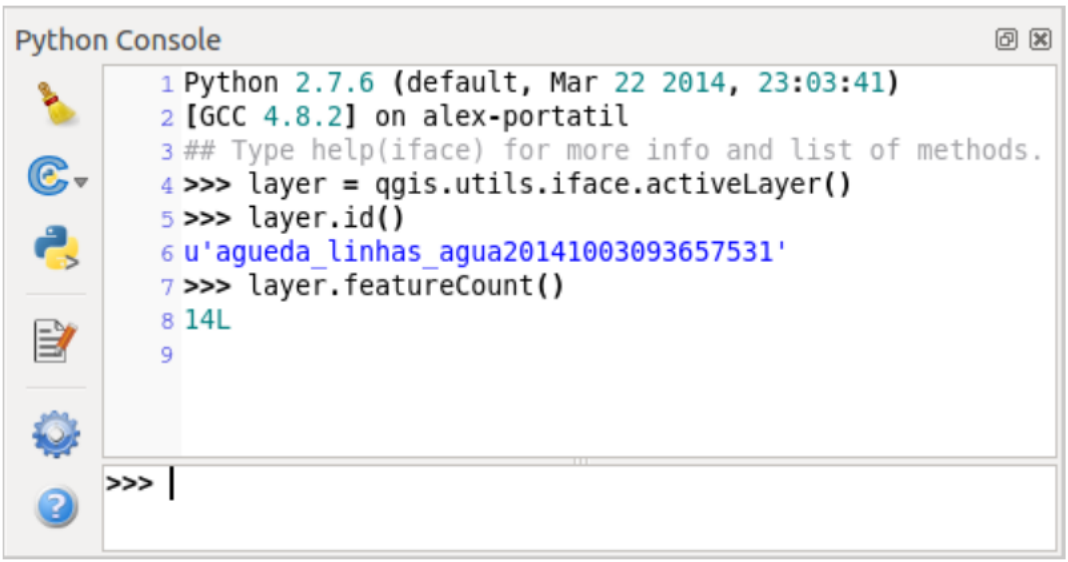

Figure 1.1: QGIS Python console

The screenshot above illustrates how to get the layer currently selected in the layer list, show its ID and optionally, if it is a vector layer, show the feature count. For interaction with QGIS environment, there is a `iface` variable, which is an instance of `QgsInterface`. This interface allows access to the map canvas, menus, toolbars and other parts of the QGIS application.

For convenience of the user, the following statements are executed when the console is started (in future it will be possible to set further initial commands)

```
from qgis.core import *
import qgis.utils
```

For those which use the console often, it may be useful to set a shortcut for triggering the console (within menu *Settings* → *Configure shortcuts...*)

1.3 Python Plugins

QGIS allows enhancement of its functionality using plugins. This was originally possible only with C++ language. With the addition of Python support to QGIS, it is also possible to use plugins written in Python. The main advantage over C++ plugins is its simplicity of distribution (no compiling for each platform needed) and easier development.

Many plugins covering various functionality have been written since the introduction of Python support. The plugin installer allows users to easily fetch, upgrade and remove Python plugins. See the Python Plugin Repositories page for various sources of plugins.

Creating plugins in Python is simple, see *Developing Python Plugins* for detailed instructions.

1.4 Python Applications

Often when processing some GIS data, it is handy to create some scripts for automating the process instead of doing the same task again and again. With PyQGIS, this is perfectly possible — import the `qgis.core` module, initialize it and you are ready for the processing.

Or you may want to create an interactive application that uses some GIS functionality — measure some data, export a map in PDF or any other functionality. The `qgis.gui` module additionally brings various GUI components, most notably the map canvas widget that can be very easily incorporated into the application with support for zooming, panning and/or any further custom map tools.

1.4.1 Using PyQGIS in custom application

Note: do *not* use `qgis.py` as a name for your test script — Python will not be able to import the bindings as the script's name will shadow them.

First of all you have to import qgis module, set QGIS path where to search for resources — database of projections, providers etc. When you set prefix path with second argument set as `True`, QGIS will initialize all paths with standard dir under the prefix directory. Calling `initQgis()` function is important to let QGIS search for the available providers.

```
from qgis.core import *

# supply path to where is your qgis installed
QgsApplication.setPrefixPath("/path/to/qgis/installation", True)

# load providers
QgsApplication.initQgis()
```

Now you can work with QGIS API — load layers and do some processing or fire up a GUI with a map canvas. The possibilities are endless :-)

When you are done with using QGIS library, call `exitQgis()` to make sure that everything is cleaned up (e.g. clear map layer registry and delete layers):

```
QgsApplication.exitQgis()
```

1.4.2 Running Custom Applications

You will need to tell your system where to search for QGIS libraries and appropriate Python modules if they are not in a well-known location — otherwise Python will complain:

```
>>> import qgis.core
ImportError: No module named qgis.core
```

This can be fixed by setting the `PYTHONPATH` environment variable. In the following commands, `qgispath` should be replaced with your actual QGIS installation path:

- on Linux: **export PYTHONPATH=/qgispath/share/qgis/python**
- on Windows: **set PYTHONPATH=c:\qgispath\python**

The path to the PyQGIS modules is now known, however they depend on `qgis_core` and `qgis_gui` libraries (the Python modules serve only as wrappers). Path to these libraries is typically unknown for the operating system, so you get an import error again (the message might vary depending on the system):

```
>>> import qgis.core
ImportError: libqgis_core.so.1.5.0: cannot open shared object file: No such file or directory
```

Fix this by adding the directories where the QGIS libraries reside to search path of the dynamic linker:

- on Linux: **export LD_LIBRARY_PATH=/qgispath/lib**

- on Windows: **set PATH=C:\qgispath;%PATH%**

These commands can be put into a bootstrap script that will take care of the startup. When deploying custom applications using PyQGIS, there are usually two possibilities:

- require user to install QGIS on his platform prior to installing your application. The application installer should look for default locations of QGIS libraries and allow user to set the path if not found. This approach has the advantage of being simpler, however it requires user to do more steps.
- package QGIS together with your application. Releasing the application may be more challenging and the package will be larger, but the user will be saved from the burden of downloading and installing additional pieces of software.

The two deployment models can be mixed - deploy standalone application on Windows and Mac OS X, for Linux leave the installation of QGIS up to user and his package manager.

CHAPTER 2

Cargar proyectos

Algunas veces se necesita cargar un proyecto existente desde un complemento o (más a menudo) al desarrollar una aplicación autónoma QGIS Python (vea : *Python Applications*).

Para cargar un proyecto en la aplicación QGIS actual necesita un objeto `QgsProject instance()` y llamar a su método `read()` de pasar a un objeto `QFileInfo` que contenga la ruta desde donde el proyecto fue cargado:

```
# If you are not inside a QGIS console you first need to import
# qgis and PyQt4 classes you will use in this script as shown below:
from qgis.core import QgsProject
from PyQt4.QtCore import QFileInfo
# Get the project instance
project = QgsProject.instance()
# Print the current project file name (might be empty in case no projects have been loaded)
print project.fileName
u'/home/user/projects/my_qgis_project.qgs'
# Load another project
project.read(QFileInfo('/home/user/projects/my_other_qgis_project.qgs'))
print project.fileName
u'/home/user/projects/my_other_qgis_project.qgs'
```

En caso de que necesite hacer algunas modificaciones al proyecto (por ejemplo añadir o eliminar algunas capas) y guardad los cambios, se puede llamar al método `write()` de la instancia del proyecto. El método `write()` también acepta una opcional `QFileInfo` que le permite especificar una ruta donde el proyecto será almacenado:

```
# Save the project to the same
project.write()
# ... or to a new file
project.write(QFileInfo('/home/user/projects/my_new_qgis_project.qgs'))
```

Ambas funciones `read()` y `write()` regresan un valor booleano que se puede utilizar para validar si la operación fue un éxito.

CHAPTER 3

Loading Layers

Let's open some layers with data. QGIS recognizes vector and raster layers. Additionally, custom layer types are available, but we are not going to discuss them here.

3.1 Vector Layers

To load a vector layer, specify layer's data source identifier, name for the layer and provider's name:

```
layer = QgsVectorLayer(data_source, layer_name, provider_name)
if not layer.isValid():
  print "Layer failed to load!"
```

The data source identifier is a string and it is specific to each vector data provider. Layer's name is used in the layer list widget. It is important to check whether the layer has been loaded successfully. If it was not, an invalid layer instance is returned.

The quickest way to open and display a vector layer in QGIS is the addVectorLayer function of the `QgisInterface`:

```
layer = iface.addVectorLayer("/path/to/shapefile/file.shp", "layer_name_you_like", "ogr")
if not layer:
  print "Layer failed to load!"
```

This creates a new layer and adds it to the map layer registry (making it appear in the layer list) in one step. The function returns the layer instance or *None* if the layer couldn't be loaded.

The following list shows how to access various data sources using vector data providers:

- OGR library (shapefiles and many other file formats) — data source is the path to the file

  ```
  vlayer = QgsVectorLayer("/path/to/shapefile/file.shp", "layer_name_you_like", "ogr")
  ```

- PostGIS database — data source is a string with all information needed to create a connection to PostgreSQL database. `QgsDataSourceURI` class can generate this string for you. Note that QGIS has to be compiled with Postgres support, otherwise this provider isn't available.

  ```
  uri = QgsDataSourceURI()
  # set host name, port, database name, username and password
  uri.setConnection("localhost", "5432", "dbname", "johny", "xxx")
  # set database schema, table name, geometry column and optionally
  # subset (WHERE clause)
  uri.setDataSource("public", "roads", "the_geom", "cityid = 2643")

  vlayer = QgsVectorLayer(uri.uri(), "layer_name_you_like", "postgres")
  ```

- CSV or other delimited text files — to open a file with a semicolon as a delimiter, with field "x" for x-coordinate and field "y" with y-coordinate you would use something like this

```
uri = "/some/path/file.csv?delimiter=%s&xField=%s&yField=%s" % (";", "x", "y")
vlayer = QgsVectorLayer(uri, "layer_name_you_like", "delimitedtext")
```

Note: from QGIS version 1.7 the provider string is structured as a URL, so the path must be prefixed with *file:///*. Also it allows WKT (well known text) formatted geometries as an alternative to "x" and "y" fields, and allows the coordinate reference system to be specified. For example

```
uri = "file:///some/path/file.csv?delimiter=%s&crs=epsg:4723&wktField=%s" % (";", "shape")
```

- GPX files — the "gpx" data provider reads tracks, routes and waypoints from gpx files. To open a file, the type (track/route/waypoint) needs to be specified as part of the url

```
uri = "path/to/gpx/file.gpx?type=track"
vlayer = QgsVectorLayer(uri, "layer_name_you_like", "gpx")
```

- SpatiaLite database — supported from QGIS v1.1. Similarly to PostGIS databases, `QgsDataSourceURI` can be used for generation of data source identifier

```
uri = QgsDataSourceURI()
uri.setDatabase('/home/martin/test-2.3.sqlite')
schema = ''
table = 'Towns'
geom_column = 'Geometry'
uri.setDataSource(schema, table, geom_column)

display_name = 'Towns'
vlayer = QgsVectorLayer(uri.uri(), display_name, 'spatialite')
```

- MySQL WKB-based geometries, through OGR — data source is the connection string to the table

```
uri = "MySQL:dbname,host=localhost,port=3306,user=root,password=xxx|layername=my_table"
vlayer = QgsVectorLayer( uri, "my_table", "ogr" )
```

- WFS connection:. the connection is defined with a URI and using the `WFS` provider

```
uri = "http://localhost:8080/geoserver/wfs?srsname=EPSG:23030&typename=union&version=1.0.0&re
vlayer = QgsVectorLayer("my_wfs_layer", "WFS")
```

The uri can be created using the standard `urllib` library.

```
params = {
    'service': 'WFS',
    'version': '1.0.0',
    'request': 'GetFeature',
    'typename': 'union',
    'srsname': "EPSG:23030"
}
uri = 'http://localhost:8080/geoserver/wfs?' + urllib.unquote(urllib.urlencode(params))
```

3.2 Raster Layers

For accessing raster files, GDAL library is used. It supports a wide range of file formats. In case you have troubles with opening some files, check whether your GDAL has support for the particular format (not all formats are available by default). To load a raster from a file, specify its file name and base name

```
fileName = "/path/to/raster/file.tif"
fileInfo = QFileInfo(fileName)
baseName = fileInfo.baseName()
rlayer = QgsRasterLayer(fileName, baseName)
if not rlayer.isValid():
  print "Layer failed to load!"
```

Similarly to vector layers, raster layers can be loaded using the addRasterLayer function of the `QgisInterface`:

```
iface.addRasterLayer("/path/to/raster/file.tif", "layer_name_you_like")
```

This creates a new layer and adds it to the map layer registry (making it appear in the layer list) in one step.

Raster layers can also be created from a WCS service.

```
layer_name = 'modis'
uri = QgsDataSourceURI()
uri.setParam('url', 'http://demo.mapserver.org/cgi-bin/wcs')
uri.setParam("identifier", layer_name)
rlayer = QgsRasterLayer(str(uri.encodedUri()), 'my_wcs_layer', 'wcs')
```

detailed URI settings can be found in provider documentation

Alternatively you can load a raster layer from WMS server. However currently it's not possible to access GetCapabilities response from API — you have to know what layers you want

```
urlWithParams = 'url=http://wms.jpl.nasa.gov/wms.cgi&layers=global_mosaic&styles=pseudo&format=im
rlayer = QgsRasterLayer(urlWithParams, 'some layer name', 'wms')
if not rlayer.isValid():
  print "Layer failed to load!"
```

3.3 Map Layer Registry

If you would like to use the opened layers for rendering, do not forget to add them to map layer registry. The map layer registry takes ownership of layers and they can be later accessed from any part of the application by their unique ID. When the layer is removed from map layer registry, it gets deleted, too.

Adding a layer to the registry

```
QgsMapLayerRegistry.instance().addMapLayer(layer)
```

Layers are destroyed automatically on exit, however if you want to delete the layer explicitly, use

```
QgsMapLayerRegistry.instance().removeMapLayer(layer_id)
```

For a list of loaded layers and layer ids, use

```
QgsMapLayerRegistry.instance().mapLayers()
```

TODO: More about map layer registry?

CHAPTER 4

Usar las capas ráster

Esta sección enumera varias operaciones que se pueden hacer con capas ráster.

4.1 Detalles de la capa

La capa ráster se compone de una o más bandas ráster — que se conoce, ya sea como una sola banda o multibanda ráster. Una banda representa una matriz de valores. La imagen en color habitual (por ejemplo, foto aérea) es un ráster que consiste en banda roja, azul y verde. Las capas de una sola banda suelen representar bien las variables continuas (por ejemplo, elevación) o variables discretas (por ejemplo, uso de la tierra). En algunos casos, una capa ráster viene con una paleta y valores ráster se refieren a los colores almacenados en la paleta:

```
rlayer.width(), rlayer.height()
(812, 301)
rlayer.extent()
<qgis._core.QgsRectangle object at 0x000000000F8A2048>
rlayer.extent().toString()
u'12.095833,48.552777 : 18.863888,51.056944'
rlayer.rasterType()
2  # 0 = GrayOrUndefined (single band), 1 = Palette (single band), 2 = Multiband
rlayer.bandCount()
3
rlayer.metadata()
u'<p class="glossy">Driver:</p>...'
rlayer.hasPyramids()
False
```

4.2 Estilo de dibujo

Cuando se carga una capa ráster, se le asigna un estilo de dibujo predeterminado basado en la escritra. Se puede cambiar en propiedades de la capa ráster o de manera programática. Existen los siguientes estilos de dibujos:

Índice	Constante: QgsRasterLater.X	Comentario
1	SingleBandGray	Imagen de una sola banda dibujada como una gama de colores gris
2	SingleBandPseudoColor	Imagen de una sola banda dibujada utilizando un algoritmo de pseudocolor
3	PalettedColor	Imagen "Paleta" dibujada utilizando la tabla de colores
4	PalettedSingleBandGray	Capa "Paleta" dibujada en escala de grises
5	PalettedSingleBandPseudoColor	Capa "Paleta" dibuja al utilizar un algoritmo de pseudocolor
7	MultiBandSingleBandGray	La capa contiene 2 o más bandas, pero una sola banda como una gama de color gris
8	MultiBandSingleBandPseudoColor	La capa contiene 2 o más bandas, pero una sola banda dibujada utiliza un algoritmo pseudocolor
9	MultiBandColor	La capa contiene 2 o más bandas, mapeada al espacio de color RGB.

Consultar el estilo de dibujo actual:

```
rlayer.renderer().type()
u'singlebandpseudocolor'
```

Las capas ráster de una sola banda se puede dibujar ya sea en colores grises (valores bajos = negro, valores altos = blanco) o con un algoritmo de pseudocolor que asigna colores para los valores de una sola banda. Los ráster de una sola banda con una paleta además se pueden dibujar al utilizar su paleta. Capas multibanda suelen dibujarse mediante la asignación de las bandas de colores RGB. Otra posibilidad es utilizar una sola banda para el dibujo gris o pseudocolor.

Las siguientes secciones explican cómo consultar y modificar el estilo de dibujo de la capa. Después de hacer los cambios, es posible que desee forzar la actualización del lienzo del mapa, ver ref:*refresh-layer*.

TODO: mejoras de contraste, la transparencia (sin datos), máximos /mínimos definidos por el usuario, estadísticas de la banda

4.2.1 Rásters de una sola banda

Por defecto, se representan en colores de grises. Para cambiar el estilo de dibujo a pseudocolor:

```
# Check the renderer
rlayer.renderer().type()
u'singlebandgray'
rlayer.setDrawingStyle("SingleBandPseudoColor")
# The renderer is now changed
rlayer.renderer().type()
u'singlebandpseudocolor'
# Set a color ramp hader function
shader_func = QgsColorRampShader()
rlayer.renderer().shader().setRasterShaderFunction(shader_func)
```

El `PseudoColorShader` es un sombreador básico que resalta los valores bajos en azul y los valores altos en rojo. También hay `ColorRampShader` que mapea los colores como se especifica en su mapa de color. Dispone de tres modos de interpolación de valores.

