PyQGIS developer cookbook

Version 3.4

QGIS Project

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Contents

CHAPTER 1

Introduction

This document is intended to be both 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.

Python support was first introduced in QGIS 0.9. Today, there are several ways to use Python in QGIS Desktop, they are covered in the following sections:

- Issue commands in the Python console within QGIS
- Create and use plugins
- Automatically run Python code when QGIS starts
- Create custom applications based on the QGIS API

Python bindings are also available for QGIS Server, including Python plugins (see *Extensions Python pour QGIS Server*) and Python bindings that can be used to embed QGIS Server into a Python application.

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

A good resource for learning how to perform common tasks is to download existing plugins from the plugin repository and examine their code.

1.1 Scripting in the Python Console

QGIS provides an integrated Python console for scripting. It can be opened from the *Plugins* → *Python Console* menu:

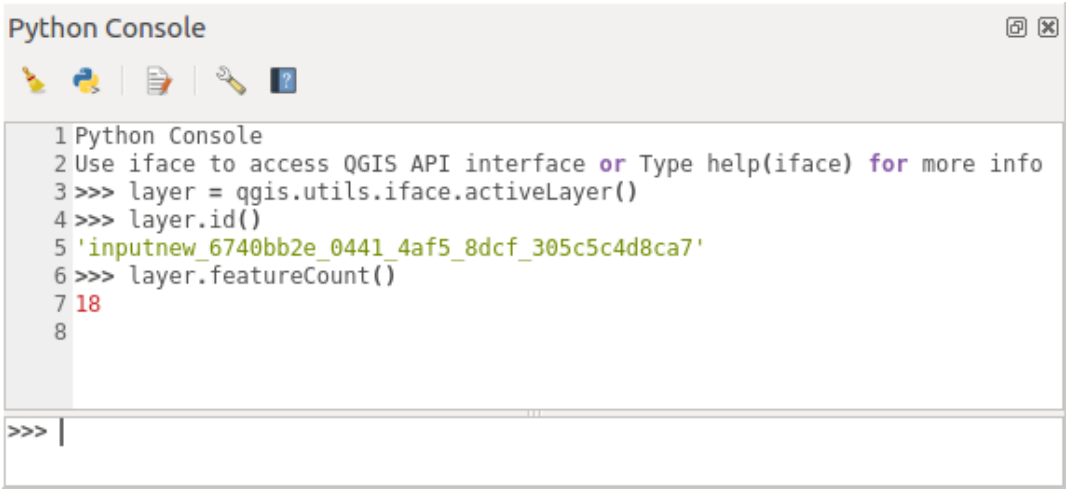


Figure 1.1: La Console Python de QGIS

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 the QGIS environment, there is a `iface` variable, which is an instance of `QgisInterface`. This interface allows access to the map canvas, menus, toolbars and other parts of the QGIS application.

For user convenience, the following statements are executed when the console is started (in the 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 *Settings* → *Configure shortcuts...*)

1.2 Extensions Python

The functionality of QGIS can be extended using plugins. It is now also possible to use plugins written in Python. The main advantage over C++ plugins is simplicity of distribution (no compiling for each platform) 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 Plugins page for more information about plugins and plugin development.

Créer des extensions Python est simple. Voir *Développer des extensions Python* pour des instructions détaillées.

Note: Python plugins are also available for QGIS server (label_qgisserver), see *Extensions Python pour QGIS Server* for further details.

1.3 Running Python code when QGIS starts

Il y a deux façons distinctes d'exécuter un programme Python chaque fois que QGIS démarre.

1. Creating a startup.py script
2. Setting the `PYQGIS_STARTUP` environment variable to an existing Python file

1.3.1 Le fichier : `startup.py`

Every time QGIS starts, the user's Python home directory

- Linux: `.local/share/QGIS/QGIS3/profiles/default/python`
- Windows: `AppData\Roaming\QGIS\QGIS3\profiles\default\python`
- macOS: `Library/Application Support/QGIS/QGIS3/profiles/default`

is searched for a file named `startup.py`. If that file exists, it is executed by the embedded Python interpreter.

Note: The default path depends on the operating system. To find the path that will work for you, open the Python Console and run `QStandardPaths.standardLocations(QStandardPaths.AppDataLocation)` to see the list of default directories.

1.3.2 Variables d'environnement PYQGIS_STARTUP

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 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 virtual environment, e.g. homebrew or MacPorts installs on Mac.

1.4 Applications Python

It is often handy to create scripts for automating processes. 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 GIS functionality — perform measurements, export a map as PDF, or any other functionality. The `qgis.gui` module brings various GUI components, most notably the map canvas widget that can be incorporated into the application with support for zooming, panning and/or any further custom map tools.

PyQGIS custom applications or standalone scripts must be configured to locate the QGIS resources such as projection information, providers for reading vector and raster layers, etc. QGIS Resources are initialized by adding a few lines to the beginning of your application or script. The code to initialize QGIS for custom applications and standalone scripts is similar. Examples of each are provided below.

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.

1.4.1 Utiliser PyQGIS dans des scripts indépendants

Pour commencer un script indépendant, initialisez les ressources QGIS au début du script tel que dans le code suivant:

```
from qgis.core import *

# supply path to qgis install location
QgsApplication.setPrefixPath("/path/to/qgis/installation", True)

# create a reference to the QgsApplication, setting the
# second argument to False disables the GUI
qgs = QgsApplication([], False)

# load providers
qgs.initQgis()

# Write your code here to load some layers, use processing
# algorithms, etc.

# When your script is complete, call exitQgis() to remove the
# provider and layer registries from memory

qgs.exitQgis()
```

Nous commençons par importer le module `qgis.core` et ensuite configurons le chemin du préfixe. Le chemin du préfixe est l'endroit où QGIS est installé sur votre système. Il est configuré dans le script en faisant appel à la méthode `setPrefixPath`. Le second argument de la méthode `setPrefixPath` est mis à `True`, ce qui contrôle si les chemins par défaut sont utilisés.