- linear (`INTERPOLATED`): el color resultante se interpola linealmente desde las entradas del mapa de color por encima y por debajo del valor real del píxel
- discrete (`DISCRETE`): el color se utiliza desde la entrada de mapa de color con valor igual o superior
- exact (`EXACT`): el color no es interpolado, solamente los píxeles con valor igual al color del mapa de entrada es dibujado

Para establecer una sombra de rampa de color interpolada que van del verde al color amarillo (por valores de píxel de 0 a 255):

```
rlayer.renderer().shader().setRasterShaderFunction(QgsColorRampShader())
lst = [QgsColorRampShader.ColorRampItem(0, QColor(0, 255, 0)), \
    QgsColorRampShader.ColorRampItem(255, QColor(255, 255 ,0))]
fcn = rlayer.renderer().shader().rasterShaderFunction()
fcn.setColorRampType(QgsColorRampShader.INTERPOLATED)
fcn.setColorRampItemList(lst)
```

Para volver a los valores predeterminados de niveles de gris, utiliza:

```
rlayer.setDrawingStyle('SingleBandGray')
```

4.2.2 Rásters multibanda

Por defecto, en los mapas de QGIS las primeras tres bandas a valores de rojo, verde y azul para crear una imagen en color (este es el estilo de dibujo `MultiBandColor`. En algunos casos es posible que desee anular estos ajustes. El siguiente código intercambia la banda roja (1) y la banda verde (2):

```
rlayer.setDrawingStyle('MultiBandColor')
rlayer.renderer().setGreenBand(1)
rlayer.setRedBand(2)
```

4.3 Actualizar capas

Si se hace el cambio de la simbología de capa y le gustaría asegurarse de que los cambios son inmediatamente visibles para el usuario, llame a estos métodos

```
if hasattr(layer, "setCacheImage"):
  layer.setCacheImage(None)
layer.triggerRepaint()
```

La primera llamada se asegurará de que la imagen en caché de la capa presentada se borra en caso de que el almacenamiento en caché este activado. Esta funcionalidad está disponible desde QGIS 1.4, en versiones anteriores no existe esta función — para asegurarse de que el código funciona con en todas las versiones de QGIS, primero comprobamos si existe el método.

La segunda llamada emite señal de que obligará a cualquier lienzo de mapa que contenga la capa de emitir una actualización.

Con capas ráster WMS, estos comandos no funcionan. En este caso, hay que hacerlo de forma explícita

```
layer.dataProvider().reloadData()
layer.triggerRepaint()
```

En caso de que haya cambiado la simbología de capa (ver secciones acerca de capas ráster y vectoriales sobre cómo hacerlo), es posible que desee forzar QGIS para actualizar la simbología de capa en la lista de capas (leyenda) de widgets. Esto se puede hacer de la siguiente manera (`iface` es una instancia de `QgisInterface`)

```
iface.legendInterface().refreshLayerSymbology(layer)
```

4.4 Valores de consulta

Para hacer una consulta sobre el valor de las bandas de capa ráster en algún momento determinado

```
ident = rlayer.dataProvider().identify(QgsPoint(15.30, 40.98), \
  QgsRaster.IdentifyFormatValue)
if ident.isValid():
  print ident.results()
```

El método `results` en este caso regresa un diccionario, con índices de bandas como llaves, y los valores de la banda como valores.

```
{1: 17, 2: 220}
```

CHAPTER 5

Usar capas vectoriales

Esta sección sumariza varias acciones que pueden ser realizadas con las capas vectoriales

5.1 Retrieving informations about attributes

You can retrieve informations about the fields associated with a vector layer by calling `pendingFields()` on a `QgsVectorLayer` instance:

```
# "layer" is a QgsVectorLayer instance
for field in layer.pendingFields():
    print field.name(), field.typeName()
```

5.2 Selecting features

In QGIS desktop, features can be selected in different ways, the user can click on a feature, draw a rectangle on the map canvas or use an expression filter. Selected fatures are normally higlighted in a different color (default is yellow) to draw user's attention on the selection. Sometimes can be useful to programmatically select features or to change the default color.

To change the selection color you can use `setSelectionColor()` method of `QgsMapCanvas` as shown in the following example:

```
iface.mapCanvas().setSelectionColor( QColor("red") )
```

To add add features to the selected features list for a given layer, you can call `setSelectedFeatures()` passing to it the list of features IDs:

```
# Get the active layer (must be a vector layer)
layer = iface.activeLayer()
# Get the first feature from the layer
feature = layer.getFeatures().next()
# Add this features to the selected list
layer.setSelectedFeatures([feature.id()])
```

To clear the selection, just pass an empty list:

```
layer.setSelectedFeatures([])
```

5.3 Iterando sobre la capa vectorial

Iterating over the features in a vector layer is one of the most common tasks. Below is an example of the simple basic code to perform this task and showing some information about each feature. the `layer` variable is assumed

to have a `QgsVectorLayer` object

```
iter = layer.getFeatures()
for feature in iter:
    # retrieve every feature with its geometry and attributes
    # fetch geometry
    geom = feature.geometry()
    print "Feature ID %d: " % feature.id()

    # show some information about the feature
    if geom.type() == QGis.Point:
        x = geom.asPoint()
        print "Point: " + str(x)
    elif geom.type() == QGis.Line:
        x = geom.asPolyline()
        print "Line: %d points" % len(x)
    elif geom.type() == QGis.Polygon:
        x = geom.asPolygon()
        numPts = 0
        for ring in x:
        numPts += len(ring)
        print "Polygon: %d rings with %d points" % (len(x), numPts)
    else:
        print "Unknown"

    # fetch attributes
    attrs = feature.attributes()

    # attrs is a list. It contains all the attribute values of this feature
    print attrs
```

5.3.1 Accessing attributes

Attributes can be referred to by their name.

```
print feature['name']
```

Alternatively, attributes can be referred to by index. This is will be a bit faster than using the name. For example, to get the first attribute:

```
print feature[0]
```

5.3.2 Iterando sobre rasgos seleccionados

if you only need selected features, you can use the `selectedFeatures()` method from vector layer:

```
selection = layer.selectedFeatures()
print len(selection)
for feature in selection:
    # do whatever you need with the feature
```

Another option is the Processing `features()` method:

```
import processing
features = processing.features(layer)
for feature in features:
    # do whatever you need with the feature
```

By default, this will iterate over all the features in the layer, in case there is no selection, or over the selected features otherwise. Note that this behavior can be changed in the Processing options to ignore selections.

5.3.3 Iterando sobre un subconjunto de rasgos

If you want to iterate over a given subset of features in a layer, such as those within a given area, you have to add a `QgsFeatureRequest` object to the `getFeatures()` call. Here's an example

```
request = QgsFeatureRequest()
request.setFilterRect(areaOfInterest)
for feature in layer.getFeatures(request):
    # do whatever you need with the feature
```

If you need an attribute-based filter instead (or in addition) of a spatial one like shown in the example above, you can build an `QgsExpression` object and pass it to the `QgsFeatureRequest` constructor. Here's an example

```
# The expression will filter the features where the field "location_name" contains
# the word "Lake" (case insensitive)
exp = QgsExpression('location_name ILIKE \'%Lake%\'')
request = QgsFeatureRequest(exp)
```

The request can be used to define the data retrieved for each feature, so the iterator returns all features, but returns partial data for each of them.

```
# Only return selected fields
request.setSubsetOfAttributes([0,2])
# More user friendly version
request.setSubsetOfAttributes(['name','id'],layer.pendingFields())
# Don't return geometry objects
request.setFlags(QgsFeatureRequest.NoGeometry)
```

Truco: If you only need a subset of the attributes or you don't need the geometry informations, you can significantly increase the **speed** of the features request by using `QgsFeatureRequest.NoGeometry` flag or specifying a subset of attributes (possibly empty) like shown in the example above.

5.4 Modifying Vector Layers

Most vector data providers support editing of layer data. Sometimes they support just a subset of possible editing actions. Use the `capabilities()` function to find out what set of functionality is supported

```
caps = layer.dataProvider().capabilities()
```

By using any of the following methods for vector layer editing, the changes are directly committed to the underlying data store (a file, database etc). In case you would like to do only temporary changes, skip to the next section that explains how to do *modifications with editing buffer*.

Nota: If you are working inside QGIS (either from the console or from a plugin), it might be necessary to force a redraw of the map canvas in order to see the changes you've done to the geometry, to the style or to the attributes:

```
# If caching is enabled, a simple canvas refresh might not be sufficient
# to trigger a redraw and you must clear the cached image for the layer
if iface.mapCanvas().isCachingEnabled():
    layer.setCacheImage(None)
else:
    iface.mapCanvas().refresh()
```

5.4.1 Add Features

Create some `QgsFeature` instances and pass a list of them to provider's `addFeatures()` method. It will return two values: result (true/false) and list of added features (their ID is set by the data store)

```
if caps & QgsVectorDataProvider.AddFeatures:
    feat = QgsFeature()
    feat.addAttribute(0, 'hello')
    feat.setGeometry(QgsGeometry.fromPoint(QgsPoint(123, 456)))
    (res, outFeats) = layer.dataProvider().addFeatures([feat])
```

5.4.2 Delete Features

To delete some features, just provide a list of their feature IDs

```
if caps & QgsVectorDataProvider.DeleteFeatures:
    res = layer.dataProvider().deleteFeatures([5, 10])
```

5.4.3 Modify Features

It is possible to either change feature's geometry or to change some attributes. The following example first changes values of attributes with index 0 and 1, then it changes the feature's geometry

```
fid = 100   # ID of the feature we will modify

if caps & QgsVectorDataProvider.ChangeAttributeValues:
    attrs = { 0 : "hello", 1 : 123 }
    layer.dataProvider().changeAttributeValues({ fid : attrs })

if caps & QgsVectorDataProvider.ChangeGeometries:
    geom = QgsGeometry.fromPoint(QgsPoint(111,222))
    layer.dataProvider().changeGeometryValues({ fid : geom })
```

Truco: If you only need to change geometries, you might consider using the `QgsVectorLayerEditUtils` which provides some of useful methods to edit geometries (translate, insert or move vertex etc.)

5.4.4 Adding and Removing Fields

To add fields (attributes), you need to specify a list of field definitions. For deletion of fields just provide a list of field indexes.

```
if caps & QgsVectorDataProvider.AddAttributes:
    res = layer.dataProvider().addAttributes([QgsField("mytext", QVariant.String), QgsField("myin
if caps & QgsVectorDataProvider.DeleteAttributes:
    res = layer.dataProvider().deleteAttributes([0])
```

After adding or removing fields in the data provider the layer's fields need to be updated because the changes are not automatically propagated.

```
layer.updateFields()
```

5.5 Modifying Vector Layers with an Editing Buffer

When editing vectors within QGIS application, you have to first start editing mode for a particular layer, then do some modifications and finally commit (or rollback) the changes. All the changes you do are not written until you commit them — they stay in layer's in-memory editing buffer. It is possible to use this functionality also programmatically — it is just another method for vector layer editing that complements the direct usage of data providers. Use this option when providing some GUI tools for vector layer editing, since this will allow user to

decide whether to commit/rollback and allows the usage of undo/redo. When committing changes, all changes from the editing buffer are saved to data provider.

To find out whether a layer is in editing mode, use `isEditing()` — the editing functions work only when the editing mode is turned on. Usage of editing functions

```
# add two features (QgsFeature instances)
layer.addFeatures([feat1,feat2])
# delete a feature with specified ID
layer.deleteFeature(fid)

# set new geometry (QgsGeometry instance) for a feature
layer.changeGeometry(fid, geometry)
# update an attribute with given field index (int) to given value (QVariant)
layer.changeAttributeValue(fid, fieldIndex, value)

# add new field
layer.addAttribute(QgsField("mytext", QVariant.String))
# remove a field
layer.deleteAttribute(fieldIndex)
```

In order to make undo/redo work properly, the above mentioned calls have to be wrapped into undo commands. (If you do not care about undo/redo and want to have the changes stored immediately, then you will have easier work by *editing with data provider*.) How to use the undo functionality

```
layer.beginEditCommand("Feature triangulation")

# ... call layer's editing methods ...

if problem_occurred:
    layer.destroyEditCommand()
   return

# ... more editing ...

layer.endEditCommand()
```

The `beginEditCommand()` will create an internal "active" command and will record subsequent changes in vector layer. With the call to `endEditCommand()` the command is pushed onto the undo stack and the user will be able to undo/redo it from GUI. In case something went wrong while doing the changes, the `destroyEditCommand()` method will remove the command and rollback all changes done while this command was active.

To start editing mode, there is `startEditing()` method, to stop editing there are `commitChanges()` and `rollback()` — however normally you should not need these methods and leave this functionality to be triggered by the user.

5.6 Using Spatial Index

Spatial indexes can dramatically improve the performance of your code if you need to do frequent queries to a vector layer. Imagine, for instance, that you are writing an interpolation algorithm, and that for a given location you need to know the 10 closest points from a points layer, in order to use those point for calculating the interpolated value. Without a spatial index, the only way for QGIS to find those 10 points is to compute the distance from each and every point to the specified location and then compare those distances. This can be a very time consuming task, especially if it needs to be repeated for several locations. If a spatial index exists for the layer, the operation is much more effective.

Think of a layer without a spatial index as a telephone book in which telephone numbers are not ordered or indexed. The only way to find the telephone number of a given person is to read from the beginning until you find it.

Spatial indexes are not created by default for a QGIS vector layer, but you can create them easily. This is what you have to do.

1. create spatial index — the following code creates an empty index

   ```
   index = QgsSpatialIndex()
   ```

2. add features to index — index takes `QgsFeature` object and adds it to the internal data structure. You can create the object manually or use one from previous call to provider's `nextFeature()`

   ```
   index.insertFeature(feat)
   ```

3. once spatial index is filled with some values, you can do some queries

   ```
   # returns array of feature IDs of five nearest features
   nearest = index.nearestNeighbor(QgsPoint(25.4, 12.7), 5)

   # returns array of IDs of features which intersect the rectangle
   intersect = index.intersects(QgsRectangle(22.5, 15.3, 23.1, 17.2))
   ```

5.7 Writing Vector Layers

You can write vector layer files using `QgsVectorFileWriter` class. It supports any other kind of vector file that OGR supports (shapefiles, GeoJSON, KML and others).

There are two possibilities how to export a vector layer:

- from an instance of `QgsVectorLayer`

  ```
  error = QgsVectorFileWriter.writeAsVectorFormat(layer, "my_shapes.shp", "CP1250", None, "ESRI
  if error == QgsVectorFileWriter.NoError:
      print "success!"

  error = QgsVectorFileWriter.writeAsVectorFormat(layer, "my_json.json", "utf-8", None, "GeoJSO
  if error == QgsVectorFileWriter.NoError:
      print "success again!"
  ```

  The third parameter specifies output text encoding. Only some drivers need this for correct operation - shapefiles are one of those — however in case you are not using international characters you do not have to care much about the encoding. The fourth parameter that we left as `None` may specify destination CRS — if a valid instance of `QgsCoordinateReferenceSystem` is passed, the layer is transformed to that CRS.

  For valid driver names please consult the supported formats by OGR — you should pass the value in the "Code" column as the driver name. Optionally you can set whether to export only selected features, pass further driver-specific options for creation or tell the writer not to create attributes — look into the documentation for full syntax.

- directly from features

  ```
  # define fields for feature attributes. A list of QgsField objects is needed
  fields = [QgsField("first", QVariant.Int),
            QgsField("second", QVariant.String)]

  # create an instance of vector file writer, which will create the vector file.
  # Arguments:
  # 1. path to new file (will fail if exists already)
  # 2. encoding of the attributes
  # 3. field map
  # 4. geometry type - from WKBTYPE enum
  # 5. layer's spatial reference (instance of
  #    QgsCoordinateReferenceSystem) - optional
  ```

```
# 6. driver name for the output file
writer = QgsVectorFileWriter("my_shapes.shp", "CP1250", fields, QGis.WKBPoint, None, "ESRI Sh

if writer.hasError() != QgsVectorFileWriter.NoError:
    print "Error when creating shapefile: ", writer.hasError()

# add a feature
fet = QgsFeature()
fet.setGeometry(QgsGeometry.fromPoint(QgsPoint(10,10)))
fet.setAttributes([1, "text"])
writer.addFeature(fet)

# delete the writer to flush features to disk (optional)
del writer
```

5.8 Memory Provider

Memory provider is intended to be used mainly by plugin or 3rd party app developers. It does not store data on disk, allowing developers to use it as a fast backend for some temporary layers.

The provider supports string, int and double fields.

The memory provider also supports spatial indexing, which is enabled by calling the provider's `createSpatialIndex()` function. Once the spatial index is created you will be able to iterate over features within smaller regions faster (since it's not necessary to traverse all the features, only those in specified rectangle).

A memory provider is created by passing `"memory"` as the provider string to the `QgsVectorLayer` constructor.

The constructor also takes a URI defining the geometry type of the layer, one of: `"Point"`, `"LineString"`, `"Polygon"`, `"MultiPoint"`, `"MultiLineString"`, or `"MultiPolygon"`.

The URI can also specify the coordinate reference system, fields, and indexing of the memory provider in the URI. The syntax is:

crs=definition Specifies the coordinate reference system, where definition may be any of the forms accepted by `QgsCoordinateReferenceSystem.createFromString()`

index=yes Specifies that the provider will use a spatial index

field=name:type(length,precision) Specifies an attribute of the layer. The attribute has a name, and optionally a type (integer, double, or string), length, and precision. There may be multiple field definitions.

The following example of a URI incorporates all these options

```
"Point?crs=epsg:4326&field=id:integer&field=name:string(20)&index=yes"
```

The following example code illustrates creating and populating a memory provider

```
# create layer
vl = QgsVectorLayer("Point", "temporary_points", "memory")
pr = vl.dataProvider()

# add fields
pr.addAttributes([QgsField("name", QVariant.String),
                  QgsField("age",  QVariant.Int),
                  QgsField("size", QVariant.Double)])
vl.updateFields() # tell the vector layer to fetch changes from the provider

# add a feature
fet = QgsFeature()
fet.setGeometry(QgsGeometry.fromPoint(QgsPoint(10,10)))
```

```
fet.setAttributes(["Johny", 2, 0.3])
pr.addFeatures([fet])

# update layer's extent when new features have been added
# because change of extent in provider is not propagated to the layer
vl.updateExtents()
```

Finally, let's check whether everything went well

```
# show some stats
print "fields:", len(pr.fields())
print "features:", pr.featureCount()
e = layer.extent()
print "extent:", e.xMiniminum(), e.yMinimum(), e.xMaximum(), e.yMaximum()

# iterate over features
f = QgsFeature()
features = vl.getFeatures()
for f in features:
    print "F:", f.id(), f.attributes(), f.geometry().asPoint()
```

5.9 Appearance (Symbology) of Vector Layers

When a vector layer is being rendered, the appearance of the data is given by **renderer** and **symbols** associated with the layer. Symbols are classes which take care of drawing of visual representation of features, while renderers determine what symbol will be used for a particular feature.

The renderer for a given layer can obtained as shown below:

```
renderer = layer.rendererV2()
```

And with that reference, let us explore it a bit

```
print "Type:", rendererV2.type()
```

There are several known renderer types available in QGIS core library:

Type	Class	Descripción
singleSymbol	`QgsSingleSymbolRendererV2`	Renders all features with the same symbol
categorizedSymbol	`QgsCategorizedSymbolRendererV2`	Renders features using a different symbol for each category
graduatedSymbol	`QgsGraduatedSymbolRendererV2`	Renders features using a different symbol for each range of values

There might be also some custom renderer types, so never make an assumption there are just these types. You can query `QgsRendererV2Registry` singleton to find out currently available renderers:

```
QgsRendererV2Registry.instance().renderersList()
# Prints:
[u'singleSymbol',
u'categorizedSymbol',
u'graduatedSymbol',
u'RuleRenderer',
u'pointDisplacement',
u'invertedPolygonRenderer',
u'heatmapRenderer']
```

It is possible to obtain a dump of a renderer contents in text form — can be useful for debugging

```
print rendererV2.dump()
```

5.9.1 Single Symbol Renderer

You can get the symbol used for rendering by calling `symbol()` method and change it with `setSymbol()` method (note for C++ devs: the renderer takes ownership of the symbol.)

You can change the symbol used by a particular vector layer by calling `setSymbol()` passing an instance of the appropriate symbol instance. Symbols for *point*, *line* and *polygon* layers can be created by calling the `createSimple()` function of the corresponding classes `QgsMarkerSymbolV2`, `QgsLineSymbolV2` and `QgsFillSymbolV2`.

The dictionary passed to `createSimple()` sets the style properties of the symbol.

For example you can change the symbol used by a particular **point** layer by calling `setSymbol()` passing an instance of a `QgsMarkerSymbolV2` as in the following code example:

```
symbol = QgsMarkerSymbolV2.createSimple({'name': 'square', 'color': 'red'})
layer.rendererV2().setSymbol(symbol)
```

`name` indicates the shape of the marker, and can be any of the following:

- `circle`
- `square`
- `rectangle`
- `diamond`
- `pentagon`
- `triangle`
- `equilateral_triangle`
- `star`
- `regular_star`
- `arrow`
- `filled_arrowhead`

5.9.2 Categorized Symbol Renderer

You can query and set attribute name which is used for classification: use `classAttribute()` and `setClassAttribute()` methods.

To get a list of categories

```
for cat in rendererV2.categories():
    print "%s: %s :: %s" % (cat.value().toString(), cat.label(), str(cat.symbol()))
```

Where `value()` is the value used for discrimination between categories, `label()` is a text used for category description and `symbol()` method returns assigned symbol.

The renderer usually stores also original symbol and color ramp which were used for the classification: `sourceColorRamp()` and `sourceSymbol()` methods.

5.9.3 Graduated Symbol Renderer

This renderer is very similar to the categorized symbol renderer described above, but instead of one attribute value per class it works with ranges of values and thus can be used only with numerical attributes.

To find out more about ranges used in the renderer

```
for ran in rendererV2.ranges():
    print "%f - %f: %s %s" % (
        ran.lowerValue(),
        ran.upperValue(),
        ran.label(),
        str(ran.symbol())
      )
```

you can again use `classAttribute()` to find out classification attribute name, `sourceSymbol()` and `sourceColorRamp()` methods. Additionally there is `mode()` method which determines how the ranges were created: using equal intervals, quantiles or some other method.

If you wish to create your own graduated symbol renderer you can do so as illustrated in the example snippet below (which creates a simple two class arrangement)

```
from qgis.core import *

myVectorLayer = QgsVectorLayer(myVectorPath, myName, 'ogr')
myTargetField = 'target_field'
myRangeList = []
myOpacity = 1
# Make our first symbol and range...
myMin = 0.0
myMax = 50.0
myLabel = 'Group 1'
myColour = QtGui.QColor('#ffee00')
mySymbol1 = QgsSymbolV2.defaultSymbol(myVectorLayer.geometryType())
mySymbol1.setColor(myColour)
mySymbol1.setAlpha(myOpacity)
myRange1 = QgsRendererRangeV2(myMin, myMax, mySymbol1, myLabel)
myRangeList.append(myRange1)
#now make another symbol and range...
myMin = 50.1
myMax = 100
myLabel = 'Group 2'
myColour = QtGui.QColor('#00eeff')
mySymbol2 = QgsSymbolV2.defaultSymbol(
     myVectorLayer.geometryType())
mySymbol2.setColor(myColour)
mySymbol2.setAlpha(myOpacity)
myRange2 = QgsRendererRangeV2(myMin, myMax, mySymbol2 myLabel)
myRangeList.append(myRange2)
myRenderer = QgsGraduatedSymbolRendererV2('', myRangeList)
myRenderer.setMode(QgsGraduatedSymbolRendererV2.EqualInterval)
myRenderer.setClassAttribute(myTargetField)

myVectorLayer.setRendererV2(myRenderer)
QgsMapLayerRegistry.instance().addMapLayer(myVectorLayer)
```

5.9.4 Working with Symbols

For representation of symbols, there is `QgsSymbolV2` base class with three derived classes:

- `QgsMarkerSymbolV2` — for point features
- `QgsLineSymbolV2` — for line features
- `QgsFillSymbolV2` — for polygon features

Every symbol consists of one or more symbol layers (classes derived from `QgsSymbolLayerV2`). The symbol layers do the actual rendering, the symbol class itself serves only as a container for the symbol layers.

Having an instance of a symbol (e.g. from a renderer), it is possible to explore it: `type()` method says whether it is a marker, line or fill symbol. There is a `dump()` method which returns a brief description of the symbol. To get a list of symbol layers

```
for i in xrange(symbol.symbolLayerCount()):
    lyr = symbol.symbolLayer(i)
    print "%d: %s" % (i, lyr.layerType())
```

To find out symbol's color use `color()` method and `setColor()` to change its color. With marker symbols additionally you can query for the symbol size and rotation with `size()` and `angle()` methods, for line symbols there is `width()` method returning line width.

Size and width are in millimeters by default, angles are in degrees.

Working with Symbol Layers

As said before, symbol layers (subclasses of `QgsSymbolLayerV2`) determine the appearance of the features. There are several basic symbol layer classes for general use. It is possible to implement new symbol layer types and thus arbitrarily customize how features will be rendered. The `layerType()` method uniquely identifies the symbol layer class — the basic and default ones are SimpleMarker, SimpleLine and SimpleFill symbol layers types.

You can get a complete list of the types of symbol layers you can create for a given symbol layer class like this

```
from qgis.core import QgsSymbolLayerV2Registry
myRegistry = QgsSymbolLayerV2Registry.instance()
myMetadata = myRegistry.symbolLayerMetadata("SimpleFill")
for item in myRegistry.symbolLayersForType(QgsSymbolV2.Marker):
    print item
```

Output

```
EllipseMarker
FontMarker
SimpleMarker
SvgMarker
VectorField
```

`QgsSymbolLayerV2Registry` class manages a database of all available symbol layer types.

To access symbol layer data, use its `properties()` method that returns a key-value dictionary of properties which determine the appearance. Each symbol layer type has a specific set of properties that it uses. Additionally, there are generic methods `color()`, `size()`, `angle()`, `width()` with their setter counterparts. Of course size and angle is available only for marker symbol layers and width for line symbol layers.

Creating Custom Symbol Layer Types

Imagine you would like to customize the way how the data gets rendered. You can create your own symbol layer class that will draw the features exactly as you wish. Here is an example of a marker that draws red circles with specified radius

```
class FooSymbolLayer(QgsMarkerSymbolLayerV2):

  def __init__(self, radius=4.0):
      QgsMarkerSymbolLayerV2.__init__(self)
      self.radius = radius
      self.color = QColor(255,0,0)

  def layerType(self):
     return "FooMarker"

  def properties(self):
```

```
        return { "radius" : str(self.radius) }

    def startRender(self, context):
      pass

    def stopRender(self, context):
        pass

    def renderPoint(self, point, context):
        # Rendering depends on whether the symbol is selected (QGIS >= 1.5)
        color = context.selectionColor() if context.selected() else self.color
        p = context.renderContext().painter()
        p.setPen(color)
        p.drawEllipse(point, self.radius, self.radius)

    def clone(self):
        return FooSymbolLayer(self.radius)
```

The `layerType()` method determines the name of the symbol layer, it has to be unique among all symbol layers. Properties are used for persistence of attributes. `clone()` method must return a copy of the symbol layer with all attributes being exactly the same. Finally there are rendering methods: `startRender()` is called before rendering first feature, `stopRender()` when rendering is done. And `renderPoint()` method which does the rendering. The coordinates of the point(s) are already transformed to the output coordinates.

For polylines and polygons the only difference would be in the rendering method: you would use `renderPolyline()` which receives a list of lines, resp. `renderPolygon()` which receives list of points on outer ring as a first parameter and a list of inner rings (or None) as a second parameter.

Usually it is convenient to add a GUI for setting attributes of the symbol layer type to allow users to customize the appearance: in case of our example above we can let user set circle radius. The following code implements such widget

```
class FooSymbolLayerWidget(QgsSymbolLayerV2Widget):
    def __init__(self, parent=None):
        QgsSymbolLayerV2Widget.__init__(self, parent)

        self.layer = None

        # setup a simple UI
        self.label = QLabel("Radius:")
        self.spinRadius = QDoubleSpinBox()
        self.hbox = QHBoxLayout()
        self.hbox.addWidget(self.label)
        self.hbox.addWidget(self.spinRadius)
        self.setLayout(self.hbox)
        self.connect(self.spinRadius, SIGNAL("valueChanged(double)"), \
            self.radiusChanged)

    def setSymbolLayer(self, layer):
        if layer.layerType() != "FooMarker":
            return
        self.layer = layer
        self.spinRadius.setValue(layer.radius)

    def symbolLayer(self):
        return self.layer

    def radiusChanged(self, value):
        self.layer.radius = value
        self.emit(SIGNAL("changed()"))
```

This widget can be embedded into the symbol properties dialog. When the symbol layer type is selected in symbol properties dialog, it creates an instance of the symbol layer and an instance of the symbol layer widget. Then it

calls `setSymbolLayer()` method to assign the symbol layer to the widget. In that method the widget should update the UI to reflect the attributes of the symbol layer. `symbolLayer()` function is used to retrieve the symbol layer again by the properties dialog to use it for the symbol.

On every change of attributes, the widget should emit `changed()` signal to let the properties dialog update the symbol preview.

Now we are missing only the final glue: to make QGIS aware of these new classes. This is done by adding the symbol layer to registry. It is possible to use the symbol layer also without adding it to the registry, but some functionality will not work: e.g. loading of project files with the custom symbol layers or inability to edit the layer's attributes in GUI.

We will have to create metadata for the symbol layer

```
class FooSymbolLayerMetadata(QgsSymbolLayerV2AbstractMetadata):

  def __init__(self):
    QgsSymbolLayerV2AbstractMetadata.__init__(self, "FooMarker", QgsSymbolV2.Marker)

  def createSymbolLayer(self, props):
    radius = float(props[QString("radius")]) if QString("radius") in props else 4.0
    return FooSymbolLayer(radius)

  def createSymbolLayerWidget(self):
    return FooSymbolLayerWidget()

QgsSymbolLayerV2Registry.instance().addSymbolLayerType(FooSymbolLayerMetadata())
```

You should pass layer type (the same as returned by the layer) and symbol type (marker/line/fill) to the constructor of parent class. `createSymbolLayer()` takes care of creating an instance of symbol layer with attributes specified in the *props* dictionary. (Beware, the keys are QString instances, not "str" objects). And there is `createSymbolLayerWidget()` method which returns settings widget for this symbol layer type.

The last step is to add this symbol layer to the registry — and we are done.

5.9.5 Creating Custom Renderers

It might be useful to create a new renderer implementation if you would like to customize the rules how to select symbols for rendering of features. Some use cases where you would want to do it: symbol is determined from a combination of fields, size of symbols changes depending on current scale etc.

The following code shows a simple custom renderer that creates two marker symbols and chooses randomly one of them for every feature

```
import random

class RandomRenderer(QgsFeatureRendererV2):
  def __init__(self, syms=None):
    QgsFeatureRendererV2.__init__(self, "RandomRenderer")
    self.syms = syms if syms else [QgsSymbolV2.defaultSymbol(QGis.Point), QgsSymbolV2.defaultSymb

  def symbolForFeature(self, feature):
    return random.choice(self.syms)

  def startRender(self, context, vlayer):
    for s in self.syms:
      s.startRender(context)

  def stopRender(self, context):
    for s in self.syms:
      s.stopRender(context)

  def usedAttributes(self):
```

```
    return []

  def clone(self):
    return RandomRenderer(self.syms)
```

The constructor of parent `QgsFeatureRendererV2` class needs renderer name (has to be unique among renderers). `symbolForFeature()` method is the one that decides what symbol will be used for a particular feature. `startRender()` and `stopRender()` take care of initialization/finalization of symbol rendering. `usedAttributes()` method can return a list of field names that renderer expects to be present. Finally `clone()` function should return a copy of the renderer.

Like with symbol layers, it is possible to attach a GUI for configuration of the renderer. It has to be derived from `QgsRendererV2Widget`. The following sample code creates a button that allows user to set symbol of the first symbol

```
class RandomRendererWidget(QgsRendererV2Widget):
  def __init__(self, layer, style, renderer):
    QgsRendererV2Widget.__init__(self, layer, style)
    if renderer is None or renderer.type() != "RandomRenderer":
      self.r = RandomRenderer()
    else:
      self.r = renderer
    # setup UI
    self.btn1 = QgsColorButtonV2("Color 1")
    self.btn1.setColor(self.r.syms[0].color())
    self.vbox = QVBoxLayout()
    self.vbox.addWidget(self.btn1)
    self.setLayout(self.vbox)
    self.connect(self.btn1, SIGNAL("clicked()"), self.setColor1)

  def setColor1(self):
    color = QColorDialog.getColor(self.r.syms[0].color(), self)
    if not color.isValid(): return
    self.r.syms[0].setColor(color);
    self.btn1.setColor(self.r.syms[0].color())

  def renderer(self):
    return self.r
```

The constructor receives instances of the active layer (`QgsVectorLayer`), the global style (`QgsStyleV2`) and current renderer. If there is no renderer or the renderer has different type, it will be replaced with our new renderer, otherwise we will use the current renderer (which has already the type we need). The widget contents should be updated to show current state of the renderer. When the renderer dialog is accepted, widget's `renderer()` method is called to get the current renderer — it will be assigned to the layer.

The last missing bit is the renderer metadata and registration in registry, otherwise loading of layers with the renderer will not work and user will not be able to select it from the list of renderers. Let us finish our RandomRenderer example

```
class RandomRendererMetadata(QgsRendererV2AbstractMetadata):
  def __init__(self):
    QgsRendererV2AbstractMetadata.__init__(self, "RandomRenderer", "Random renderer")

  def createRenderer(self, element):
    return RandomRenderer()
  def createRendererWidget(self, layer, style, renderer):
    return RandomRendererWidget(layer, style, renderer)

QgsRendererV2Registry.instance().addRenderer(RandomRendererMetadata())
```

Similarly as with symbol layers, abstract metadata constructor awaits renderer name, name visible for users and optionally name of renderer's icon. `createRenderer()` method passes `QDomElement` instance that can be used to restore renderer's state from DOM tree. `createRendererWidget()` method creates the configuration

widget. It does not have to be present or can return *None* if the renderer does not come with GUI.

To associate an icon with the renderer you can assign it in `QgsRendererV2AbstractMetadata` constructor as a third (optional) argument — the base class constructor in the RandomRendererMetadata `__init__()` function becomes

```
QgsRendererV2AbstractMetadata.__init__(self,
        "RandomRenderer",
        "Random renderer",
        QIcon(QPixmap("RandomRendererIcon.png", "png")))
```

The icon can be associated also at any later time using `setIcon()` method of the metadata class. The icon can be loaded from a file (as shown above) or can be loaded from a Qt resource (PyQt4 includes .qrc compiler for Python).

5.10 Further Topics

TODO: creating/modifying symbols working with style (`QgsStyleV2`) working with color ramps (`QgsVectorColorRampV2`) rule-based renderer (see this blogpost) exploring symbol layer and renderer registries

CHAPTER 6

Manejo de Geometría

Puntos, líneas y polígonos que representan una entidad espacial son comunmente referidas como geometrías. En QGIS ellos son representados con la clase `QgsGeometry`. Todas las posibles geometrías son mostradas agradablemente en la página de discusión JTS.

A veces una geometría es realmente una colección simple (partes simples) geométricas. Tal geometría se llama geometría de múltiples partes. Si contiene un tipo de geometría simple, lo llamamos un punto múltiple, lineas múltiples o polígonos múltiples. Por ejemplo, un país consiste en múltiples islas que se pueden representar como un polígono múltiple.

Las coordenadas de las geometrías pueden estar en cualquier sistema de referencia de coordenadas (SRC). Cuando extrae características de una capa, las geometrías asociadas tendrán sus coordenadas en el SRC de la capa.

6.1 Construcción de Geometría

Existen varias opciones para crear una geometría:

- desde coordenadas

```
gPnt = QgsGeometry.fromPoint(QgsPoint(1,1))
gLine = QgsGeometry.fromPolyline([QgsPoint(1, 1), QgsPoint(2, 2)])
gPolygon = QgsGeometry.fromPolygon([[QgsPoint(1, 1), QgsPoint(2, 2), QgsPoint(2, 1)]])
```

  Las coordenadas son dadas usando la clase: *QgsPoint*.

  La Polilínea (Linestring) se representa mediante una lista de puntos. Un Polígono se representa por una lista de anillos lineales (Ej. polilíneas cerradas). El primer anillo es el anillo externo (límite), los subsecuentes anillos opcionales son huecos en el polígono.

  Las geometrías multi-parte van un nivel más allá: multi-punto es una lista de puntos, multi-linea es una lista de polilíneas y multi-polígono es una lista de polígonos.

- desde well-known text (WKT)

```
geom = QgsGeometry.fromWkt("POINT(3 4)")
```

- desde well-known binary (WKB)

```
g = QgsGeometry()
g.setWkbAndOwnership(wkb, len(wkb))
```

6.2 Acceso a Geometría

First, you should find out geometry type, `wkbType()` method is the one to use — it returns a value from `QGis.WkbType` enumeration

```
>>> gPnt.wkbType() == QGis.WKBPoint
True
>>> gLine.wkbType() == QGis.WKBLineString
True
>>> gPolygon.wkbType() == QGis.WKBPolygon
True
>>> gPolygon.wkbType() == QGis.WKBMultiPolygon
False
```

As an alternative, one can use `type()` method which returns a value from `QGis.GeometryType` enumeration. There is also a helper function `isMultipart()` to find out whether a geometry is multipart or not.

Para extraer información de una geometría existen funciones de acceso para cada tipo vectorial. Cómo usar accesos

```
>>> gPnt.asPoint()
(1, 1)
>>> gLine.asPolyline()
[(1, 1), (2, 2)]
>>> gPolygon.asPolygon()
[[(1, 1), (2, 2), (2, 1), (1, 1)]]
```

Nota: Las tuplas (x, y) no son tuplas reales, son objetos: `QgsPoint` , los valores son accesibles con los métodos: `x()` and `y()`.

Para geometrias multiples existen funciones similares para accesar : `asMultiPoint()`, `asMultiPolyline()`, `asMultiPolygon()`.