Le chemin d'installation de QGIS varie suivant XXXXX ; le moyen le plus simple pour trouver celle qui correspond à votre système est d'utiliser la *Scripting in the Python Console*

Une fois la configuration du chemin faite, nous sauvegardons une références à `QgsApplication` dans la variable `qgs`. Le second argument est défini à `False`, indiquant que nous n'envisageons pas d'utiliser une interface graphique étant donné que nous écrivons un script indépendant. `QgsApplication` étant configuré, nous chargeons les fournisseurs de données de QGIS et le registre de couches via la méthode `qgs.initQgis()`. Avec l'initialisation de QGIS, nous sommes désormais prêts à écrire le reste de notre script. A la fin, nous utilisons `qgs.exitQgis()` pour nous assurer de supprimer de la mémoire les fournisseurs de données et le registre de couches.

1.4.2 Utiliser PyQGIS dans une application personnalisée

La seule différence entre *Utiliser PyQGIS dans des scripts indépendants* et une application PyQGIS personnalisée réside dans le second argument lors de l'initialisation de `QgsApplication`. Passer `True` au lieu de `False` pour indiquer que nous allons utiliser une interface graphique.

```
from qgis.core import *

# supply path to qgis install location
QgsApplication.setPrefixPath("/path/to/qgis/installation", True)

# create a reference to the QgsApplication
# setting the second argument to True enables the GUI, which we need
# to do since this is a custom application

qgs = QgsApplication([], True)

# load providers
qgs.initQgis()

# Write your code here to load some layers, use processing
# algorithms, etc.

# When your script is complete, call exitQgis() to remove the
```

```
# provider and layer registries from memory
qgs.exitQgis()
```

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

1.4.3 Exécuter des applications personnalisées

Vous devrez indiquer au système où trouver les librairies de QGIS et les modules Python appropriés s'ils ne sont pas à un emplacement connu — autrement, Python se plaindra:

```
>>> 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`**
- on macOS: **`export PYTHONPATH=/<qgispath>/Contents/Resources/python`**

The path to the PyQGIS modules is now known, however they depend on the `qgis_core` and `qgis_gui` libraries (the Python modules serve only as wrappers). The path to these libraries is typically unknown to 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.3.2.0: cannot open shared object file:
  No such file or directory
```

Corrigez ce problème en ajoutant les répertoires d'emplacement des bibliothèques QGIS au chemin de recherche de l'éditeur dynamique de liens:

- on Linux: **`export LD_LIBRARY_PATH=/<qgispath>/lib`**
- on Windows: **`set PATH=C:\<qgispath>\bin;C:\<qgispath>\apps\<qgisrelease>\bin; %PATH%`** where `<qgisrelease>` should be replaced with the type of release you are targeting (eg, `qgis-ltr`, `qgis`, `qgis-dev`)

Ces commandes peuvent être écrites dans un script de lancement qui gérera le démarrage. Lorsque vous déployez des applications personnalisées qui utilisent PyQGIS, il existe généralement deux possibilités:

- require the 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 the user to do more steps.
- Créer un paquet QGIS qui contiendra votre application. Publier l'application sera plus complexe et le paquet d'installation sera plus volumineux mais l'utilisateur n'aura pas à télécharger et à installer d'autres logiciels.

Les deux modèles de déploiement peuvent être mélangés: déployer une application autonome sous Windows et Mac OS et laisser l'installation de QGIS par l'utilisateur (via son gestionnaire de paquets) pour Linux.

1.5 Technical notes on PyQt and SIP

We've decided for Python as it's one of the most favoured languages for scripting. PyQGIS bindings in QGIS 3 depend on SIP and PyQt5. The reason for using SIP instead of more widely used SWIG is that the QGIS code depends on Qt libraries. Python bindings for Qt (PyQt) are also done using SIP and this allows seamless integration of PyQGIS with PyQt.

CHAPTER 2

Chargement de projets

Sometimes you need to load an existing project from a plugin or (more often) when developing a standalone QGIS Python application (see: *Applications Python*).

To load a project into the current QGIS application you need to create an instance of the `QgsProject` class. This is a singleton class, so you must use its `instance()` method to do it. You can call its `read()` method, passing the path of the project to be loaded:

```
# If you are not inside a QGIS console you first need to import
# qgis and PyQt classes you will use in this script as shown below:
from qgis.core import QgsProject
# 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())
'/home/user/projects/my_qgis_project.qgs'
# Load another project
project.read('/home/user/projects/my_other_qgis_project.qgs')
print(project.fileName())
'/home/user/projects/my_other_qgis_project.qgs'
```

If you need to make modifications to the project (for example to add or remove some layers) and save your changes, call the `write()` method of your project instance. The `write()` method also accepts an optional path for saving the project to a new location:

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

Both `read()` and `write()` functions return a boolean value that you can use to check if the operation was successful.

Note: If you are writing a QGIS standalone application, in order to synchronise the loaded project with the canvas you need to instantiate a `QgsLayerTreeMapCanvasBridge` as in the example below:

```
bridge = QgsLayerTreeMapCanvasBridge( \
         QgsProject.instance().layerTreeRoot(), canvas)
```

```
# Now you can safely load your project and see it in the canvas
project.read('/home/user/projects/my_other_qgis_project.qgs')
```

CHAPTER 3

Chargement de couches

The code snippets on this page needs the following imports:

```
import os # This is is needed in the pyqgis console also
from qgis.core import (
    QgsVectorLayer
)
```

- *Couches vectorielles*
- *Couches raster*
- *QgsProject instance*

Ouvrons donc quelques couches de données. QGIS reconnaît les couches vectorielles et raster. En plus, des types de couches personnalisés sont disponibles mais nous ne les aborderons pas ici.

3.1 Couches vectorielles

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

```
# get the path to the shapefile e.g. /home/project/data/ports.shp
path_to_ports_layer = os.path.join(QgsProject.instance().homePath(), "data", "ports
↪", "ports.shp")

# The format is:
# vlayer = QgsVectorLayer(data_source, layer_name, provider_name)

vlayer = QgsVectorLayer(path_to_ports_layer, "Ports layer", "ogr")
if not vlayer.isValid():
    print("Layer failed to load!")
```

L'identifiant de source de données est une chaîne de texte, spécifique à chaque type de fournisseur de données vectorielles. Le nom de la couche est utilisée dans le widget liste de couches. Il est important de vérifier si la couche a été chargée ou pas. Si ce n'était pas le cas, une instance de couche non valide est retournée.

For a geopackage vector layer:

```
# get the path to a geopackage  e.g. /home/project/data/data.gpkg
path_to_gpkg = os.path.join(QgsProject.instance().homePath(), "data", "data.gpkg")
# append the layername part
gpkg_places_layer = path_to_gpkg + "|layername=places"
# e.g. gpkg_places_layer = "/home/project/data/data.gpkg|layername=places"
vlayer = QgsVectorLayer(gpkg_places_layer, "Places layer", "ogr")
if not vlayer.isValid():
    print("Layer failed to load!")
```

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

```
vlayer = iface.addVectorLayer(path_to_ports_layer, "Ports layer", "ogr")
if not vlayer:
  print("Layer failed to load!")
```

This creates a new layer and adds it to the current QGIS project (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.

La liste suivante montre comment accéder à différentes sources de données provenant de différents fournisseurs de données vectorielles:

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

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

  - for dxf (note the internal options in data source uri):

    ```
    uri = "/path/to/dxffile/file.dxf|layername=entities|geometrytype=Point"
    vlayer = QgsVectorLayer(uri, "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(False), "layer name you like", "postgres")
  ```

  Note: L'argument `False` passé à `uri.uri(False)` empêche l'expansion des paramètres du système d'authentification. si vous n'avez pas configuré d'authentification, cet argument n'a aucun effet.

- 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 » for Y coordinate you would use something like this:

  ```
  uri = "/some/path/file.csv?delimiter={}&xField={}&yField={}".format(";", "x",
  ↪"y")
  vlayer = QgsVectorLayer(uri, "layer name you like", "delimitedtext")
  ```

  Note: Le fournisseur de chaîne est structuré comme une URL, donc le chemin doit être préfixé avec

`file://`. Il permet aussi d'utiliser les géométries formatées en WKT (well-known text) à la place des champs `x` et `y`, et permet de spécifier le système de référence géographique. Par exemple :

```
uri = "file:///some/path/file.csv?delimiter={}&crs=epsg:4723&wktField={}".
↪format(";", "shape")
```

- Fichiers GPS — le fournisseur de données « gpx » lit les trajets, routes et points de passage d'un fichier gpx. Pour ouvrir un fichier, le type (trajet/route/point) doit être fourni dans l'url :

```
uri = "path/to/gpx/file.gpx?type=track"
vlayer = QgsVectorLayer(uri, "layer name you like", "gpx")
```

- SpatiaLite database — 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')
```

- Géométries MySQL basées sur WKB, avec OGR — la source des données est la chaîne de connexion à la table :

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

- Connexion WFS : la connexion est définie par une URL et utilise le fournisseur de données `WFS`

```
uri = "http://localhost:8080/geoserver/wfs?srsname=EPSG:23030&typename=union&
↪version=1.0.0&request=GetFeature&service=WFS",
vlayer = QgsVectorLayer(uri, "my wfs layer", "WFS")
```

L'url peut être crée en utilisant la bibliothèque standard : « urllib »

```
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))
```

Note: You can change the data source of an existing layer by calling `setDataSource()` on a `QgsVectorLayer` instance, as in the following example:

```
# vlayer is a vector layer, uri is a QgsDataSourceUri instance
vlayer.setDataSource(uri.uri(), "layer name you like", "postgres")
```

3.2 Couches raster

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 filename and display name:

```
# get the path to a tif file  e.g. /home/project/data/srtm.tif
path_to_tif = os.path.join(QgsProject.instance().homePath(), "data", "srtm.tif")
rlayer = QgsRasterLayer(path_to_tif, "SRTM layer name")
if not rlayer.isValid():
    print("Layer failed to load!")
```

To load a raster from a geopackage:

```
# get the path to a geopackage  e.g. /home/project/data/data.gpkg
path_to_gpkg = os.path.join(QgsProject.instance().homePath(), "data", "data.gpkg")
# gpkg_raster_layer = "GPKG:/home/project/data/data.gpkg:srtm"
gpkg_raster_layer = "GPKG:" + path_to_gpkg + ":srtm"

rlayer = QgsRasterLayer(gpkg_raster_layer, "layer name you like", "gdal")

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` object:

```
iface.addRasterLayer("/path/to/raster/file.tif", "layer name you like")
```

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

Les couches raster peuvent également être créées à partir d'un service WCS.

```
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')
```

Here is a description of the parameters that the WCS URI can contain:

WCS URI is composed of **key=value** pairs separated by `&`. It is the same format like query string in URL, encoded the same way. `QgsDataSourceUri` should be used to construct the URI to ensure that special characters are encoded properly.

- **url** (required) : WCS Server URL. Do not use VERSION in URL, because each version of WCS is using different parameter name for **GetCapabilities** version, see param version.
- **identifier** (required) : Coverage name
- **time** (optional) : time position or time period (beginPosition/endPosition[/timeResolution])
- **format** (optional) : Supported format name. Default is the first supported format with tif in name or the first supported format.
- **crs** (optional) : CRS in form AUTHORITY:ID, e.g. EPSG:4326. Default is EPSG:4326 if supported or the first supported CRS.
- **username** (optional) : Username for basic authentication.
- **password** (optional) : Password for basic authentication.
- **IgnoreGetMapUrl** (optional, hack) : If specified (set to 1), ignore GetCoverage URL advertised by GetCapabilities. May be necessary if a server is not configured properly.

- **InvertAxisOrientation** (optional, hack) : If specified (set to 1), switch axis in GetCoverage request. May be necessary for geographic CRS if a server is using wrong axis order.
- **IgnoreAxisOrientation** (optional, hack) : If specified (set to 1), do not invert axis orientation according to WCS standard for geographic CRS.
- **cache** (optional) : cache load control, as described in QNetworkRequest::CacheLoadControl, but request is resend as PreferCache if failed with AlwaysCache. Allowed values: AlwaysCache, PreferCache, PreferNetwork, AlwaysNetwork. Default is AlwaysCache.

Vous pouvez aussi charger une couche raster à partir d'un serveur WMS. Il n'est cependant pas encore possible d'avoir accès à la réponse de GetCapabilities à partir de l'API — vous devez connaître les couches que vous voulez :

```
urlWithParams = 'url=http://irs.gis-lab.info/?layers=landsat&styles=&format=image/
↪jpeg&crs=EPSG:4326'
rlayer = QgsRasterLayer(urlWithParams, 'some layer name', 'wms')
if not rlayer.isValid():
  print("Layer failed to load!")
```

3.3 QgsProject instance

If you would like to use the opened layers for rendering, do not forget to add them to the `QgsProject` instance. The `QgsProject` instance 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 the project, it gets deleted, too. Layers can be removed by the user in the QGIS interface, or via Python using the `removeMapLayer()` method.

Adding a layer to the current project is done using the `addMapLayer()` method:

```
QgsProject.instance().addMapLayer(rlayer)
```

To add a layer at an absolute position:

```
# first add the layer without showing it
QgsProject.instance().addMapLayer(rlayer, False)
# obtain the layer tree of the top-level group in the project
layerTree = iface.layerTreeCanvasBridge().rootGroup()
# the position is a number starting from 0, with -1 an alias for the end
layerTree.insertChildNode(-1, QgsLayerTreeLayer(rlayer))
```

If you want to delete the layer use the `removeMapLayer()` method:

```
# QgsProject.instance().removeMapLayer(layer_id)
QgsProject.instance().removeMapLayer(rlayer.id())
```

In the above code, the layer id is passed (you can get it calling the `id()` method of the layer), but you can also pass the layer object itself.

For a list of loaded layers and layer ids, use the `mapLayers()` method:

```
QgsProject.instance().mapLayers()
```

CHAPTER 4

Utiliser des couches raster

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

The code snippets on this page needs the following imports if you're outside the pyqgis console:

```
from qgis.core import (
  QgsRasterLayer,
  QgsColorRampShader,
  QgsSingleBandPseudoColorRenderer
)
```

4.1 Détails d'une couche

A raster layer consists of one or more raster bands — it is referred to as either single band or multi band raster. One band represents a matrix of values. Usual color image (e.g. aerial photo) is a raster consisting of red, blue and green bands. Single band layers typically represent either continuous variables (e.g. elevation) or discrete variables (e.g. land use). In some cases, a raster layer comes with a palette and raster values refer to colors stored in the palette.

The following code assumes `rlayer` is a `QgsRasterLayer` object.

```
rlayer = QgsProject.instance().mapLayersByName('srtm')[0]
# get the resolution of the raster in layer unit
```

```
rlayer.width(), rlayer.height()
(919, 619)
# get the extent of the layer as QgsRectangle
rlayer.extent()
<QgsRectangle: 20.06856808199999875 -34.27001076999999896, 20.83945284300000012 -
↪33.75077500700000144>
# get the extent of the layer as Strings
rlayer.extent().toString()
'20.0685680819999988,-34.2700107699999990 : 20.8394528430000001,-33.
↪7507750070000014'
# get the raster type: 0 = GrayOrUndefined (single band), 1 = Palette (single␣
↪band), 2 = Multiband
rlayer.rasterType()
0
# get the total band count of the raster
rlayer.bandCount()
1
# get all the available metadata as a QgsLayerMetadata object
rlayer.metadata()
'<qgis._core.QgsLayerMetadata object at 0x13711d558>'
```

4.2 Moteur de rendu

Lorsqu'un raster est chargé, il récupère un moteur de rendu par défaut basé sur son type. Ce moteur peut être modifié dans les propriétés de la couche ou par programmation.

To query the current renderer:

```
rlayer.renderer()
<qgis._core.QgsSingleBandGrayRenderer object at 0x7f471c1da8a0>
rlayer.renderer().type()
'singlebandgray'
```

To set a renderer use `setRenderer()` method of `QgsRasterLayer`. There are several available renderer classes (derived from `QgsRasterRenderer`):

- `QgsMultiBandColorRenderer`
- `QgsPalettedRasterRenderer`
- `QgsSingleBandColorDataRenderer`
- `QgsSingleBandGrayRenderer`
- `QgsSingleBandPseudoColorRenderer`

Les couches rasters mono-bande peuvent être affichées soit en niveaux de gris (faibles valeurs: noir, valeurs hautes = blanc) ou avec un algorithme de pseudo-couleurs qui affecte des couleurs aux valeurs de la bande unique. Les rasters mono-bande avec une palette peut être affichés en utilisant leur palette. Les couches multi-bandes sont affichées en calquant les bandes sur les couleurs RGB. L'autre possibilité est d'utiliser juste une bande pour le niveau de gris ou la pseudo-coleur.

4.2.1 Rasters mono-bande

Let's say we want to render our raster layer (assuming one band only) with colors ranging from green to yellow (for pixel values from 0 to 255). In the first stage we will prepare a `QgsRasterShader` object and configure its shader function:

```
fcn = QgsColorRampShader()
fcn.setColorRampType(QgsColorRampShader.Interpolated)
```

```
lst = [ QgsColorRampShader.ColorRampItem(0, QColor(0,255,0)),
      QgsColorRampShader.ColorRampItem(255, QColor(255,255,0)) ]
fcn.setColorRampItemList(lst)
shader = QgsRasterShader()
shader.setRasterShaderFunction(fcn)
```

Le shader affecte les couleurs comme indiqué par sa rampe de couleur. La rampe de couleur est fournie sous forme d'une liste contenant la valeur de pixel avec sa couleur associée. Il existe trois modes d'interpolation des valeurs:

- linear (`Interpolated`): resulting color is linearly interpolated from the color map entries above and below the actual pixel value
- discrete (`Discrete`): color is used from the color map entry with equal or higher value
- exact (`Exact`): color is not interpolated, only the pixels with value equal to color map entries are drawn

In the second step we will associate this shader with the raster layer:

```
renderer = QgsSingleBandPseudoColorRenderer(rlayer.dataProvider(), 1, shader)
rlayer.setRenderer(renderer)
```

The number 1 in the code above is then band number (raster bands are indexed from one).

Finally we have to use the `triggerRepaint()` to see the results:

```
rlayer.triggerRepaint()
```

4.2.2 Rasters multi-bandes

By default, QGIS maps the first three bands to red, green and blue values to create a color image (this is the `MultiBandColor` drawing style. In some cases you might want to override these setting. The following code interchanges red band (1) and green band (2):

```
rlayer_multi = QgsProject.instance().mapLayersByName('multiband')[0]
rlayer_multi.renderer().setGreenBand(1)
rlayer_multi.renderer().setRedBand(2)
```

In case only one band is necessary for visualization of the raster, single band drawing can be chosen, either gray levels or pseudocolor.

As we did before, we have to use `triggerRepaint()` to update the map and see the results:

```
rlayer_multi.triggerRepaint()
```

4.3 Interrogation des données

The first method to query raster values is using the `sample()` method of the `QgsRasterDataProvider` class. You have to specify a `QgsPointXY` and the band number of the raster layer you want to query. The method returns a tuple with the value and `True` or `False` depending on the results:

```
val, res = rlayer.dataProvider().sample(QgsPointXY(20.50, -34), 1)
```

The second method is using the `identify()` method that returns a `QgsRasterIdentifyResult` object.