6.3 Geometría predicados y Operaciones

QGIS uses GEOS library for advanced geometry operations such as geometry predicates (`contains()`, `intersects()`, ...) and set operations (`union()`, `difference()`, ...). It can also compute geometric properties of geometries, such as area (in the case of polygons) or lengths (for polygons and lines)

Here you have a small example that combines iterating over the features in a given layer and performing some geometric computations based on their geometries.

```
# we assume that 'layer' is a polygon layer
features = layer.getFeatures()
for f in features:
  geom = f.geometry()
  print "Area:", geom.area()
  print "Perimeter:", geom.length()
```

Areas and perimeters don't take CRS into account when computed using these methods from the `QgsGeometry` class. For a more powerful area and distance calculation, the `QgsDistanceArea` class can be used. If projections are turned off, calculations will be planar, otherwise they'll be done on the ellipsoid. When an ellipsoid is not set explicitly, WGS84 parameters are used for calculations.

```
d = QgsDistanceArea()
d.setProjectionsEnabled(True)

print "distance in meters: ", d.measureLine(QgsPoint(10,10),QgsPoint(11,11))
```

You can find many example of algorithms that are included in QGIS and use these methods to analyze and transform vector data. Here are some links to the code of a few of them.

Información adicional puede ser encontrada en las siguientes fuentes:

- Geometry transformation: Reproject algorithm
- Distance and area using the `QgsDistanceArea` class: Distance matrix algorithm

- Multi-part to single-part algorithm

CHAPTER 7

Soporte de Proyecciones

7.1 Sistemas de coordenadas de referencia

Los sistemas de referencia de coordenadas (SRC) están encapsuladas por la clase `QgsCoordinateReferenceSystem`. Las instancias de esta clase pueden ser creados por varias formas diferentes:

- especificar SRC por su ID

```
# PostGIS SRID 4326 is allocated for WGS84
crs = QgsCoordinateReferenceSystem(4326, QgsCoordinateReferenceSystem.PostgisCrsId)
```

  QGIS utliza tres tipos diferentes de ID para cada sistema de referencia:

  - `PostgisCrsId` — los IDs utilizados dentro de la base de datos PostGIS
  - `InternalCrsId` — IDs internamente utilizados en la base de datos de QGIS.
  - `EpsgCrsId` — IDs asignados por la organización EPSG

  Si no se especifica lo contrario en el segundo parámetro, PostGIS SRID se utiliza por defecto.

- especificar SRC por su well-known text (WKT)

```
wkt = 'GEOGCS["WGS84", DATUM["WGS84", SPHEROID["WGS84", 6378137.0, 298.257223563]],'
       PRIMEM["Greenwich", 0.0], UNIT["degree",0.01745329251994295],'
       AXIS["Longitude",EAST], AXIS["Latitude",NORTH]]'
crs = QgsCoordinateReferenceSystem(wkt)
```

- crear un SRC inválido y después utilizar una de las funciones `create*()` para inicializarlo. En el siguiente ejemplo usamos una cadena Proj4 para inicializar la proyección

```
crs = QgsCoordinateReferenceSystem()
crs.createFromProj4("+proj=longlat +ellps=WGS84 +datum=WGS84 +no_defs")
```

Es aconsejable comprobar si la creación (es decir, operaciones de búsqueda en la base de datos) del SRC ha tenido éxito: `isValid()` debe regresar `True`.

Tenga en cuenta que para la inicialización de los sistemas de referencia QGIS tiene que buscar valores apropiados en su base de datos interna `srs.db`. Así, en caso de de crear una aplicación independiente, necesita definir las rutas correctamente con `QgsApplication.setPrefixPath()` de lo contrario, no podrá encontrar la base de datos. Si se están ejecutando los comandos de consola python QGIS o desarrolla un complemento que no le importe: todo está ya preparado para usted.

Accediendo a información del sistema de referencia espacial

```
print "QGIS CRS ID:", crs.srsid()
print "PostGIS SRID:", crs.srid()
print "EPSG ID:", crs.epsg()
print "Description:", crs.description()
```

```
print "Projection Acronym:", crs.projectionAcronym()
print "Ellipsoid Acronym:", crs.ellipsoidAcronym()
print "Proj4 String:", crs.proj4String()
# check whether it's geographic or projected coordinate system
print "Is geographic:", crs.geographicFlag()
# check type of map units in this CRS (values defined in QGis::units enum)
print "Map units:", crs.mapUnits()
```

7.2 Proyecciones

Se puede hacer la transformación entre diferentes sistemas de referencia espacial al utilizar la clase `QgsCoordinateTransform`. La forma más fácil de usar que es crear origen y el destino de SRC y construir la instancia :class: *QgsCoordinateTransform* con ellos. Luego llame simplemente repetidamente la función `transform()` para hacer la transformación. Por defecto se hace la transformación hacia adelante, pero es capaz de hacer también la transformación inversa

```
crsSrc = QgsCoordinateReferenceSystem(4326)    # WGS 84
crsDest = QgsCoordinateReferenceSystem(32633)  # WGS 84 / UTM zone 33N
xform = QgsCoordinateTransform(crsSrc, crsDest)

# forward transformation: src -> dest
pt1 = xform.transform(QgsPoint(18,5))
print "Transformed point:", pt1

# inverse transformation: dest -> src
pt2 = xform.transform(pt1, QgsCoordinateTransform.ReverseTransform)
print "Transformed back:", pt2
```

CHAPTER 8

Usando el Lienzo de Mapa

The Map canvas widget is probably the most important widget within QGIS because it shows the map composed from overlaid map layers and allows interaction with the map and layers. The canvas shows always a part of the map defined by the current canvas extent. The interaction is done through the use of **map tools**: there are tools for panning, zooming, identifying layers, measuring, vector editing and others. Similar to other graphics programs, there is always one tool active and the user can switch between the available tools.

Map canvas is implemented as `QgsMapCanvas` class in `qgis.gui` module. The implementation is based on the Qt Graphics View framework. This framework generally provides a surface and a view where custom graphics items are placed and user can interact with them. We will assume that you are familiar enough with Qt to understand the concepts of the graphics scene, view and items. If not, please make sure to read the overview of the framework.

Whenever the map has been panned, zoomed in/out (or some other action triggers a refresh), the map is rendered again within the current extent. The layers are rendered to an image (using `QgsMapRenderer` class) and that image is then displayed in the canvas. The graphics item (in terms of the Qt graphics view framework) responsible for showing the map is `QgsMapCanvasMap` class. This class also controls refreshing of the rendered map. Besides this item which acts as a background, there may be more **map canvas items**. Typical map canvas items are rubber bands (used for measuring, vector editing etc.) or vertex markers. The canvas items are usually used to give some visual feedback for map tools, for example, when creating a new polygon, the map tool creates a rubber band canvas item that shows the current shape of the polygon. All map canvas items are subclasses of `QgsMapCanvasItem` which adds some more functionality to the basic `QGraphicsItem` objects.

To summarize, the map canvas architecture consists of three concepts:

- map canvas — for viewing of the map
- map canvas items — additional items that can be displayed in map canvas
- map tools — for interaction with map canvas

8.1 Embedding Map Canvas

Map canvas is a widget like any other Qt widget, so using it is as simple as creating and showing it

```
canvas = QgsMapCanvas()
canvas.show()
```

This produces a standalone window with map canvas. It can be also embedded into an existing widget or window. When using .ui files and Qt Designer, place a `QWidget` on the form and promote it to a new class: set `QgsMapCanvas` as class name and set `qgis.gui` as header file. The `pyuic4` utility will take care of it. This is a very convenient way of embedding the canvas. The other possibility is to manually write the code to construct map canvas and other widgets (as children of a main window or dialog) and create a layout.

By default, map canvas has black background and does not use anti-aliasing. To set white background and enable anti-aliasing for smooth rendering

```
canvas.setCanvasColor(Qt.white)
canvas.enableAntiAliasing(True)
```

(In case you are wondering, `Qt` comes from `PyQt4.QtCore` module and `Qt.white` is one of the predefined `QColor` instances.)

Now it is time to add some map layers. We will first open a layer and add it to the map layer registry. Then we will set the canvas extent and set the list of layers for canvas

```
layer = QgsVectorLayer(path, name, provider)
if not layer.isValid():
  raise IOError, "Failed to open the layer"

# add layer to the registry
QgsMapLayerRegistry.instance().addMapLayer(layer)

# set extent to the extent of our layer
canvas.setExtent(layer.extent())

# set the map canvas layer set
canvas.setLayerSet([QgsMapCanvasLayer(layer)])
```

After executing these commands, the canvas should show the layer you have loaded.

8.2 Using Map Tools with Canvas

The following example constructs a window that contains a map canvas and basic map tools for map panning and zooming. Actions are created for activation of each tool: panning is done with `QgsMapToolPan`, zooming in/out with a pair of `QgsMapToolZoom` instances. The actions are set as checkable and later assigned to the tools to allow automatic handling of checked/unchecked state of the actions – when a map tool gets activated, its action is marked as selected and the action of the previous map tool is deselected. The map tools are activated using `setMapTool()` method.

```
from qgis.gui import *
from PyQt4.QtGui import QAction, QMainWindow
from PyQt4.QtCore import SIGNAL, Qt, QString

class MyWnd(QMainWindow):
  def __init__(self, layer):
    QMainWindow.__init__(self)

    self.canvas = QgsMapCanvas()
    self.canvas.setCanvasColor(Qt.white)

    self.canvas.setExtent(layer.extent())
    self.canvas.setLayerSet([QgsMapCanvasLayer(layer)])

    self.setCentralWidget(self.canvas)

    actionZoomIn = QAction(QString("Zoom in"), self)
    actionZoomOut = QAction(QString("Zoom out"), self)
    actionPan = QAction(QString("Pan"), self)

    actionZoomIn.setCheckable(True)
    actionZoomOut.setCheckable(True)
    actionPan.setCheckable(True)

    self.connect(actionZoomIn, SIGNAL("triggered()"), self.zoomIn)
    self.connect(actionZoomOut, SIGNAL("triggered()"), self.zoomOut)
    self.connect(actionPan, SIGNAL("triggered()"), self.pan)
```

```
    self.toolbar = self.addToolBar("Canvas actions")
    self.toolbar.addAction(actionZoomIn)
    self.toolbar.addAction(actionZoomOut)
    self.toolbar.addAction(actionPan)

    # create the map tools
    self.toolPan = QgsMapToolPan(self.canvas)
    self.toolPan.setAction(actionPan)
    self.toolZoomIn = QgsMapToolZoom(self.canvas, False) # false = in
    self.toolZoomIn.setAction(actionZoomIn)
    self.toolZoomOut = QgsMapToolZoom(self.canvas, True) # true = out
    self.toolZoomOut.setAction(actionZoomOut)

    self.pan()

  def zoomIn(self):
    self.canvas.setMapTool(self.toolZoomIn)

  def zoomOut(self):
    self.canvas.setMapTool(self.toolZoomOut)

  def pan(self):
    self.canvas.setMapTool(self.toolPan)
```

You can put the above code to a file, e.g. `mywnd.py` and try it out in Python console within QGIS. This code will put the currently selected layer into newly created canvas

```
import mywnd
w = mywnd.MyWnd(qgis.utils.iface.activeLayer())
w.show()
```

Just make sure that the `mywnd.py` file is located within Python search path (`sys.path`). If it isn't, you can simply add it: `sys.path.insert(0, '/my/path')` — otherwise the import statement will fail, not finding the module.

8.3 Rubber Bands and Vertex Markers

To show some additional data on top of the map in canvas, use map canvas items. It is possible to create custom canvas item classes (covered below), however there are two useful canvas item classes for convenience: `QgsRubberBand` for drawing polylines or polygons, and `QgsVertexMarker` for drawing points. They both work with map coordinates, so the shape is moved/scaled automatically when the canvas is being panned or zoomed.

To show a polyline

```
r = QgsRubberBand(canvas, False)  # False = not a polygon
points = [QgsPoint(-1, -1), QgsPoint(0, 1), QgsPoint(1, -1)]
r.setToGeometry(QgsGeometry.fromPolyline(points), None)
```

To show a polygon

```
r = QgsRubberBand(canvas, True)  # True = a polygon
points = [[QgsPoint(-1, -1), QgsPoint(0, 1), QgsPoint(1, -1)]]
r.setToGeometry(QgsGeometry.fromPolygon(points), None)
```

Note that points for polygon is not a plain list: in fact, it is a list of rings containing linear rings of the polygon: first ring is the outer border, further (optional) rings correspond to holes in the polygon.

Rubber bands allow some customization, namely to change their color and line width

```
r.setColor(QColor(0, 0, 255))
r.setWidth(3)
```

The canvas items are bound to the canvas scene. To temporarily hide them (and show again, use the `hide()` and `show()` combo. To completely remove the item, you have to remove it from the scene of the canvas

```
canvas.scene().removeItem(r)
```

(in C++ it's possible to just delete the item, however in Python `del r` would just delete the reference and the object will still exist as it is owned by the canvas)

Rubber band can be also used for drawing points, however `QgsVertexMarker` class is better suited for this (`QgsRubberBand` would only draw a rectangle around the desired point). How to use the vertex marker

```
m = QgsVertexMarker(canvas)
m.setCenter(QgsPoint(0, 0))
```

This will draw a red cross on position [0,0]. It is possible to customize the icon type, size, color and pen width

```
m.setColor(QColor(0, 255, 0))
m.setIconSize(5)
m.setIconType(QgsVertexMarker.ICON_BOX) # or ICON_CROSS, ICON_X
m.setPenWidth(3)
```

For temporary hiding of vertex markers and removing them from canvas, the same applies as for the rubber bands.

8.4 Writing Custom Map Tools

You can write your custom tools, to implement a custom behaviour to actions performed by users on the canvas.

Map tools should inherit from the `QgsMapTool` class or any derived class, and selected as active tools in the canvas using the `setMapTool()` method as we have already seen.

Here is an example of a map tool that allows to define a rectangular extent by clicking and dragging on the canvas. When the rectangle is defined, it prints its boundary coordinates in the console. It uses the rubber band elements described before to show the selected rectangle as it is being defined.

```
class RectangleMapTool(QgsMapToolEmitPoint):
  def __init__(self, canvas):
      self.canvas = canvas
      QgsMapToolEmitPoint.__init__(self, self.canvas)
      self.rubberBand = QgsRubberBand(self.canvas, QGis.Polygon)
      self.rubberBand.setColor(Qt.red)
      self.rubberBand.setWidth(1)
      self.reset()

  def reset(self):
      self.startPoint = self.endPoint = None
      self.isEmittingPoint = False
      self.rubberBand.reset(QGis.Polygon)

  def canvasPressEvent(self, e):
      self.startPoint = self.toMapCoordinates(e.pos())
      self.endPoint = self.startPoint
      self.isEmittingPoint = True
      self.showRect(self.startPoint, self.endPoint)

  def canvasReleaseEvent(self, e):
      self.isEmittingPoint = False
      r = self.rectangle()
      if r is not None:
        print "Rectangle:", r.xMinimum(), r.yMinimum(), r.xMaximum(), r.yMaximum()

  def canvasMoveEvent(self, e):
      if not self.isEmittingPoint:
        return
```

```
        self.endPoint = self.toMapCoordinates(e.pos())
        self.showRect(self.startPoint, self.endPoint)

    def showRect(self, startPoint, endPoint):
        self.rubberBand.reset(QGis.Polygon)
        if startPoint.x() == endPoint.x() or startPoint.y() == endPoint.y():
            return

        point1 = QgsPoint(startPoint.x(), startPoint.y())
        point2 = QgsPoint(startPoint.x(), endPoint.y())
        point3 = QgsPoint(endPoint.x(), endPoint.y())
        point4 = QgsPoint(endPoint.x(), startPoint.y())

        self.rubberBand.addPoint(point1, False)
        self.rubberBand.addPoint(point2, False)
        self.rubberBand.addPoint(point3, False)
        self.rubberBand.addPoint(point4, True)    # true to update canvas
        self.rubberBand.show()

    def rectangle(self):
        if self.startPoint is None or self.endPoint is None:
            return None
        elif self.startPoint.x() == self.endPoint.x() or self.startPoint.y() == self.endPoint.y():
            return None

        return QgsRectangle(self.startPoint, self.endPoint)

    def deactivate(self):
        QgsMapTool.deactivate(self)
        self.emit(SIGNAL("deactivated()"))
```

8.5 Writing Custom Map Canvas Items

TODO: how to create a map canvas item

```
import sys
from qgis.core import QgsApplication
from qgis.gui import QgsMapCanvas

def init():
    a = QgsApplication(sys.argv, True)
    QgsApplication.setPrefixPath('/home/martin/qgis/inst', True)
    QgsApplication.initQgis()
    return a

def show_canvas(app):
    canvas = QgsMapCanvas()
    canvas.show()
    app.exec_()
app = init()
show_canvas(app)
```

CHAPTER 9

Representación del Mapa e Impresión

Generalmente hay dos maneras de importar datos para renderizar en el mapa; hacerlo rápido usando `QgsMapRenderer` o producir una salida afinada componiendo el mapa con `QgsComposition` clase y amigos.

9.1 Representación Simple

Hacer algunas capas usando `QgsMapRenderer` — crea un destino en el dispositivo de pintura (`QImage`, `QPainter` etc.), establecer conjunto de capas, extensión, salida y renderizar.

```
# create image
img = QImage(QSize(800, 600), QImage.Format_ARGB32_Premultiplied)

# set image's background color
color = QColor(255, 255, 255)
img.fill(color.rgb())

# create painter
p = QPainter()
p.begin(img)
p.setRenderHint(QPainter.Antialiasing)

render = QgsMapRenderer()

# set layer set
lst = [layer.getLayerID()]  # add ID of every layer
render.setLayerSet(lst)

# set extent
rect = QgsRect(render.fullExtent())
rect.scale(1.1)
render.setExtent(rect)

# set output size
render.setOutputSize(img.size(), img.logicalDpiX())

# do the rendering
render.render(p)

p.end()

# save image
img.save("render.png","png")
```

9.2 Representando capas con diferente SRC

Si tiene más de una capa y ellas tienen diferente SRC, el sencillo ejemplo de arriba probablemente no funcionará: para obtener los valores correctos en los cálculos de dimensiones, tiene que fijar explicitamente el SRC de destino y activar reproyección al vuelo como en el ejemplo de abajo (solo la parte de configuración de representación se indica)

```
...
# set layer set
layers = QgsMapLayerRegistry.instance().mapLayers()
lst = layers.keys()
render.setLayerSet(lst)

# Set destination CRS to match the CRS of the first layer
render.setDestinationCrs(layers.values()[0].crs())
# Enable OTF reprojection
render.setProjectionsEnabled(True)
...
```

9.3 Producción usando el Diseñador de impresión

El Diseñador de Mapas es una herramienta muy útil si desea hacer diseños más sofisticados que la representación simple mostrada arriba. Usando el diseñador es posible crear diseños complejos de mapa incluyendo vistas de mapas, etiquetas, leyendas, tablas y otros elementos que usalmente están presentes en mapas impresos. Los diseños pueden exportarse a PDF, imágenes ráster o directamente impresos en una impresora.