```
ident = rlayer.dataProvider().identify(QgsPointXY(20.5, -34), QgsRaster.
↪IdentifyFormatValue)

if ident.isValid():
  print(ident.results())
```

The `results()` method in this case returns a dictionary, with band indices as keys, and band values as values. For instance, something like `{1: 323.0}`

CHAPTER 5

Utilisation de couches vectorielles

Cette section résume les diverses actions possibles sur les couches vectorielles.

Most work here is based on the methods of the `QgsVectorLayer` class.

5.1 Récupérer les informations relatives aux attributs

You can retrieve information about the fields associated with a vector layer by calling `fields()` on a `QgsVectorLayer` object:

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

5.2 Itérer sur une couche vecteur

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.

```
layer = iface.activeLayer()
features = layer.getFeatures()

for feature in features:
    # retrieve every feature with its geometry and attributes
    print("Feature ID: ", feature.id())
    # fetch geometry
    # show some information about the feature geometry
    geom = feature.geometry()
    geomSingleType = QgsWkbTypes.isSingleType(geom.wkbType())
    if geom.type() == QgsWkbTypes.PointGeometry:
        # the geometry type can be of single or multi type
        if geomSingleType:
            x = geom.asPoint()
            print("Point: ", x)
        else:
            x = geom.asMultiPoint()
            print("MultiPoint: ", x)
    elif geom.type() == QgsWkbTypes.LineGeometry:
        if geomSingleType:
            x = geom.asPolyline()
            print("Line: ", x, "length: ", geom.length())
        else:
            x = geom.asMultiPolyline()
            print("MultiLine: ", x, "length: ", geom.length())
    elif geom.type() == QgsWkbTypes.PolygonGeometry:
        if geomSingleType:
            x = geom.asPolygon()
            print("Polygon: ", x, "Area: ", geom.area())
        else:
            x = geom.asMultiPolygon()
            print("MultiPolygon: ", x, "Area: ", geom.area())
    else:
```

```
        print("Unknown or invalid geometry")
    # fetch attributes
    attrs = feature.attributes()
    # attrs is a list. It contains all the attribute values of this feature
    print(attrs)
```

5.3 Sélection des entités

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 features are normally highlighted in a different color (default is yellow) to draw user's attention on the selection.

Sometimes it can be useful to programmatically select features or to change the default color.

To select all the features, the `selectAll()` method can be used:

```
# Get the active layer (must be a vector layer)
layer = iface.activeLayer()
layer.selectAll()
```

To select using an expression, use the `selectByExpression()` method:

```
# Assumes that the active layer is points.shp file from the QGIS test suite
# (Class (string) and Heading (number) are attributes in points.shp)
layer = iface.activeLayer()
layer.selectByExpression('"Class"=\'B52\' and "Heading" > 10 and "Heading" <70',␣
↪QgsVectorLayer.SetSelection)
```

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

```
selected_fid = []

# Get the first feature id from the layer
for feature in layer.getFeatures():
    selected_fid.append(feature.id())
    break

# Add these features to the selected list
layer.select(selected_fid)
```

To clear the selection:

```
layer.removeSelection()
```

5.3.1 Accès aux attributs

Attributes can be referred to by their name:

```
print(feature['name'])
```

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

```
print(feature[0])
```

5.3.2 Itérer sur une sélection d'entités

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

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

5.3.3 Itérer sur un sous-ensemble d'entités

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:

```
areaOfInterest = QgsRectangle(450290,400520, 450750,400780)

request = QgsFeatureRequest().setFilterRect(areaOfInterest)

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

For the sake of speed, the intersection is often done only using feature's bounding box. There is however a flag `ExactIntersect` that makes sure that only intersecting features will be returned:

```
request = QgsFeatureRequest().setFilterRect(areaOfInterest).
↪setFlags(QgsFeatureRequest.ExactIntersect)
```

With `setLimit()` you can limit the number of requested features. Here's an example:

```
request = QgsFeatureRequest()
request.setLimit(2)
for feature in layer.getFeatures(request):
    # loop through only 2 features
```

If you need an attribute-based filter instead (or in addition) of a spatial one like shown in the examples above, you can build a `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)
```

See *Expressions, Filtrage et Calcul de valeurs* for the details about the syntax supported by `QgsExpression`.

La requête peut être utilisée pour définir les données à récupérer de chaque entité, de manière à ce que l'itérateur ne retourne que des données partielles pour toutes les entités.

```
# Only return selected fields to increase the "speed" of the request
request.setSubsetOfAttributes([0,2])

# More user friendly version
request.setSubsetOfAttributes(['name','id'],layer.fields())

# Don't return geometry objects to increase the "speed" of the request
request.setFlags(QgsFeatureRequest.NoGeometry)

# Fetch only the feature with id 45
```

```
request.setFilterFid(45)

# The options may be chained
request.setFilterRect(areaOfInterest).setFlags(QgsFeatureRequest.NoGeometry).
↪setFilterFid(45).setSubsetOfAttributes([0,2])
```

5.4 Modifier des couches vecteur

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()
# Check if a particular capability is supported:
if caps & QgsVectorDataProvider.DeleteFeatures:
    print('The layer supports DeleteFeatures')
```

For a list of all available capabilities, please refer to the `API Documentation of QgsVectorDataProvider`.

To print layer's capabilities textual description in a comma separated list you can use `capabilitiesString()` as in the following example:

```
caps_string = layer.dataProvider().capabilitiesString()
# Print:
# 'Add Features, Delete Features, Change Attribute Values, Add Attributes,
# Delete Attributes, Rename Attributes, Fast Access to Features at ID,
# Presimplify Geometries, Presimplify Geometries with Validity Check,
# Transactions, Curved Geometries'
```

En utilisant l'une des méthodes qui suivent pour l'édition de couches vectorielles, les changements sont directement validés dans le dispositif de stockage d'informations sous-jacent (base de données, fichier, etc.). Si vous désirez uniquement faire des changements temporaires, passez à la section suivante qui explique comment réaliser des *modifications à l'aide d'un tampon d'édition*.