El compositor consiste en un grupo de clases. Pertenecen a la biblioteca central. La aplicación de QGIS tiene un GUI conveniente para colocar elementos, a pesar de que no esta disponible en la biblioteca GUI. Si no conoces Qt Graphics View framework, entonces se recomienda que se revise la documentación ahora, ya que el compositor se basa en el.

El compositior central de clase es: `QgsComposition` which is derived from `QGraphicsScene`. Vamos a crear uno

```
mapRenderer = iface.mapCanvas().mapRenderer()
c = QgsComposition(mapRenderer)
c.setPlotStyle(QgsComposition.Print)
```

Anote que la composición toma una instancia de:class:*QgsMapRenderer*. El el código esperamos que se corra dentro de la aplicación de QGIS y así crear los mapas dentro del cambas. La composición utiliza varios parámetros dentro del creador de mapas, mas importante las capas de mapa y el tamaño se pone por defecto. Cuanto se utiliza el compositor como aplicación independiente se puede crear su propio renderizador como se demuestra en la selección arriba y pasar al compositor.

Es posible agregar carios elementos (mapa, etiquetas, ...) a la composicion – estos elemenos tienen que descender de `QgsComposerItem` class.. Actualmente el apoyo a estos itemes son:

- map — this item tells the libraries where to put the map itself. Here we create a map and stretch it over the whole paper size

  ```
  x, y = 0, 0
  w, h = c.paperWidth(), c.paperHeight()
  composerMap = QgsComposerMap(c, x ,y, w, h)
  c.addItem(composerMap)
  ```

- etiqueta — permite mostrar etiquetas. Es posible modificar su letra, color, alineación y margen.

  ```
  composerLabel = QgsComposerLabel(c)
  composerLabel.setText("Hello world")
  composerLabel.adjustSizeToText()
  c.addItem(composerLabel)
  ```

- leyenda

```
legend = QgsComposerLegend(c)
legend.model().setLayerSet(mapRenderer.layerSet())
c.addItem(legend)
```

- barra de escala

```
item = QgsComposerScaleBar(c)
item.setStyle('Numeric') # optionally modify the style
item.setComposerMap(composerMap)
item.applyDefaultSize()
c.addItem(item)
```

- flecha
- imagen
- forma
- tabla

Por defecto el los ítemes del compositor nuevo no tienen posición (esquina superior izquierda de la pagina) ademas de un tamaño de cero. La posición y el tamaño siempre se miden en milímetros.

```
# set label 1cm from the top and 2cm from the left of the page
composerLabel.setItemPosition(20, 10)
# set both label's position and size (width 10cm, height 3cm)
composerLabel.setItemPosition(20, 10, 100, 30)
```

Un marco es dibujado alrededor de cada elemento por defecto. Cómo quitar el marco

```
composerLabel.setFrame(False)
```

Además de crear a mano los elementos del diseñador, QGIS soporta las plantillas de composición que escencialmente son diseños con todos sus elementos guardados en un archivo .qpt (con formato XML). Por desgracia esta funcionalidad no está disponible todavía en la API.

Una vez que la composición está lista (los elemntos del compositor han sido añadidos al diseño), podemos proceder a producir una salida ráster y/o vectorial.

La configuración por defecto para el dseño son: tamaño de página A4 con una resolución de 300 DPI. Se puede cambiar de ser necesario. El tamaño de papel está especificado en milímetros.

```
c.setPaperSize(width, height)
c.setPrintResolution(dpi)
```

9.3.1 Exportar como imagen ráster

El siguiente fragmento de código muestra cómo exportar una composición a una imagen ráster

```
dpi = c.printResolution()
dpmm = dpi / 25.4
width = int(dpmm * c.paperWidth())
height = int(dpmm * c.paperHeight())

# create output image and initialize it
image = QImage(QSize(width, height), QImage.Format_ARGB32)
image.setDotsPerMeterX(dpmm * 1000)
image.setDotsPerMeterY(dpmm * 1000)
image.fill(0)

# render the composition
imagePainter = QPainter(image)
sourceArea = QRectF(0, 0, c.paperWidth(), c.paperHeight())
```

```
targetArea = QRectF(0, 0, width, height)
c.render(imagePainter, targetArea, sourceArea)
imagePainter.end()

image.save("out.png", "png")
```

9.3.2 Exportar como PDF

El siguiente fragmento de código exporta una composición a un archivo PDF

```
printer = QPrinter()
printer.setOutputFormat(QPrinter.PdfFormat)
printer.setOutputFileName("out.pdf")
printer.setPaperSize(QSizeF(c.paperWidth(), c.paperHeight()), QPrinter.Millimeter)
printer.setFullPage(True)
printer.setColorMode(QPrinter.Color)
printer.setResolution(c.printResolution())

pdfPainter = QPainter(printer)
paperRectMM = printer.pageRect(QPrinter.Millimeter)
paperRectPixel = printer.pageRect(QPrinter.DevicePixel)
c.render(pdfPainter, paperRectPixel, paperRectMM)
pdfPainter.end()
```

CHAPTER 10

Expresiones, Filtros y Calculando Valores

QGIS tiene apoyo para el análisis de expresiones parecidas al SQL. Solo se apoya un subconjunto pequeño de sintaxis de SQL. Las expresiones se pueden evaluar por predicciones al azar (que regresan falso o verdadero) o funciones (que regresan en una escala de valores).

Se le da apoyo a tres tipos:

- numero - números enteros y números con decimales, e.j. `123`, `3.14`
- cadena - se tiene que encerrar en comas individuales: `'hola mundo'`
- columna de referencia - cuando se evalúa, la referencia se substituye con el valor actual del campo. Los nombres no se escapan.

Los siguientes operadores están disponibles:

- operadores aritméticos: "+". "-", "/", ^
- paréntesis: para hacer cumplir la precedencia del operador: `(1 + 1) * 3`
- unario mas y menos: `-12`, `+5`
- funciones matemáticas: `sqrt`, `sin`, `cos`, `tan`, `asin`, `acos`, `atan`
- funciones geométricas: `$area`, `$length`
- conversiones de funciones: `to int`, `to real`, `to string`

Se apoya las siguientes predicciones:

- comparación: `=`, `!=`, `>`, `>=`, `<`, `<=`
- patrones iguales: `LIKE` (using % and _), ~ (expresión regular)
- lógica predicado: `AND`, `OR`, `NOT`
- revisión de valores NULO: `IS NULL`, `IS NOT NULL`

Ejemplos de predicado:

- `1 + 2 = 3`
- `sin(angulo) > 0`
- *'Hello' LIKE 'He%''*
- `(x > 10 AND y > 10) OR z = 0`

Ejemplo de escala de expresiones:

- `2 ^ 10`
- `sqrt(val)`
- `$length + 1`

10.1 Análisis de expresiones

```
>>> exp = QgsExpression('1 + 1 = 2')
>>> exp.hasParserError()
False
>>> exp = QgsExpression('1 + 1 = ')
>>> exp.hasParserError()
True
>>> exp.parserErrorString()
PyQt4.QtCore.QString(u'syntax error, unexpected $end')
```

10.2 Evaluar expresiones

10.2.1 Expresiones Basicas

```
>>> exp = QgsExpression('1 + 1 = 2')
>>> value = exp.evaluate()
>>> value
1
```

10.2.2 Expresiones con caracteristicas

El siguiente ejemplo evalua las expresiones dadas con un elemento. "Columna" es el nombre del campo en una capa.

```
>>> exp = QgsExpression('Column = 99')
>>> value = exp.evaluate(feature, layer.pendingFields())
>>> bool(value)
True
```

También puedes utilizar `QgsExpression.prepare()` Si necesitas mas de una característica, utilizando, Using `QgsExpression.prepare()` puede aumentar la velocidad de la cual se corre evaluación.

```
>>> exp = QgsExpression('Column = 99')
>>> exp.prepare(layer.pendingFields())
>>> value = exp.evaluate(feature)
>>> bool(value)
True
```

10.2.3 Manejar errores

```
exp = QgsExpression("1 + 1 = 2 ")
if exp.hasParserError():
  raise Exception(exp.parserErrorString())

value = exp.evaluate()
if exp.hasEvalError():
  raise ValueError(exp.evalErrorString())

print value
```

10.3 Ejemplos

El siguiente ejemplo se puede utilizar para filtra capas y regresar cualquier característica que empata con el predicado.

```
def where(layer, exp):
  print "Where"
  exp = QgsExpression(exp)
  if exp.hasParserError():
    raise Exception(exp.parserErrorString())
  exp.prepare(layer.pendingFields())
  for feature in layer.getFeatures():
    value = exp.evaluate(feature)
    if exp.hasEvalError():
      raise ValueError(exp.evalErrorString())
    if bool(value):
      yield feature

layer = qgis.utils.iface.activeLayer()
for f in where(layer, 'Test > 1.0'):
  print f + " Matches expression"
```

Configuración de lectura y almacenamiento

Muchas veces es útil para un complemento guardar algunas variables para que el usuario no tenga que introducir o seleccionar de nuevo la próxima vez que el complemento se ejecute.

Estas variables se pueden guardar y recuperar con ayuda de Qt y QGIS API. Para cada variable, se debe escoger una clave que será utilizada para acceder a la variable — para el color favorito del usuario podría utilizarse la clave "favourite_color" o cualquier otra cadena que tenga sentido. Es recomendable dar un poco de estructura al nombrar las claves.

Podemos hacer la diferencia entre varios tipos de ajustes:

- **Configuración global** — Están unidos a el usuario de una maquina en particular. QGIS almacena una gran cantidad de ajustes globales, por ejemplo, tamaño de ventana principal o tolerancia de autoensamblado predeterminado. Esta funcionalidad es proporcionada directamente por el marco Qt por medio de la clase `QSettings`. Por defecto, esta clase almacena la configuración en forma de sistema "nativo" de la configuración de almacenamiento, que es — Registro (en Windows), archivo .plist (en Mac OS X) o un archivo .ini (en Unix). El Documentación QSettings es amplia, por lo que vamos a ofrecer sólo un ejemplo sencillo

  ```
  def store():
    s = QSettings()
    s.setValue("myplugin/mytext", "hello world")
    s.setValue("myplugin/myint",  10)
    s.setValue("myplugin/myreal", 3.14)

  def read():
    s = QSettings()
    mytext = s.value("myplugin/mytext", "default text")
    myint  = s.value("myplugin/myint", 123)
    myreal = s.value("myplugin/myreal", 2.71)
  ```

  El segundo parámetro del método `value()` es opcional y especifica el valor por defecto si no hay valor previo establecido para el nombre de la configuración aprobada.

- **Configuración del proyecto** — varia entre los diferentes proyectos y por lo tanto están conectados con un archivo de proyecto. El color fondo del lienzo de mapa o destino del sistema de referencia de coordenadas (SRC) son ejemplos —fondo blanco y WGS84 podría ser adecuado para un proyecto, mientras que el fondo amarillo y la proyección UTM son mejores para otro. Un ejemplo de uso es el siguiente

  ```
  proj = QgsProject.instance()

  # store values
  proj.writeEntry("myplugin", "mytext", "hello world")
  proj.writeEntry("myplugin", "myint", 10)
  proj.writeEntry("myplugin", "mydouble", 0.01)
  proj.writeEntry("myplugin", "mybool", True)

  # read values
  mytext = proj.readEntry("myplugin", "mytext", "default text")[0]
  myint = proj.readNumEntry("myplugin", "myint", 123)[0]
  ```

Como puede ver, el método `writeEntry()` es utilizado para todo tipo de dato, pero existen varios métodos para leer el valor de configuración de nuevo, y la correspondiente tiene que ser seleccionada para cada tipo de datos.

- **Ajustes de la capa de mapa** — estos ajustes están relacionados a un caso en particular de una capa de mapa con un proyecto. Ellos *no* están conectados con la fuente de datos subyacentes de una capa, por lo que si crea dos instancias de capa de mapa de un archivo shape, no van a compartir los ajustes. La configuración se almacena en el archivo del proyecto, por lo que si el usuario abre el archivo de nuevo, los ajustes relacionados a la capa estarán allí de nuevo. Esta funcionalidad se ha añadido en QGIS v1.4. El API es similar a QSettings —que toma y regresa instancias QVariant

```
# save a value
layer.setCustomProperty("mytext", "hello world")

# read the value again
mytext = layer.customProperty("mytext", "default text")
```

CHAPTER 12

Comunicarse con el usuario

Esta sección muestra algunos métodos y elementos que deberían utilizarse para comunicarse con el usuario, con el objetivo de mantener la consistencia en la Interfaz del Usuario.

12.1 Mostrar mensajes. La :class:‘QgsMessageBar‘class

Utilizar las bandejas de mensajes puede ser una mala idea desde el punto de vista de la experiencia de un usuario. Para mostrar una pequeña línea de información o mensajes de advertencia/error, la barrar de mensajes de QGIS suele ser una mejor opción.

Utilizar la referencia a la interfaz objeto de QGIS, puede mostrar un mensaje en la barra de mensajes con el siguiente código

```
iface.messageBar().pushMessage("Error", "I'm sorry Dave, I'm afraid I can't do that", level=QgsMe
```

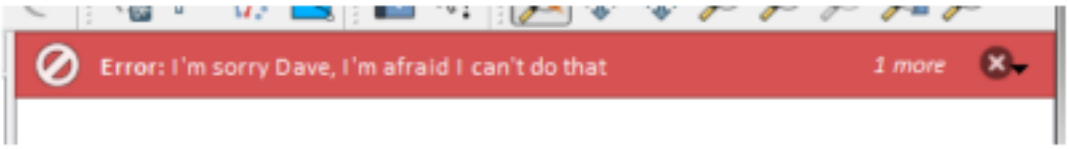

Figure 12.1: Barra de Mensajes de QGIS

Se puede establecer una duración para mostrarlo en un tiempo limitado

```
iface.messageBar().pushMessage("Error", ""Ooops, the plugin is not working as it should", level=Q
```

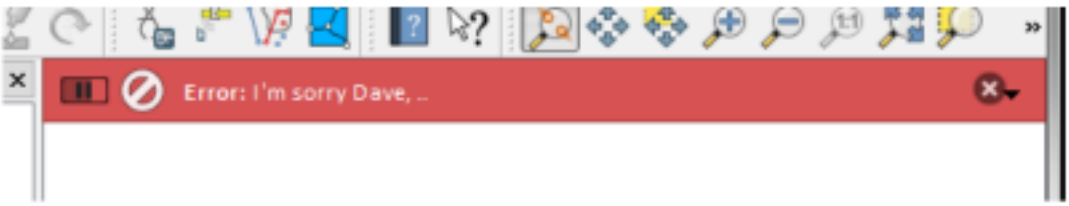

Figure 12.2: Barra de Mensajes de QGIS con temporizador

Los ejemplos anteriores muestran una barra de error, pero el parámetro `nivel` puede utilizarse para crear mensajes de alerta o de información, utilizando las constantes `QgsMessageBar.WARNING` y `QgsMessageBar.INFO` respectivamente.

Se puede añadir complementos a la barra de mensajes, como por ejemplo un botón para mostrar más información

```
def showError():
    pass
```

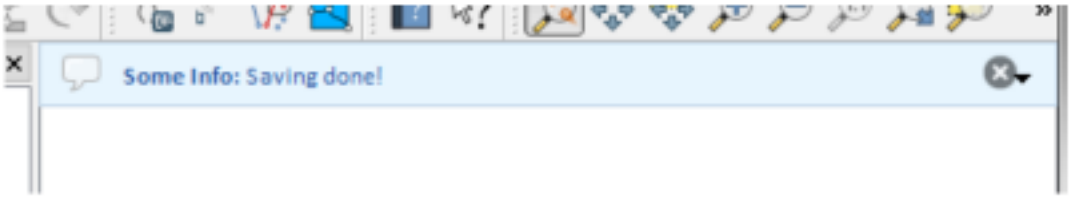

Figure 12.3: Barra de Mensajes de QGIS (información)

```
widget = iface.messageBar().createMessage("Missing Layers", "Show Me")
button = QPushButton(widget)
button.setText("Show Me")
button.pressed.connect(showError)
widget.layout().addWidget(button)
iface.messageBar().pushWidget(widget, QgsMessageBar.WARNING)
```

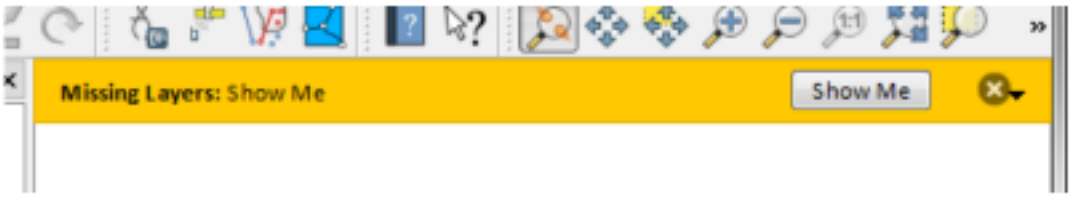

Figure 12.4: Barra de Mensajes de QGIS con un botón

Incluso puedes utilizar una barra de mensajes en tu propio cuadro de diálogo para no tener que mostrar la bandeja de mensajes o si no tiene sentido mostrarla en la pantalla principal de QGIS.

```
class MyDialog(QDialog):
    def __init__(self):
        QDialog.__init__(self)
        self.bar = QgsMessageBar()
        self.bar.setSizePolicy( QSizePolicy.Minimum, QSizePolicy.Fixed )
        self.setLayout(QGridLayout())
        self.layout().setContentsMargins(0, 0, 0, 0)
        self.buttonbox = QDialogButtonBox(QDialogButtonBox.Ok)
        self.buttonbox.accepted.connect(self.run)
        self.layout().addWidget(self.buttonbox, 0, 0, 2, 1)
        self.layout().addWidget(self.bar, 0, 0, 1, 1)

    def run(self):
        self.bar.pushMessage("Hello", "World", level=QgsMessageBar.INFO)
```

12.2 Mostrando el progreso

Las barras de progreso también pueden ponerse en la barra de Mensajes de QGIS, ya que, como hemos visto, admite complementos. Este es un ejemplo que puedes probar en la consola.

```
import time
from PyQt4.QtGui import QProgressBar
from PyQt4.QtCore import *
progressMessageBar = iface.messageBar().createMessage("Doing something boring...")
progress = QProgressBar()
progress.setMaximum(10)
progress.setAlignment(Qt.AlignLeft|Qt.AlignVCenter)
progressMessageBar.layout().addWidget(progress)
iface.messageBar().pushWidget(progressMessageBar, iface.messageBar().INFO)
for i in range(10):
```

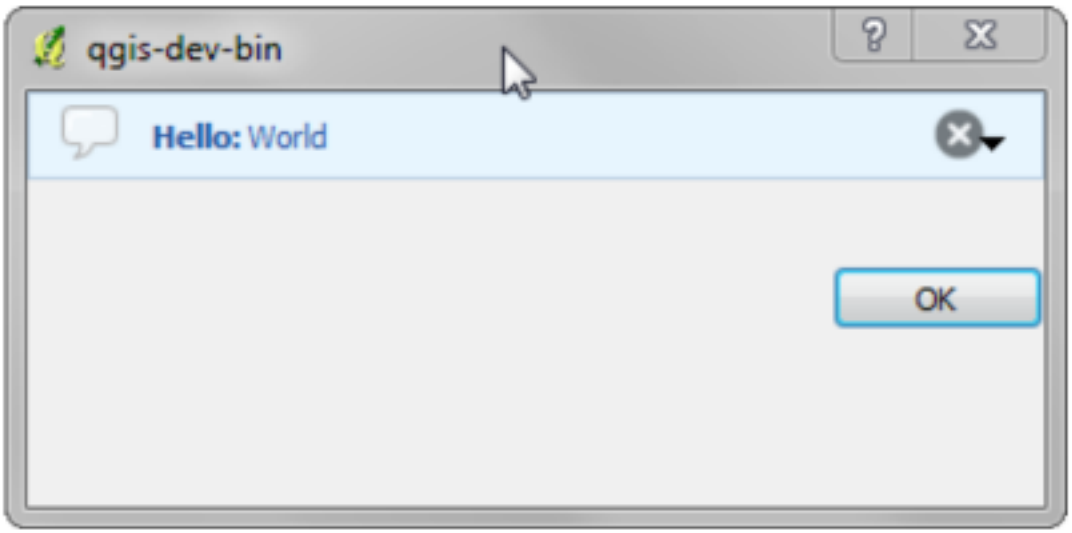

Figure 12.5: Barra de Mensajes de QGIS con un cuadro de diálogo personalizado

```
    time.sleep(1)
    progress.setValue(i + 1)
iface.messageBar().clearWidgets()
```

Además, puedes utilizar una barra de estatus incorporada para mostrar el progreso, como en el siguiente ejemplo

```
count = layers.featureCount()
for i, feature in enumerate(features):
    #do something time-consuming here
    ...
    percent = i / float(count) * 100
    iface.mainWindow().statusBar().showMessage("Processed {} %".format(int(percent)))
iface.mainWindow().statusBar().clearMessage()
```

12.3 Registro

Se puede utilizar el sistema de registro de QGIS para registrar toda la información de la ejecución de su código que se quiera guardar.

```
# You can optionally pass a 'tag' and a 'level' parameters
QgsMessageLog.logMessage("Your plugin code has been executed correctly", 'MyPlugin', QgsMessageLo
QgsMessageLog.logMessage("Your plugin code might have some problems", level=QgsMessageLog.WARNING
QgsMessageLog.logMessage("Your plugin code has crashed!", level=QgsMessageLog.CRITICAL)
```

CHAPTER 13

Developing Python Plugins

It is possible to create plugins in Python programming language. In comparison with classical plugins written in C++ these should be easier to write, understand, maintain and distribute due the dynamic nature of the Python language.

Python plugins are listed together with C++ plugins in QGIS plugin manager. They are searched for in these paths:

- UNIX/Mac: `~/.qgis/python/plugins` and `(qgis_prefix)/share/qgis/python/plugins`
- Windows: `~/.qgis/python/plugins` and `(qgis_prefix)/python/plugins`

Home directory (denoted by above ~) on Windows is usually something like `C:\Documents and Settings\(user)` (on Windows XP or earlier) or `C:\Users\(user)`. Since QGIS is using Python 2.7, subdirectories of these paths have to contain an __init__.py file to be considered Python packages that can be imported as plugins.

Nota: By setting *QGIS_PLUGINPATH* to an existing directory path, you can add this path to the list of paths that are searched for plugins.

Steps:

1. *Idea*: Have an idea about what you want to do with your new QGIS plugin. Why do you do it? What problem do you want to solve? Is there already another plugin for that problem?
2. *Create files*: Create the files described next. A starting point (`__init__.py`). Fill in the *Plugin metadata* (`metadata.txt`) A main python plugin body (`mainplugin.py`). A form in QT-Designer (`form.ui`), with its `resources.qrc`.
3. *Write code*: Write the code inside the `mainplugin.py`
4. *Test*: Close and re-open QGIS and import your plugin again. Check if everything is OK.
5. *Publish*: Publish your plugin in QGIS repository or make your own repository as an "arsenal" of personal "GIS weapons".

13.1 Writing a plugin

Since the introduction of Python plugins in QGIS, a number of plugins have appeared - on Plugin Repositories wiki page you can find some of them, you can use their source to learn more about programming with PyQGIS or find out whether you are not duplicating development effort. The QGIS team also maintains an *Official python plugin repository*. Ready to create a plugin but no idea what to do? Python Plugin Ideas wiki page lists wishes from the community!

13.1.1 Plugin files

Here's the directory structure of our example plugin

```
PYTHON_PLUGINS_PATH/
  MyPlugin/
    __init__.py     --> *required*
    mainPlugin.py   --> *required*
    metadata.txt    --> *required*
    resources.qrc   --> *likely useful*
    resources.py    --> *compiled version, likely useful*
    form.ui         --> *likely useful*
    form.py         --> *compiled version, likely useful*
```

What is the meaning of the files:

- `__init__.py` = The starting point of the plugin. It has to have the `classFactory()` method and may have any other initialisation code.
- `mainPlugin.py` = The main working code of the plugin. Contains all the information about the actions of the plugin and the main code.
- `resources.qrc` = The .xml document created by Qt Designer. Contains relative paths to resources of the forms.
- `resources.py` = The translation of the .qrc file described above to Python.
- `form.ui` = The GUI created by Qt Designer.
- `form.py` = The translation of the form.ui described above to Python.
- `metadata.txt` = Required for QGIS >= 1.8.0. Containts general info, version, name and some other metadata used by plugins website and plugin infrastructure. Since QGIS 2.0 the metadata from `__init__.py` are not accepted anymore and the `metadata.txt` is required.

Here is an online automated way of creating the basic files (skeleton) of a typical QGIS Python plugin.

Also there is a QGIS plugin called Plugin Builder that creates plugin template from QGIS and doesn't require internet connection. This is the recommended option, as it produces 2.0 compatible sources.

Advertencia: If you plan to upload the plugin to the *Official python plugin repository* you must check that your plugin follows some additional rules, required for plugin *Validation*

13.2 Plugin content

Here you can find information and examples about what to add in each of the files in the file structure described above.

13.2.1 Plugin metadata

First, plugin manager needs to retrieve some basic information about the plugin such as its name, description etc. File `metadata.txt` is the right place to put this information.

Importante: All metadata must be in UTF-8 encoding.

Metadata name	Required	Notes
name	True	a short string containing the name of the plugin
qgisMinimumVersion	True	dotted notation of minimum QGIS version
qgisMaximumVersion	False	dotted notation of maximum QGIS version
description	True	short text which describes the plugin, no HTML allowed
about	False	longer text which describes the plugin in details, no HTML allowed
version	True	short string with the version dotted notation
author	True	author name
email	True	email of the author, will *not* be shown on the web site
changelog	False	string, can be multiline, no HTML allowed
experimental	False	boolean flag, *True* or *False*
deprecated	False	boolean flag, *True* or *False*, applies to the whole plugin and not just to the uploaded version
tags	False	comma separated list, spaces are allowed inside individual tags
homepage	False	a valid URL pointing to the homepage of your plugin
repository	False	a valid URL for the source code repository
tracker	False	a valid URL for tickets and bug reports
icon	False	a file name or a relative path (relative to the base folder of the plugin's compressed package)
category	False	one of *Raster*, *Vector*, *Database* and *Web*

By default, plugins are placed in the *Plugins* menu (we will see in the next section how to add a menu entry for your plugin) but they can also be placed the into *Raster*, *Vector*, *Database* and *Web* menus.

A corresponding "category" metadata entry exists to specify that, so the plugin can be classified accordingly. This metadata entry is used as tip for users and tells them where (in which menu) the plugin can be found. Allowed values for "category" are: Vector, Raster, Database or Web. For example, if your plugin will be available from *Raster* menu, add this to `metadata.txt`

```
category=Raster
```

Nota: If *qgisMaximumVersion* is empty, it will be automatically set to the major version plus *.99* when uploaded to the *Official python plugin repository*.

An example for this metadata.txt

```
; the next section is mandatory

[general]
name=HelloWorld
email=me@example.com
author=Just Me
qgisMinimumVersion=2.0
description=This is an example plugin for greeting the world.
    Multiline is allowed:
    lines starting with spaces belong to the same
    field, in this case to the "description" field.
    HTML formatting is not allowed.
about=This paragraph can contain a detailed description
    of the plugin. Multiline is allowed, HTML is not.
version=version 1.2
; end of mandatory metadata

; start of optional metadata
category=Raster
changelog=The changelog lists the plugin versions
    and their changes as in the example below:
    1.0 - First stable release
```

```
    0.9 - All features implemented
    0.8 - First testing release

; Tags are in comma separated value format, spaces are allowed within the
; tag name.
; Tags should be in English language. Please also check for existing tags and
; synonyms before creating a new one.
tags=wkt,raster,hello world

; these metadata can be empty, they will eventually become mandatory.
homepage=http://www.itopen.it
tracker=http://bugs.itopen.it
repository=http://www.itopen.it/repo
icon=icon.png

; experimental flag (applies to the single version)
experimental=True

; deprecated flag (applies to the whole plugin and not only to the uploaded version)
deprecated=False

; if empty, it will be automatically set to major version + .99
qgisMaximumVersion=2.0
```

13.2.2 __init__.py

This file is required by Python's import system. Also, QGIS requires that this file contains a `classFactory()` function, which is called when the plugin gets loaded to QGIS. It receives reference to instance of `QgisInterface` and must return instance of your plugin's class from the `mainplugin.py` — in our case it's called `TestPlugin` (see below). This is how `__init__.py` should look like

```
def classFactory(iface):
  from mainPlugin import TestPlugin
  return TestPlugin(iface)

## any other initialisation needed
```

13.2.3 mainPlugin.py

This is where the magic happens and this is how magic looks like: (e.g. `mainPlugin.py`)

```
from PyQt4.QtCore import *
from PyQt4.QtGui import *
from qgis.core import *

# initialize Qt resources from file resources.py
import resources

class TestPlugin:

  def __init__(self, iface):
    # save reference to the QGIS interface
    self.iface = iface

  def initGui(self):
    # create action that will start plugin configuration
    self.action = QAction(QIcon(":/plugins/testplug/icon.png"), "Test plugin", self.iface.mainWin
    self.action.setObjectName("testAction")
    self.action.setWhatsThis("Configuration for test plugin")
    self.action.setStatusTip("This is status tip")
```

```
    QObject.connect(self.action, SIGNAL("triggered()"), self.run)

    # add toolbar button and menu item
    self.iface.addToolBarIcon(self.action)
    self.iface.addPluginToMenu("&Test plugins", self.action)

    # connect to signal renderComplete which is emitted when canvas
    # rendering is done
    QObject.connect(self.iface.mapCanvas(), SIGNAL("renderComplete(QPainter *)"), self.renderTest

  def unload(self):
    # remove the plugin menu item and icon
    self.iface.removePluginMenu("&Test plugins", self.action)
    self.iface.removeToolBarIcon(self.action)

    # disconnect form signal of the canvas
    QObject.disconnect(self.iface.mapCanvas(), SIGNAL("renderComplete(QPainter *)"), self.renderT

  def run(self):
    # create and show a configuration dialog or something similar
    print "TestPlugin: run called!"

  def renderTest(self, painter):
    # use painter for drawing to map canvas
    print "TestPlugin: renderTest called!"
```

The only plugin functions that must exist in the main plugin source file (e.g. `mainPlugin.py`) are:

- `__init__` –> which gives access to QGIS interface
- `initGui()` –> called when the plugin is loaded
- `unload()` –> called when the plugin is unloaded

You can see that in the above example, the `addPluginToMenu()` is used. This will add the corresponding menu action to the *Plugins* menu. Alternative methods exist to add the action to a different menu. Here is a list of those methods:

- `addPluginToRasterMenu()`
- `addPluginToVectorMenu()`
- `addPluginToDatabaseMenu()`
- `addPluginToWebMenu()`

All of them have the same syntax as the `addPluginToMenu()` method.

Adding your plugin menu to one of those predefined method is recommended to keep consistency in how plugin entries are organized. However, you can add your custom menu group directly to the menu bar, as the next example demonstrates:

```
def initGui(self):
    self.menu = QMenu(self.iface.mainWindow())
    self.menu.setObjectName("testMenu")
    self.menu.setTitle("MyMenu")

    self.action = QAction(QIcon(":/plugins/testplug/icon.png"), "Test plugin", self.iface.mainWin
    self.action.setObjectName("testAction")
    self.action.setWhatsThis("Configuration for test plugin")
    self.action.setStatusTip("This is status tip")
    QObject.connect(self.action, SIGNAL("triggered()"), self.run)
    self.menu.addAction(self.action)

    menuBar = self.iface.mainWindow().menuBar()
    menuBar.insertMenu(self.iface.firstRightStandardMenu().menuAction(), self.menu)
```

```
def unload(self):
    self.menu.deleteLater()
```

Don't forget to set `QAction` and `QMenu objectName` to a name specific to your plugin so that it can be customized.

13.2.4 Resource File

You can see that in `initGui()` we've used an icon from the resource file (called `resources.qrc` in our case)

```
<RCC>
  <qresource prefix="/plugins/testplug" >
     <file>icon.png</file>
  </qresource>
</RCC>
```

It is good to use a prefix that will not collide with other plugins or any parts of QGIS, otherwise you might get resources you did not want. Now you just need to generate a Python file that will contain the resources. It's done with **pyrcc4** command

```
pyrcc4 -o resources.py resources.qrc
```

And that's all... nothing complicated :)

If you've done everything correctly you should be able to find and load your plugin in the plugin manager and see a message in console when toolbar icon or appropriate menu item is selected.

When working on a real plugin it's wise to write the plugin in another (working) directory and create a makefile which will generate UI + resource files and install the plugin to your QGIS installation.

13.3 Documentation

The documentation for the plugin can be written as HTML help files. The `qgis.utils` module provides a function, `showPluginHelp()` which will open the help file browser, in the same way as other QGIS help.

The `showPluginHelp'()` function looks for help files in the same directory as the calling module. It will look for, in turn, `index-ll_cc.html`, `index-ll.html`, `index-en.html`, `index-en_us.html` and `index.html`, displaying whichever it finds first. Here `ll_cc` is the QGIS locale. This allows multiple translations of the documentation to be included with the plugin.

The `showPluginHelp()` function can also take parameters packageName, which identifies a specific plugin for which the help will be displayed, filename, which can replace "index" in the names of files being searched, and section, which is the name of an html anchor tag in the document on which the browser will be positioned.

CHAPTER 14

IDE settings for writing and debugging plugins

Although each programmer has his preferred IDE/Text editor, here are some recommendations for setting up popular IDE's for writing and debugging QGIS Python plugins.

14.1 A note on configuring your IDE on Windows

On Linux there is no additional configuration needed to develop plug-ins. But on Windows you need to make sure you that you have the same environment settings and use the same libraries and interpreter as QGIS. The fastest way to do this, is to modify the startup batch file of QGIS.

If you used the OSGeo4W Installer, you can find this under the bin folder of your OSGoeW install. Look for something like `C:\OSGeo4W\bin\qgis-unstable.bat`.

For using Pyscripter IDE, here's what you have to do:

- Make a copy of qgis-unstable.bat and rename it pyscripter.bat.
- Open it in an editor. And remove the last line, the one that starts QGIS.
- Add a line that points to the your Pyscripter executable and add the commandline argument that sets the version of Python to be used (2.7 in the case of QGIS 2.0)
- Also add the argument that points to the folder where Pyscripter can find the Python dll used by QGIS, you can find this under the bin folder of your OSGeoW install

```
@echo off
SET OSGEO4W_ROOT=C:\OSGeo4W
call "%OSGEO4W_ROOT%"\bin\o4w_env.bat
call "%OSGEO4W_ROOT%"\bin\gdal16.bat
@echo off
path %PATH%;%GISBASE%\bin
Start C:\pyscripter\pyscripter.exe --python25 --pythondllpath=C:\OSGeo4W\bin
```

Now when you double click this batch file it will start Pyscripter, with the correct path.

More popular that Pyscripter, Eclipse is a common choice among developers. In the following sections, we will be explaining how to configure it for developing and testing plugins. To prepare your environment for using Eclipse in Windows, you should also create a batch file and use it to start Eclipse.

To create that batch file, follow these steps.

- Locate the folder where file:*qgis_core.dll* resides in. Normally this is `C:OSGeo4Wappsqgisbin`, but if you compiled your own QGIS application this is in your build folder in `output/bin/RelWithDebInfo`
- Locate your `eclipse.exe` executable.
- Create the following script and use this to start eclipse when developing QGIS plugins.

```
call "C:\OSGeo4W\bin\o4w_env.bat"
set PATH=%PATH%;C:\path\to\your\qgis_core.dll\parent\folder
C:\path\to\your\eclipse.exe
```

14.2 Debugging using Eclipse and PyDev

14.2.1 Installation

To use Eclipse, make sure you have installed the following

- Eclipse
- Aptana Eclipse Plugin or PyDev
- QGIS 2.0

14.2.2 Preparing QGIS

There is some preparation to be done on QGIS itself. Two plugins are of interest: *Remote Debug* and *Plugin reloader*.

- Go to *Plugins* → *Fetch python plugins*
- Search for *Remote Debug* (at the moment it's still experimental, so enable experimental plugins under the Options tab in case it does not show up). Install it.
- Search for *Plugin reloader* and install it as well. This will let you reload a plugin instead of having to close and restart QGIS to have the plugin reloaded.

14.2.3 Setting up Eclipse

In Eclipse, create a new project. You can select *General Project* and link your real sources later on, so it does not really matter where you place this project.

Now right click your new project and choose *New* → *Folder*.

Click **[Advanced]** and choose *Link to alternate location (Linked Folder)*. In case you already have sources you want to debug, choose these, in case you don't, create a folder as it was already explained

Now in the view *Project Explorer*, your source tree pops up and you can start working with the code. You already have syntax highlighting and all the other powerful IDE tools available.

14.2.4 Configuring the debugger

To get the debugger working, switch to the Debug perspective in Eclipse (*Window* → *Open Perspective* → *Other* → *Debug*).

Now start the PyDev debug server by choosing *PyDev* → *Start Debug Server*.