Note: Si vous travaillez dans QGIS (soit à partir de la console, soit à partir d'une extension), il peut être nécessaire de forcer la mise à jour du canevas de cartes pour pouvoir voir les changements que vous avez effectués aux géométries, au style ou aux attributs

```
# 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.triggerRepaint()
else:
    iface.mapCanvas().refresh()
```

5.4.1 Ajout d'Entités

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).

To set up the attributes of the feature, you can either initialize the feature passing a `QgsFields` object (you can obtain that from the `fields()` method of the vector layer) or call `initAttributes()` passing the number of fields you want to be added.

```
if caps & QgsVectorDataProvider.AddFeatures:
    feat = QgsFeature(layer.fields())
```

```
    feat.setAttributes([0, 'hello'])
    # Or set a single attribute by key or by index:
    feat.setAttribute('name', 'hello')
    feat.setAttribute(0, 'hello')
    feat.setGeometry(QgsGeometry.fromPointXY(QgsPointXY(123, 456)))
    (res, outFeats) = layer.dataProvider().addFeatures([feat])
```

5.4.2 Suppression d'Entités

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 Modifier des Entités

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.fromPointXY(QgsPointXY(111,222))
    layer.dataProvider().changeGeometryValues({ fid : geom })
```

Astuce: Favor QgsVectorLayerEditUtils class for geometry-only edits

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

5.4.4 Modifier des couches vecteur à l'aide d'un tampon d'édition

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 make 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 changes are commited, all changes from the editing buffer are saved to data provider.

The methods are similar to the ones we have seen in the provider, but they are called on the `QgsVectorLayer` object instead.

For these methods to work, the layer must be in editing mode. To start the editing mode, use the `startEditing()` method. To stop editing, use the `commitChanges()` or `rollBack()` methods. The first one will commit all your changes to the data source, while the second one will discard them and will not modify the data source at all.

To find out whether a layer is in editing mode, use the `isEditable()` method.

Here you have some examples that demonstrate how to use these editing methods.

```
from qgis.PyQt.QtCore import QVariant

# 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 a given value
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*.)

Here is how you can use the the undo functionality:

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

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

if problem_occurred:
  layer.destroyEditCommand()
  return

# ... more editing ...

layer.endEditCommand()
```

The `beginEditCommand()` method 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.

Vous pouvez également utiliser le: code: *with edit (layer)* -déclaration pour envelopper l'acceptation et l'annulation dans un bloc de code plus sémantique comme illustré dans l'exemple ci-dessous:

```
with edit(layer):
  feat = next(layer.getFeatures())
  feat[0] = 5
  layer.updateFeature(feat)
```

This will automatically call `commitChanges()` in the end. If any exception occurs, it will `rollBack()` all the changes. In case a problem is encountered within `commitChanges()` (when the method returns False) a `QgsEditError` exception will be raised.

5.4.5 Ajout et Suppression de Champs

Pour ajouter des champs (attributs) vous devez indiquer une liste de définitions de champs. Pour la suppression de champs, fournissez juste une liste des index des champs.

```
from qgis.PyQt.QtCore import QVariant

if caps & QgsVectorDataProvider.AddAttributes:
```

```
    res = layer.dataProvider().addAttributes(
        [QgsField("mytext", QVariant.String),
        QgsField("myint", QVariant.Int)])

if caps & QgsVectorDataProvider.DeleteAttributes:
    res = layer.dataProvider().deleteAttributes([0])
```

Après l'ajout ou la suppression de champs dans le pilote de données, les champs de la couche doivent être rafraîchis car les changements ne sont pas automatiquement propagés.

```
layer.updateFields()
```

Astuce: Directly save changes using `with` based command

Using `with edit(layer):` the changes will be commited automatically calling `commitChanges()` at the end. If any exception occurs, it will `rollBack()` all the changes. See *Modifier des couches vecteur à l'aide d'un tampon d'édition*.

5.5 Utilisation des index spatiaux

Les index spatiaux peuvent améliorer fortement les performances de votre code si vous réalisez de fréquentes requêtes sur une couche vecteur. Imaginez par exemple que vous écrivez un algorithme d'interpolation et que pour une position donnée, vous devez déterminer les 10 points les plus proches dans une couche de points, dans l'objectif d'utiliser ces points pour calculer une valeur interpolée. Sans index spatial, la seule méthode pour QGIS de trouver ces 10 points est de calculer la distance entre tous les points de la couche et l'endroit indiqué et de comparer ces distances entre-elles. Cela peut prendre beaucoup de temps spécialement si vous devez répeter l'opération sur plusieurs emplacements. Si index spatial existe pour la couche, l'opération est bien plus efficace.

Vous pouvez vous représenter une couche sans index spatial comme un annuaire dans lequel les numéros de téléphone ne sont pas ordonnés ou indexés. Le seul moyen de trouver le numéro de téléphone d'une personne est de lire l'annuaire en commençant du début jusqu'à ce que vous le trouviez.

Les index spatiaux ne sont pas créés par défaut pour une couche vectorielle QGIS, mais vous pouvez les créer facilement. C'est ce que vous devez faire:

- create spatial index using the `QgsSpatialIndex()` class:

  ```
  index = QgsSpatialIndex()
  ```

- 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 a previous call to provider's `nextFeature()`

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

- Alternativement, vous pouvez charger toutes les entités de la couche en une fois en utilisant un chargement en volume.

  ```
  index = QgsSpatialIndex(layer.getFeatures())
  ```

- Une fois que l'index est rempli avec des valeurs, vous pouvez lancer vos requêtes:

  ```
  # returns array of feature IDs of five nearest features
  nearest = index.nearestNeighbor(QgsPointXY(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))
  ```

5.6 Creating Vector Layers

There are several ways to generate a vector layer dataset:

- the `QgsVectorFileWriter` class: A convenient class for writing vector files to disk, using either a static call to `writeAsVectorFormat()` which saves the whole vector layer or creating an instance of the class and issue calls to `addFeature()`. This class supports all the vector formats that OGR supports (GeoPackage, Shapefile, GeoJSON, KML and others).
- the `QgsVectorLayer` class: instantiates a data provider that interprets the supplied path (url) of the data source to connect to and access the data. It can be used to create temporary, memory-based layers (`memory`) and connect to OGR datasets (`ogr`), databases (`postgres`, `spatialite`, `mysql`, `mssql`) and more (`wfs`, `gpx`, `delimitedtext`...).

5.6.1 From an instance of `QgsVectorFileWriter`