Eclipse is now waiting for a connection from QGIS to its debug server and when QGIS connects to the debug server it will allow it to control the python scripts. That's exactly what we installed the *Remote Debug* plugin for. So start QGIS in case you did not already and click the bug symbol .

Now you can set a breakpoint and as soon as the code hits it, execution will stop and you can inspect the current state of your plugin. (The breakpoint is the green dot in the image below, set one by double clicking in the white space left to the line you want the breakpoint to be set)

A very interesting thing you can make use of now is the debug console. Make sure that the execution is currently stopped at a break point, before you proceed.

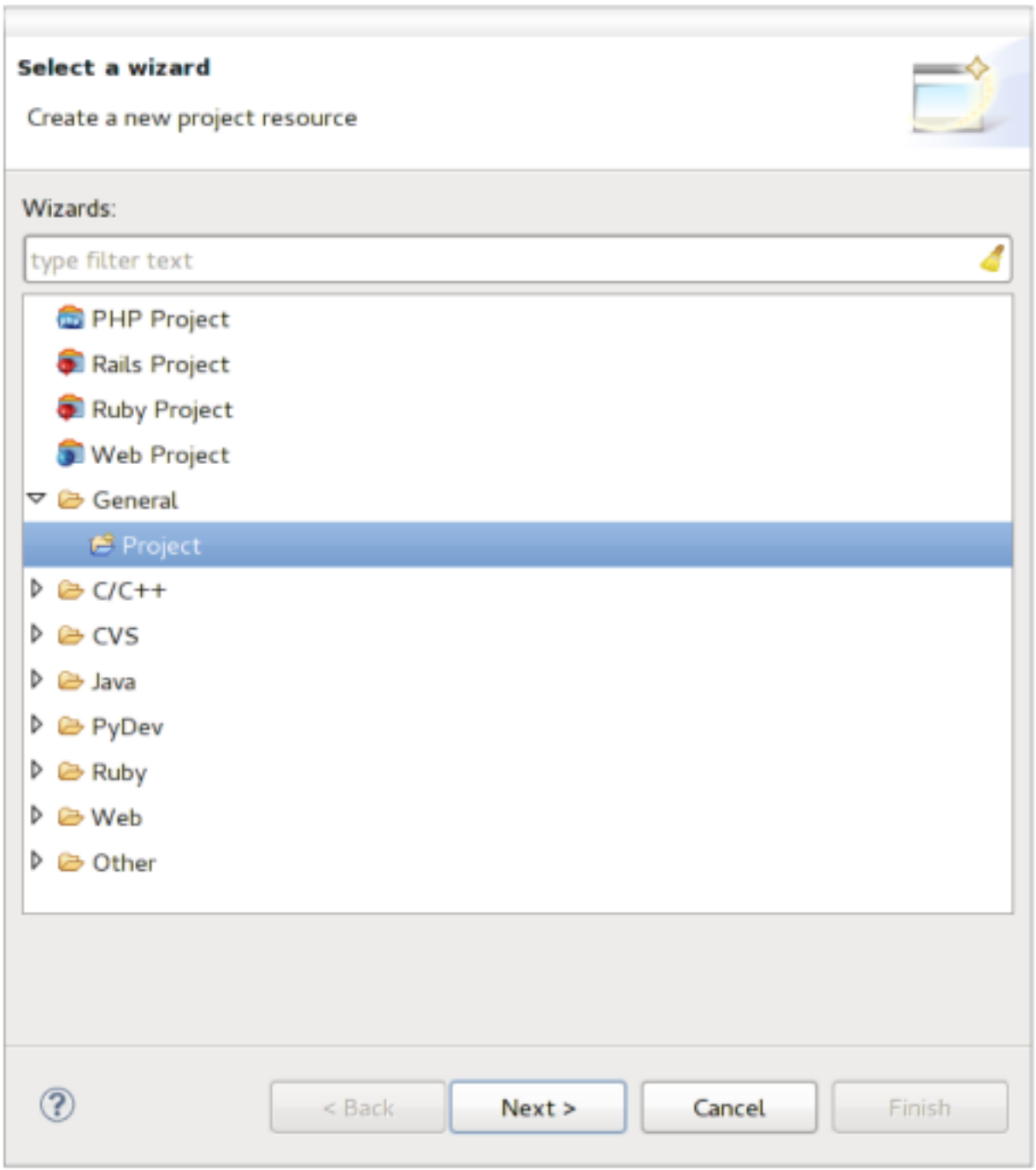

Figure 14.1: Eclipse project

```
88
89      def printProfile(self):
90          printer = QPrinter( QPrinter.HighResolution )
91          printer.setOutputFormat( QPrinter.PdfFormat )
92          printer.setPaperSize( QPrinter.A4 )
93          printer.setOrientation( QPrinter.Landscape )
94
95          printPreviewDlg = QPrintPreviewDialog( )
96          printPreviewDlg.paintRequested.connect( self.printRequested )
97
98          printPreviewDlg.exec_()
99
100     @pyqtSlot( QPrinter )
101     def printRequested( self, printer ):
102         self.webView.print_( printer )
```

Figure 14.2: Breakpoint

Open the Console view (*Window → Show view*). It will show the *Debug Server* console which is not very interesting. But there is a button **[Open Console]** which lets you change to a more interesting PyDev Debug Console. Click the arrow next to the **[Open Console]** button and choose *PyDev Console*. A window opens up to ask you which console you want to start. Choose *PyDev Debug Console*. In case its greyed out and tells you to Start the debugger and select the valid frame, make sure that you've got the remote debugger attached and are currently on a breakpoint.

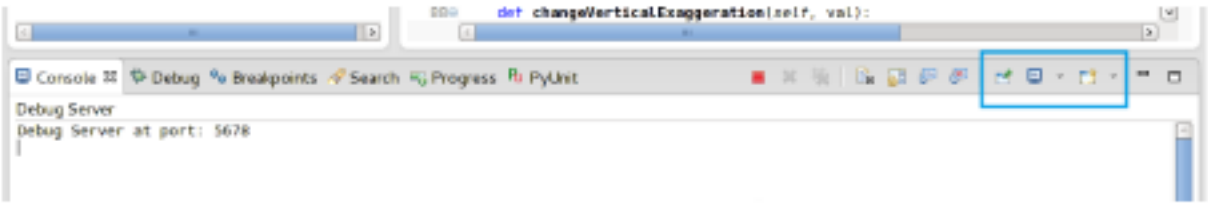

Figure 14.3: PyDev Debug Console

You have now an interactive console which let's you test any commands from within the current context. You can manipulate variables or make API calls or whatever you like.

A little bit annoying is, that every time you enter a command, the console switches back to the Debug Server. To stop this behavior, you can click the *Pin Console* button when on the Debug Server page and it should remember this decision at least for the current debug session.

14.2.5 Making eclipse understand the API

A very handy feature is to have Eclipse actually know about the QGIS API. This enables it to check your code for typos. But not only this, it also enables Eclipse to help you with autocompletion from the imports to API calls.

To do this, Eclipse parses the QGIS library files and gets all the information out there. The only thing you have to do is to tell Eclipse where to find the libraries.

Click *Window → Preferences → PyDev → Interpreter → Python*.

You will see your configured python interpreter in the upper part of the window (at the moment python2.7 for QGIS) and some tabs in the lower part. The interesting tabs for us are *Libraries* and *Forced Builtins*.

First open the Libraries tab. Add a New Folder and choose the python folder of your QGIS installation. If you do not know where this folder is (it's not the plugins folder) open QGIS, start a python console and simply enter `qgis` and press Enter. It will show you which QGIS module it uses and its path. Strip the trailing `/qgis/__init__.pyc` from this path and you've got the path you are looking for.

You should also add your plugins folder here (on Linux it is `~/.qgis/python/plugins`).

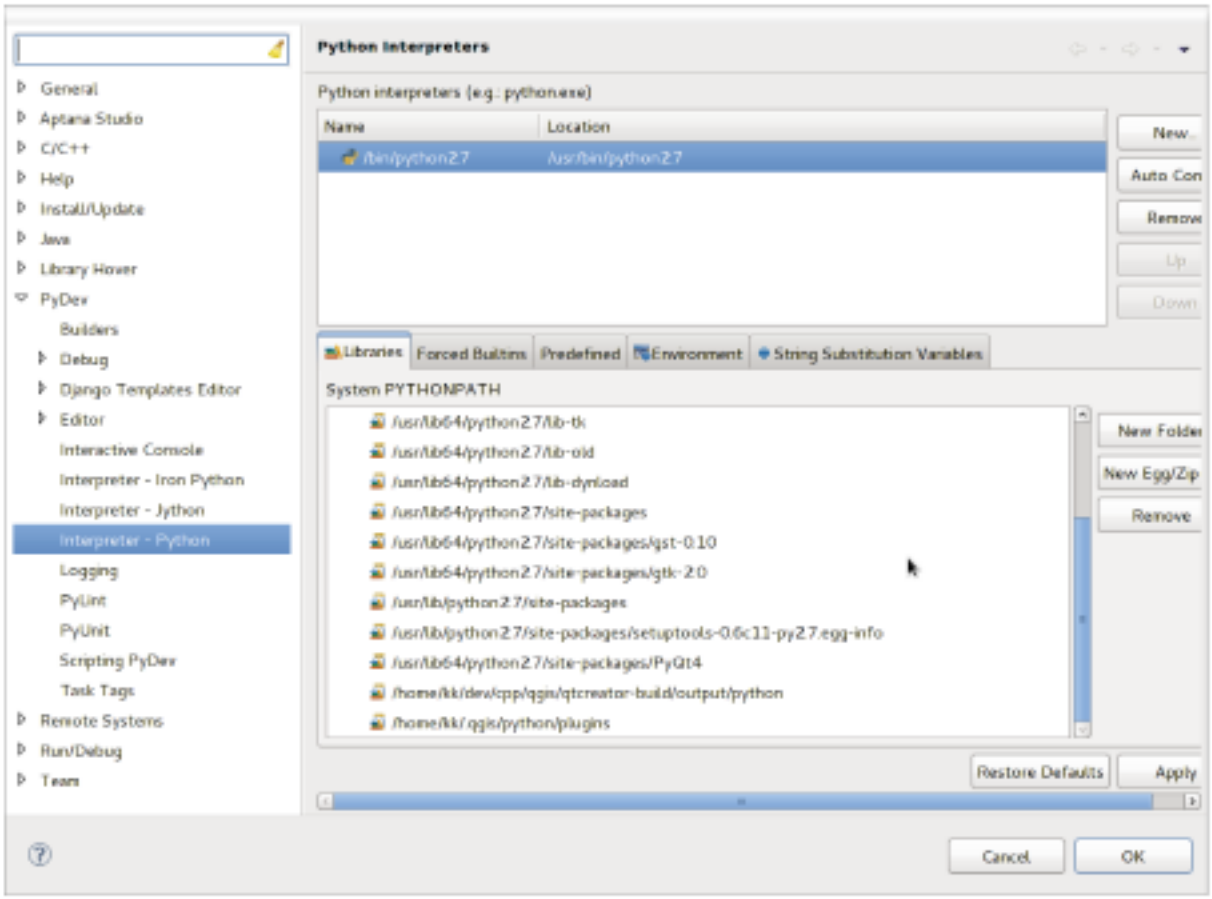

Figure 14.4: PyDev Debug Console

Next jump to the *Forced Builtins* tab, click on *New...* and enter `qgis`. This will make Eclipse parse the QGIS API. You probably also want eclipse to know about the PyQt4 API. Therefore also add PyQt4 as forced builtin. That should probably already be present in your libraries tab.

Click *OK* and you're done.

Note: every time the QGIS API changes (e.g. if you're compiling QGIS master and the SIP file changed), you should go back to this page and simply click *Apply*. This will let Eclipse parse all the libraries again.

For another possible setting of Eclipse to work with QGIS Python plugins, check this link

14.3 Debugging using PDB

If you do not use an IDE such as Eclipse, you can debug using PDB, following these steps.

First add this code in the spot where you would like to debug

```
# Use pdb for debugging
import pdb
# These lines allow you to set a breakpoint in the app
pyqtRemoveInputHook()
pdb.set_trace()
```

Then run QGIS from the command line.

On Linux do:

$ ./Qgis

On Mac OS X do:

$ /Applications/Qgis.app/Contents/MacOS/Qgis

And when the application hits your breakpoint you can type in the console!

TODO: Add testing information

CHAPTER 15

Utilizar complemento Capas

Si su complemento utiliza métodos propios para representar una capa de mapa, escribir su propio tipo de capa basado en QgsPluginLayer puede ser la mejor forma de implementarla.

TODO: Comprobar la corrección y elaborar buenos casos de uso de QgsPluginLayer

15.1 Subclassing QgsPluginLayer

A continuación es un ejemplo de una implementación mínima de QgsPluginLayer. Es un extracto del Complemento de ejemplo de marca de agua

```
class WatermarkPluginLayer(QgsPluginLayer):

  LAYER_TYPE="watermark"

  def __init__(self):
    QgsPluginLayer.__init__(self, WatermarkPluginLayer.LAYER_TYPE, "Watermark plugin layer")
    self.setValid(True)

  def draw(self, rendererContext):
    image = QImage("myimage.png")
    painter = rendererContext.painter()
    painter.save()
    painter.drawImage(10, 10, image)
    painter.restore()
    return True
```

Métodos de lectura y escritura de información especifica para el archivo del proyecto también puede ser añadido

```
def readXml(self, node):
  pass

def writeXml(self, node, doc):
  pass
```

Al cargar un proyecto que contiene una capa de este tipo, se necesita una clase de fábrica

```
class WatermarkPluginLayerType(QgsPluginLayerType):

  def __init__(self):
    QgsPluginLayerType.__init__(self, WatermarkPluginLayer.LAYER_TYPE)

  def createLayer(self):
    return WatermarkPluginLayer()
```

Se puede también añadir código para mostrar información personalizada en las propiedades de la capa

```
def showLayerProperties(self, layer):
  pass
```

CHAPTER 16

Compatibilidad con versiones antiguas de QGIS

16.1 Menu de plugins

Si se coloca las entradas del menú de complementos en uno de los nuevos menús (*Ráster*, *Vector*, *Base de Datos* o *Web*), se debe modificar el código de las funciones `initGui()` y `unload()`. Dado que estos nuevos menús sólo están disponibles en QGIS 2.0 y versiones superiores, el primer paso es comprobar que la versión de QGIS que se esta ejecutando tenga todas las funciones. Si los nuevos menús están disponibles, colocaremos nuestros complementos bajo estos menús, de lo contrario utilizaremos el anterior menú *Complementos*. Aquí un ejemplo para el menú *Ráster*

```
def initGui(self):
  # create action that will start plugin configuration
  self.action = QAction(QIcon(":/plugins/testplug/icon.png"), "Test plugin", self.iface.mainWindo
  self.action.setWhatsThis("Configuration for test plugin")
  self.action.setStatusTip("This is status tip")
  QObject.connect(self.action, SIGNAL("triggered()"), self.run)

  # check if Raster menu available
  if hasattr(self.iface, "addPluginToRasterMenu"):
    # Raster menu and toolbar available
    self.iface.addRasterToolBarIcon(self.action)
    self.iface.addPluginToRasterMenu("&Test plugins", self.action)
  else:
    # there is no Raster menu, place plugin under Plugins menu as usual
    self.iface.addToolBarIcon(self.action)
    self.iface.addPluginToMenu("&Test plugins", self.action)

  # connect to signal renderComplete which is emitted when canvas rendering is done
  QObject.connect(self.iface.mapCanvas(), SIGNAL("renderComplete(QPainter *)"), self.renderTest)

def unload(self):
  # check if Raster menu available and remove our buttons from appropriate
  # menu and toolbar
  if hasattr(self.iface, "addPluginToRasterMenu"):
    self.iface.removePluginRasterMenu("&Test plugins", self.action)
    self.iface.removeRasterToolBarIcon(self.action)
  else:
    self.iface.removePluginMenu("&Test plugins", self.action)
    self.iface.removeToolBarIcon(self.action)

  # disconnect from signal of the canvas
  QObject.disconnect(self.iface.mapCanvas(), SIGNAL("renderComplete(QPainter *)"), self.renderTes
```

CHAPTER 17

Releasing your plugin

Once your plugin is ready and you think the plugin could be helpful for some people, do not hesitate to upload it to *Official python plugin repository*. On that page you can find also packaging guidelines about how to prepare the plugin to work well with the plugin installer. Or in case you would like to set up your own plugin repository, create a simple XML file that will list the plugins and their metadata, for examples see other plugin repositories.

Please take special care to the following suggestions:

17.1 Metadata and names

- avoid using a name too similar to existing plugins
- if your plugin has a similar functionality to an existing plugin, please explain the differences in the About field, so the user will know which one to use without the need to install and test it
- avoid repeating "plugin" in the name of the plugin itself
- use the description field in metadata for a 1 line description, the About field for more detailed instructions
- include a code repository, a bug tracker, and a home page; this will greatly enhance the possibility of collaboration, and can be done very easily with one of the available web infrastructures (GitHub, GitLab, Bitbucket, etc.)
- choose tags with care: avoid the uninformative ones (e.g. vector) and prefer the ones already used by others (see the plugin website)
- add a proper icon, do not leave the default one; see QGIS interface for a suggestion of the style to be used

17.2 Code and help

- do not include generated file (ui_*.py, resources_rc.py, generated help files...) and useless stuff (e.g. .gitignore) in repository
- add the plugin to the appropriate menu (Vector, Raster, Web, Database)
- when appropriate (plugins performing analyses), consider adding the plugin as a subplugin of Processing framework: this will allow users to run it in batch, to integrate it in more complex workflows, and will free you from the burden of designing an interface
- include at least minimal documentation and, if useful for testing and understanding, sample data.

17.3 Official python plugin repository

You can find the *official* python plugin repository at http://plugins.qgis.org/.

In order to use the official repository you must obtain an OSGEO ID from the OSGEO web portal.

Once you have uploaded your plugin it will be approved by a staff member and you will be notified.

TODO: Insert a link to the governance document

17.3.1 Permissions

These rules have been implemented in the official plugin repository:

- every registered user can add a new plugin
- *staff* users can approve or disapprove all plugin versions
- users which have the special permission *plugins.can_approve* get the versions they upload automatically approved
- users which have the special permission *plugins.can_approve* can approve versions uploaded by others as long as they are in the list of the plugin *owners*
- a particular plugin can be deleted and edited only by *staff* users and plugin *owners*
- if a user without *plugins.can_approve* permission uploads a new version, the plugin version is automatically unapproved.

17.3.2 Trust management

Staff members can grant *trust* to selected plugin creators setting *plugins.can_approve* permission through the front-end application.

The plugin details view offers direct links to grant trust to the plugin creator or the plugin *owners*.

17.3.3 Validation

Plugin's metadata are automatically imported and validated from the compressed package when the plugin is uploaded.