```
error = QgsVectorFileWriter.writeAsVectorFormat(layer, "my_data", "UTF-8")
if error[0] == QgsVectorFileWriter.NoError:
    print("success!")

error = QgsVectorFileWriter.writeAsVectorFormat(layer, "my_json", "UTF-8", ␣
↪driverName="GeoJSON")
if error[0] == QgsVectorFileWriter.NoError:
    print("success again!")
```

The third parameter specifies output text encoding. Only some drivers need this for correct operation (Shapefile is one of those), but if 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 the destination CRS — if a valid instance of `QgsCoordinateReferenceSystem` is passed, the layer is transformed to that CRS.

Consultez les formats gérés par OGR pour trouver les noms de pilote valides. Vous devez indiquer la valeur dans la colonne » Code « comme nom du pilote. En option, vous pouvez définir si vous souhaitez exporter uniquement les fonctions sélectionnées, transmettre d'autres options spécifiques au pilote pour la création ou indiquer à l'auteur de ne pas créer d'attributs. Consultez la documentation pour connaître la syntaxe complète.

5.6.2 Directly from features

```
from qgis.PyQt.QtCore import QVariant

# define fields for feature attributes. A QgsFields object is needed
fields = QgsFields()
fields.append(QgsField("first", QVariant.Int))
fields.append(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", "UTF-8", fields, QgsWkbTypes.Point, ␣
↪driverName="ESRI Shapefile")

if writer.hasError() != QgsVectorFileWriter.NoError:
```

```
    print("Error when creating shapefile: ",  w.errorMessage())

# add a feature
fet = QgsFeature()

fet.setGeometry(QgsGeometry.fromPointXY(QgsPointXY(10,10)))
fet.setAttributes([1, "text"])
writer.addFeature(fet)

# delete the writer to flush features to disk
del writer
```

5.6.3 From an instance of `QgsVectorLayer`

Among all the data providers supported by the `QgsVectorLayer` class, let's focus on the memory-based layers. 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.

Le fournisseur gère les champs en chaînes de caractères, en entiers et en réels.

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.

Le constructeur utilise également une URI qui définit le type de géométrie de la couche parmi: `"Point"`, `"LineString"`, `"Polygon"`, `"MultiPoint"`, `"MultiLineString"`, ou `"MultiPolygon"`.

L'URI peut également indiquer un système de coordonnée de référence, des champs et l'indexation. La syntaxe est la suivante:

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

index=yes Spécifie que le fournisseur utilisera un index spatial

field=nom:type(longueur,précision) Spécifie un attribut de la couche. L'attribut dispose d'un nom et optionnellement d'un type (integer, double ou string), d'une longueur et d'une précision. Il peut y avoir plusieurs définitions de champs.

L'exemple suivant montre une URI intégrant toutes ces options

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

L'exemple suivant illustre la création et le remplissage d'un fournisseur de données en mémoire

```
from qgis.PyQt.QtCore import QVariant

# 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.fromPointXY(QgsPointXY(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()
```

Finalement, vérifions que tout s'est bien déroulé

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

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

5.7 Apparence (Symbologie) des couches vecteur

Lorsqu'une couche vecteur est en cours de rendu, l'apparence des données est assurée par un **moteur de rendu** et des **symboles** associés à la couche. Les symboles sont des classes qui gèrent le dessin de la représentation visuelle des entités alors que les moteurs de rendu déterminent quel symbole doit être utilisé pour une entité particulière.

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

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

Munis de cette référence, faisons un peu d'exploration:

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

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

Type	Classe	Description
singleSymbol	QgsSingleSymbolRenderer	Affiche toutes les entités avec le même symbole.
categorizedSymbol	QgsCategorizedSymbolRenderer	Affiche les entités en utilisant un symbole différent pour chaque catégorie.
graduatedSymbol	QgsGraduatedSymbolRenderer	Affiche les entités en utilisant un symbole différent pour chaque plage de valeurs.

There might be also some custom renderer types, so never make an assumption there are just these types. You can query the application's QgsRendererRegistry to find out currently available renderers:

```
print(QgsApplication.rendererRegistry().renderersList())
# Print:
['nullSymbol',
'singleSymbol',
'categorizedSymbol',
'graduatedSymbol',
'RuleRenderer',
```

```
'pointDisplacement',
'pointCluster',
'invertedPolygonRenderer',
'heatmapRenderer',
'25dRenderer']
```

Il est possible d'obtenir un extrait du contenu d'un moteur de rendu sous forme de texte, ce qui peut être utile lors du débogage:

```
print(renderer.dump())
```

5.7.1 Moteur de rendu à symbole unique

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 `QgsMarkerSymbol`, `QgsLineSymbol` and `QgsFillSymbol`.

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

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

```
symbol = QgsMarkerSymbol.createSimple({'name': 'square', 'color': 'red'})
layer.renderer().setSymbol(symbol)
# show the change
layer.triggerRepaint()
```

`name` indique la forme du marqueur, et peut être l'une des valeurs suivantes :

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

To get the full list of properties for the first symbol layer of a symbol instance you can follow the example code:

```
print(layer.renderer().symbol().symbolLayers()[0].properties())
# Prints
{'angle': '0',
'color': '0,128,0,255',
'horizontal_anchor_point': '1',
```

```
'joinstyle': 'bevel',
'name': 'circle',
'offset': '0,0',
'offset_map_unit_scale': '0,0',
'offset_unit': 'MM',
'outline_color': '0,0,0,255',
'outline_style': 'solid',
'outline_width': '0',
'outline_width_map_unit_scale': '0,0',
'outline_width_unit': 'MM',
'scale_method': 'area',
'size': '2',
'size_map_unit_scale': '0,0',
'size_unit': 'MM',
'vertical_anchor_point': '1'}
```

Cela peut être utile si vous souhaitez modifier certaines propriétés:

```
# You can alter a single property...
layer.renderer().symbol().symbolLayer(0).setSize(3)
# ... but not all properties are accessible from methods,
# you can also replace the symbol completely:
props = layer.renderer().symbol().symbolLayer(0).properties()
props['color'] = 'yellow'
props['name'] = 'square'
layer.renderer().setSymbol(QgsMarkerSymbol.createSimple(props))
# show the changes
layer.triggerRepaint()
```

5.7.2 Moteur de rendu à symboles catégorisés

When using a categorized renderer, you can query and set the attribute that is used for classification: use the `classAttribute()` and `setClassAttribute()` methods.

Pour obtenir la liste des catégories