Here are some validation rules that you should aware of when you want to upload a plugin on the official repository:

1. the name of the main folder containing your plugin must contain only ASCII characters (A-Z and a-z), digits and the characters underscore (_) and minus (-), also it cannot start with a digit
2. `metadata.txt` is required
3. all required metadata listed in *metadata table* must be present
4. the *version* metadata field must be unique

17.3.4 Plugin structure

Following the validation rules the compressed (.zip) package of your plugin must have a specific structure to validate as a functional plugin. As the plugin will be unzipped inside the users plugins folder it must have it's own directory inside the .zip file to not interfere with other plugins. Mandatory files are: `metadata.txt` and `__init__.py`. But it would be nice to have a `README` and of course an icon to represent the plugin (`resources.qrc`). Following is an example of how a plugin.zip should look like.

```
plugin.zip
  pluginfolder/
  |-- i18n
  |   |-- translation_file_de.ts
  |-- img
```

```
|   |-- icon.png
|   `-- iconsource.svg
|-- __init__.py
|-- Makefile
|-- metadata.txt
|-- more_code.py
|-- main_code.py
|-- README
|-- resources.qrc
|-- resources_rc.py
`-- ui_Qt_user_interface_file.ui
```

CHAPTER 18

Fragmentos de código

Esta sección cuenta con fragmentos de código para facilitar el desarrollo de complementos.

18.1 Cómo llamar a un método por un atajo de teclado

En el complemento añadir a la `initGui()`

```
self.keyAction = QAction("Test Plugin", self.iface.mainWindow())
self.iface.registerMainWindowAction(self.keyAction, "F7") # actionI triggered by F7 key
self.iface.addPluginToMenu("&Test plugins", self.keyAction)
QObject.connect(self.keyAction, SIGNAL("triggered()"),self.keyActionF7)
```

Para añadir `unload()`

```
self.iface.unregisterMainWindowAction(self.keyAction)
```

El método que se llama cuando se presiona F7

```
def keyActionF7(self):
  QMessageBox.information(self.iface.mainWindow(),"Ok", "You pressed F7")
```

18.2 Como alternar capas

Desde QGIS 2.4 hay un nuevo API de árbol de capas que permite acceder directamente al árbol de capas en la leyenda. Aquí un ejemplo de cómo alternar la visibilidad de la capa activa.

```
root = QgsProject.instance().layerTreeRoot()
node = root.findLayer(iface.activeLayer().id())
new_state = Qt.Checked if node.isVisible() == Qt.Unchecked else Qt.Unchecked
node.setVisible(new_state)
```

18.3 Cómo acceder a la tabla de atributos de los objetos espaciales seleccionados

```
def changeValue(self, value):
  layer = self.iface.activeLayer()
  if(layer):
    nF = layer.selectedFeatureCount()
    if (nF > 0):
      layer.startEditing()
    ob = layer.selectedFeaturesIds()
```

```
    b = QVariant(value)
    if (nF > 1):
      for i in ob:
      layer.changeAttributeValue(int(i), 1, b) # 1 being the second column
    else:
      layer.changeAttributeValue(int(ob[0]), 1, b) # 1 being the second column
    layer.commitChanges()
    else:
      QMessageBox.critical(self.iface.mainWindow(), "Error", "Please select at least one feature
  else:
    QMessageBox.critical(self.iface.mainWindow(), "Error", "Please select a layer")
```

El método requiere un parámetro (el nuevo valor para el campo de atributo de los objeto(s) espaciales seleccionados) y puede ser llamado por

```
self.changeValue(50)
```

CHAPTER 19

Network analysis library

Starting from revision ee19294562 (QGIS >= 1.8) the new network analysis library was added to the QGIS core analysis library. The library:

- creates mathematical graph from geographical data (polyline vector layers)
- implements basic methods from graph theory (currently only Dijkstra's algorithm)

The network analysis library was created by exporting basic functions from the RoadGraph core plugin and now you can use it's methods in plugins or directly from the Python console.

19.1 General information

Briefly, a typical use case can be described as:

1. create graph from geodata (usually polyline vector layer)
2. run graph analysis
3. use analysis results (for example, visualize them)

19.2 Building a graph

The first thing you need to do — is to prepare input data, that is to convert a vector layer into a graph. All further actions will use this graph, not the layer.

As a source we can use any polyline vector layer. Nodes of the polylines become graph vertexes, and segments of the polylines are graph edges. If several nodes have the same coordinates then they are the same graph vertex. So two lines that have a common node become connected to each other.

Additionally, during graph creation it is possible to "fix" ("tie") to the input vector layer any number of additional points. For each additional point a match will be found — the closest graph vertex or closest graph edge. In the latter case the edge will be split and a new vertex added.

Vector layer attributes and length of an edge can be used as the properties of an edge.

Converting from a vector layer to the graph is done using the Builder programming pattern. A graph is constructed using a so-called Director. There is only one Director for now: QgsLineVectorLayerDirector. The director sets the basic settings that will be used to construct a graph from a line vector layer, used by the builder to create the graph. Currently, as in the case with the director, only one builder exists: QgsGraphBuilder, that creates QgsGraph objects. You may want to implement your own builders that will build a graphs compatible with such libraries as BGL or NetworkX.

To calculate edge properties the programming pattern strategy is used. For now only QgsDistanceArcProperter strategy is available, that takes into account the length of the route. You can implement your own strategy that will use all necessary parameters. For example, RoadGraph plugin uses a strategy that computes travel time using edge length and speed value from attributes.

It's time to dive into the process.

First of all, to use this library we should import the networkanalysis module

```
from qgis.networkanalysis import *
```

Then some examples for creating a director

```
# don't use information about road direction from layer attributes,
# all roads are treated as two-way
director = QgsLineVectorLayerDirector(vLayer, -1, '', '', '', 3)

# use field with index 5 as source of information about road direction.
# one-way roads with direct direction have attribute value "yes",
# one-way roads with reverse direction have the value "1", and accordingly
# bidirectional roads have "no". By default roads are treated as two-way.
# This scheme can be used with OpenStreetMap data
director = QgsLineVectorLayerDirector(vLayer, 5, 'yes', '1', 'no', 3)
```

To construct a director we should pass a vector layer, that will be used as the source for the graph structure and information about allowed movement on each road segment (one-way or bidirectional movement, direct or reverse direction). The call looks like this

```
director = QgsLineVectorLayerDirector(vl, directionFieldId,
                                      directDirectionValue,
                                      reverseDirectionValue,
                                      bothDirectionValue,
                                      defaultDirection)
```

And here is full list of what these parameters mean:

- `vl` — vector layer used to build the graph
- `directionFieldId` — index of the attribute table field, where information about roads direction is stored. If `-1`, then don't use this info at all. An integer.
- `directDirectionValue` — field value for roads with direct direction (moving from first line point to last one). A string.
- `reverseDirectionValue` — field value for roads with reverse direction (moving from last line point to first one). A string.
- `bothDirectionValue` — field value for bidirectional roads (for such roads we can move from first point to last and from last to first). A string.
- `defaultDirection` — default road direction. This value will be used for those roads where field `directionFieldId` is not set or has some value different from any of the three values specified above. An integer. `1` indicates direct direction, `2` indicates reverse direction, and `3` indicates both directions.

It is necessary then to create a strategy for calculating edge properties

```
properter = QgsDistanceArcProperter()
```

And tell the director about this strategy

```
director.addProperter(properter)
```

Now we can use the builder, which will create the graph. The QgsGraphBuilder class constructor takes several arguments:

- crs — coordinate reference system to use. Mandatory argument.
- otfEnabled — use "on the fly" reprojection or no. By default const:*True* (use OTF).
- topologyTolerance — topological tolerance. Default value is 0.
- ellipsoidID — ellipsoid to use. By default "WGS84".

```
# only CRS is set, all other values are defaults
builder = QgsGraphBuilder(myCRS)
```

Also we can define several points, which will be used in the analysis. For example

```
startPoint = QgsPoint(82.7112, 55.1672)
endPoint = QgsPoint(83.1879, 54.7079)
```

Now all is in place so we can build the graph and "tie" these points to it

```
tiedPoints = director.makeGraph(builder, [startPoint, endPoint])
```

Building the graph can take some time (which depends on the number of features in a layer and layer size). `tiedPoints` is a list with coordinates of "tied" points. When the build operation is finished we can get the graph and use it for the analysis

```
graph = builder.graph()
```

With the next code we can get the vertex indexes of our points

```
startId = graph.findVertex(tiedPoints[0])
endId = graph.findVertex(tiedPoints[1])
```

19.3 Graph analysis

Networks analysis is used to find answers to two questions: which vertexes are connected and how to find a shortest path. To solve these problems the network analysis library provides Dijkstra's algorithm.

Dijkstra's algorithm finds the shortest route from one of the vertexes of the graph to all the others and the values of the optimization parameters. The results can be represented as a shortest path tree.

The shortest path tree is a directed weighted graph (or more precisely — tree) with the following properties:

- only one vertex has no incoming edges — the root of the tree
- all other vertexes have only one incoming edge
- if vertex B is reachable from vertex A, then the path from A to B is the single available path and it is optimal (shortest) on this graph

To get the shortest path tree use the methods `shortestTree()` and `dijkstra()` of QgsGraphAnalyzer class. It is recommended to use method `dijkstra()` because it works faster and uses memory more efficiently.

The `shortestTree()` method is useful when you want to walk around the shortest path tree. It always creates a new graph object (QgsGraph) and accepts three variables:

- source — input graph
- startVertexIdx — index of the point on the tree (the root of the tree)
- criterionNum — number of edge property to use (started from 0).

```
tree = QgsGraphAnalyzer.shortestTree(graph, startId, 0)
```

The `dijkstra()` method has the same arguments, but returns two arrays. In the first array element i contains index of the incoming edge or -1 if there are no incoming edges. In the second array element i contains distance from the root of the tree to vertex i or DOUBLE_MAX if vertex i is unreachable from the root.

```
(tree, cost) = QgsGraphAnalyzer.dijkstra(graph, startId, 0)
```

Here is some very simple code to display the shortest path tree using the graph created with the `shortestTree()` method (select linestring layer in TOC and replace coordinates with your own). **Warning**: use this code only as an example, it creates a lots of QgsRubberBand objects and may be slow on large data-sets.

```
from PyQt4.QtCore import *
from PyQt4.QtGui import *

from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *

vl = qgis.utils.iface.mapCanvas().currentLayer()
director = QgsLineVectorLayerDirector(vl, -1, '', '', '', 3)
properter = QgsDistanceArcProperter()
director.addProperter(properter)
crs = qgis.utils.iface.mapCanvas().mapRenderer().destinationCrs()
builder = QgsGraphBuilder(crs)

pStart = QgsPoint(-0.743804, 0.22954)
tiedPoint = director.makeGraph(builder, [pStart])
pStart = tiedPoint[0]

graph = builder.graph()

idStart = graph.findVertex(pStart)

tree = QgsGraphAnalyzer.shortestTree(graph, idStart, 0)

i = 0;
while (i < tree.arcCount()):
  rb = QgsRubberBand(qgis.utils.iface.mapCanvas())
  rb.setColor (Qt.red)
  rb.addPoint (tree.vertex(tree.arc(i).inVertex()).point())
  rb.addPoint (tree.vertex(tree.arc(i).outVertex()).point())
  i = i + 1
```

Same thing but using `dijkstra()` method

```
from PyQt4.QtCore import *
from PyQt4.QtGui import *

from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *

vl = qgis.utils.iface.mapCanvas().currentLayer()
director = QgsLineVectorLayerDirector(vl, -1, '', '', '', 3)
properter = QgsDistanceArcProperter()
director.addProperter(properter)
crs = qgis.utils.iface.mapCanvas().mapRenderer().destinationCrs()
builder = QgsGraphBuilder(crs)

pStart = QgsPoint(-1.37144, 0.543836)
tiedPoint = director.makeGraph(builder, [pStart])
pStart = tiedPoint[0]

graph = builder.graph()

idStart = graph.findVertex(pStart)

(tree, costs) = QgsGraphAnalyzer.dijkstra(graph, idStart, 0)

for edgeId in tree:
  if edgeId == -1:
    continue
  rb = QgsRubberBand(qgis.utils.iface.mapCanvas())
  rb.setColor (Qt.red)
```

```
  rb.addPoint (graph.vertex(graph.arc(edgeId).inVertex()).point())
  rb.addPoint (graph.vertex(graph.arc(edgeId).outVertex()).point())
```

19.3.1 Finding shortest paths

To find the optimal path between two points the following approach is used. Both points (start A and end B) are "tied" to the graph when it is built. Then using the methods `shortestTree()` or `dijkstra()` we build the shortest path tree with root in the start point A. In the same tree we also find the end point B and start to walk through the tree from point B to point A. The whole algorithm can be written as

```
assign  = B
while  != A
    add point  to path
    get incoming edge for point
    look for point , that is start point of this edge
    assign  =
add point  to path
```

At this point we have the path, in the form of the inverted list of vertexes (vertexes are listed in reversed order from end point to start point) that will be visited during traveling by this path.

Here is the sample code for QGIS Python Console (you will need to select linestring layer in TOC and replace coordinates in the code with yours) that uses method `shortestTree()`

```
from PyQt4.QtCore import *
from PyQt4.QtGui import *

from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *

vl = qgis.utils.iface.mapCanvas().currentLayer()
director = QgsLineVectorLayerDirector(vl, -1, '', '', '', 3)
properter = QgsDistanceArcProperter()
director.addProperter(properter)
crs = qgis.utils.iface.mapCanvas().mapRenderer().destinationCrs()
builder = QgsGraphBuilder(crs)

pStart = QgsPoint(-0.835953, 0.15679)
pStop = QgsPoint(-1.1027, 0.699986)

tiedPoints = director.makeGraph(builder, [pStart, pStop])
graph = builder.graph()

tStart = tiedPoints[0]
tStop = tiedPoints[1]

idStart = graph.findVertex(tStart)
tree = QgsGraphAnalyzer.shortestTree(graph, idStart, 0)

idStart = tree.findVertex(tStart)
idStop = tree.findVertex(tStop)

if idStop == -1:
  print "Path not found"
else:
  p = []
  while (idStart != idStop):
    l = tree.vertex(idStop).inArc()
    if len(l) == 0:
      break
    e = tree.arc(l[0])
```

```
    p.insert(0, tree.vertex(e.inVertex()).point())
    idStop = e.outVertex()

  p.insert(0, tStart)
  rb = QgsRubberBand(qgis.utils.iface.mapCanvas())
  rb.setColor(Qt.red)

  for pnt in p:
    rb.addPoint(pnt)
```

And here is the same sample but using `dijkstra()` method

```
from PyQt4.QtCore import *
from PyQt4.QtGui import *

from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *

vl = qgis.utils.iface.mapCanvas().currentLayer()
director = QgsLineVectorLayerDirector(vl, -1, '', '', '', 3)
properter = QgsDistanceArcProperter()
director.addProperter(properter)
crs = qgis.utils.iface.mapCanvas().mapRenderer().destinationCrs()
builder = QgsGraphBuilder(crs)

pStart = QgsPoint(-0.835953, 0.15679)
pStop = QgsPoint(-1.1027, 0.699986)

tiedPoints = director.makeGraph(builder, [pStart, pStop])
graph = builder.graph()

tStart = tiedPoints[0]
tStop = tiedPoints[1]

idStart = graph.findVertex(tStart)
idStop = graph.findVertex(tStop)

(tree, cost) = QgsGraphAnalyzer.dijkstra(graph, idStart, 0)

if tree[idStop] == -1:
  print "Path not found"
else:
  p = []
  curPos = idStop
  while curPos != idStart:
    p.append(graph.vertex(graph.arc(tree[curPos]).inVertex()).point())
    curPos = graph.arc(tree[curPos]).outVertex();

  p.append(tStart)

  rb = QgsRubberBand(qgis.utils.iface.mapCanvas())
  rb.setColor(Qt.red)

  for pnt in p:
    rb.addPoint(pnt)
```

19.3.2 Areas of availability

The area of availability for vertex A is the subset of graph vertexes that are accessible from vertex A and the cost of the paths from A to these vertexes are not greater that some value.

More clearly this can be shown with the following example: "There is a fire station. Which parts of city can a fire truck reach in 5 minutes? 10 minutes? 15 minutes?". Answers to these questions are fire station's areas of availability.

To find the areas of availability we can use method `dijkstra()` of the `QgsGraphAnalyzer` class. It is enough to compare the elements of the cost array with a predefined value. If cost[i] is less than or equal to a predefined value, then vertex i is inside the area of availability, otherwise it is outside.

A more difficult problem is to get the borders of the area of availability. The bottom border is the set of vertexes that are still accessible, and the top border is the set of vertexes that are not accessible. In fact this is simple: it is the availability border based on the edges of the shortest path tree for which the source vertex of the edge is accessible and the target vertex of the edge is not.

Here is an example

```
from PyQt4.QtCore import *
from PyQt4.QtGui import *

from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *

vl = qgis.utils.iface.mapCanvas().currentLayer()
director = QgsLineVectorLayerDirector(vl, -1, '', '', '', 3)
properter = QgsDistanceArcProperter()
director.addProperter(properter)
crs = qgis.utils.iface.mapCanvas().mapRenderer().destinationCrs()
builder = QgsGraphBuilder(crs)

pStart = QgsPoint(65.5462, 57.1509)
delta = qgis.utils.iface.mapCanvas().getCoordinateTransform().mapUnitsPerPixel() * 1

rb = QgsRubberBand(qgis.utils.iface.mapCanvas(), True)
rb.setColor(Qt.green)
rb.addPoint(QgsPoint(pStart.x() - delta, pStart.y() - delta))
rb.addPoint(QgsPoint(pStart.x() + delta, pStart.y() - delta))
rb.addPoint(QgsPoint(pStart.x() + delta, pStart.y() + delta))
rb.addPoint(QgsPoint(pStart.x() - delta, pStart.y() + delta))

tiedPoints = director.makeGraph(builder, [pStart])
graph = builder.graph()
tStart = tiedPoints[0]

idStart = graph.findVertex(tStart)

(tree, cost) = QgsGraphAnalyzer.dijkstra(graph, idStart, 0)

upperBound = []
r = 2000.0
i = 0
while i < len(cost):
  if cost[i] > r and tree[i] != -1:
    outVertexId = graph.arc(tree [i]).outVertex()
    if cost[outVertexId] < r:
      upperBound.append(i)
  i = i + 1

for i in upperBound:
  centerPoint = graph.vertex(i).point()
  rb = QgsRubberBand(qgis.utils.iface.mapCanvas(), True)
  rb.setColor(Qt.red)
  rb.addPoint(QgsPoint(centerPoint.x() - delta, centerPoint.y() - delta))
  rb.addPoint(QgsPoint(centerPoint.x() + delta, centerPoint.y() - delta))
  rb.addPoint(QgsPoint(centerPoint.x() + delta, centerPoint.y() + delta))
```

```
rb.addPoint(QgsPoint(centerPoint.x() - delta, centerPoint.y() + delta))
```

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