```
for cat in renderer.categories():
    print("{}: {} :: {}".format(cat.value(), cat.label(), cat.symbol()))
```

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

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

5.7.3 Moteur de rendu à symboles gradués

Ce moteur de rendu est très similaire au moteur de rendu par symbole catégorisé ci-dessus mais au lieu d'utiliser une seule valeur d'attribut par classe, il utilise une classification par plages de valeurs et peut donc être employé uniquement sur des attributs numériques.

Pour avoir plus d'informations sur les plages utilisées par le moteur de rendu:

```
for ran in renderer.ranges():
    print("{} - {}: {} {}".format(
        ran.lowerValue(),
        ran.upperValue(),
        ran.label(),
        ran.symbol()
      ))
```

Vous pouvez à nouveau utiliser `classAttribute()` pour trouver le nom de l'attribut de classification ainsi que les méthodes `sourceSymbol()` et `sourceColorRamp()`. Il existe en plus une méthode `mode()` qui permet de déterminer comment les classes ont été créées: en utilisant des intervalles égaux, des quantiles ou tout autre méthode.

Si vous souhaitez créer votre propre moteur de rendu gradué, vous pouvez utiliser l'extrait de code qui est présenté dans l'exemple ci-dessous (qui créé simplement un arrangement en deux classes):

```
from qgis.PyQt import QtGui

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 = QgsSymbol.defaultSymbol(myVectorLayer.geometryType())
mySymbol1.setColor(myColour)
mySymbol1.setOpacity(myOpacity)
myRange1 = QgsRendererRange(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 = QgsSymbol.defaultSymbol(
     myVectorLayer.geometryType())
mySymbol2.setColor(myColour)
mySymbol2.setOpacity(myOpacity)
myRange2 = QgsRendererRange(myMin, myMax, mySymbol2, myLabel)
myRangeList.append(myRange2)
myRenderer = QgsGraduatedSymbolRenderer('', myRangeList)
myRenderer.setMode(QgsGraduatedSymbolRenderer.EqualInterval)
myRenderer.setClassAttribute(myTargetField)

myVectorLayer.setRenderer(myRenderer)
QgsProject.instance().addMapLayer(myVectorLayer)
```

5.7.4 Travailler avec les symboles

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

- `QgsMarkerSymbol` — for point features
- `QgsLineSymbol` — for line features
- `QgsFillSymbol` — for polygon features

Every symbol consists of one or more symbol layers (classes derived from `QgsSymbolLayer`). 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 range(symbol.symbolLayerCount()):
    lyr = symbol.symbolLayer(i)
    print("{}: {}".format(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.

La taille et la largeur sont exprimées en millimètres par défaut, les angles sont en degrés.

Travailler avec des couches de symboles

As said before, symbol layers (subclasses of `QgsSymbolLayer`) 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 with the following code:

```
from qgis.core import QgsSymbolLayerRegistry
myRegistry = QgsApplication.symbolLayerRegistry()
myMetadata = myRegistry.symbolLayerMetadata("SimpleFill")
for item in myRegistry.symbolLayersForType(QgsSymbol.Marker):
    print(item)
```

Output:

```
EllipseMarker
FilledMarker
FontMarker
GeometryGenerator
SimpleMarker
SvgMarker
VectorField
```

`QgsSymbolLayerRegistry` 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.

Créer des types personnalisés de couches de symbole

Imaginons que vous souhaitez personnaliser la manière dont sont affichées les données. Vous pouvez créer votre propre classe de couche de symbole qui dessinera les entités de la manière voulue. Voici un exemple de marqueur qui dessine des cercles rouges avec un rayon spécifique.

```
from qgis.core import QgsMarkerSymbolLayer
from qgis.PyQt.QtGui import QColor

class FooSymbolLayer(QgsMarkerSymbolLayer):

  def __init__(self, radius=4.0):
      QgsMarkerSymbolLayer.__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, while `renderPolygon` receives list of points on outer ring as a first parameter and a list of inner rings (or None) as a second parameter.

En général, il est pratique d'ajouter une interface graphique pour paramétrer les attributs des couches de symbole pour permettre aux utilisateurs de personnaliser l'apparence. Dans le cadre de notre exemple ci-dessus, nous laissons l'utilisateur paramétrer le rayon du cercle. Le code qui suit implémente une telle interface:

```
from qgis.gui import QgsSymbolLayerWidget

class FooSymbolLayerWidget(QgsSymbolLayerWidget):
    def __init__(self, parent=None):
        QgsSymbolLayerWidget.__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()"))
```

Cette interface peut être incorporée dans la boîte de dialogue sur les propriétés de symbole. Lorsque le type couche de symbole est sélectionné dans la boîte de dialogue des propriétés de symbole, cela créé une instance de la couche de symbole et une instance de l'interface. Ensuite, la méthode `setSymbolLayer()` est appelée pour affecter la couche de symbole à l'interface. Dans cette méthode, l'interface doit rafraîchir l'environnement graphique pour afficher les attributs de la couche de symbole. La fonction `symbolLayer()` est utilisée pour retrouver la couche de symbole des propriétés de la boîte de dialogue afin de l'utiliser pour le symbole.

A chaque changement d'attributs, l'interface doit émettre le signal `changed()` pour laisser les propriétés de la boîte de dialogue mettre à jour l'aperçu de sumbole.

Maintenant, il nous manque un dernier détail: informer QGIS de ces nouvelles classes. On peut le faire en ajoutant la couche de symbole au registre. Il est possible d'utiliser la couche de symbole sans l'ajouter au registre mais certaines fonctionnalités ne fonctionneront pas comme le chargement de fichiers de projet avec une couche de symbole personnalisée ou l'impossibilité d'éditer les attributs de la couche dans l'interface graphique.

Nous devons ensuite créer les métadonnées de la couche de symbole.

```
from qgis.core import QgsSymbol, QgsSymbolLayerAbstractMetadata,␣
↪QgsSymbolLayerRegistry

class FooSymbolLayerMetadata(QgsSymbolLayerAbstractMetadata):

  def __init__(self):
    QgsSymbolLayerAbstractMetadata.__init__(self, "FooMarker", QgsSymbol.Marker)

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

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

QgsApplication.symbolLayerRegistry().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. And there is `createSymbolLayerWidget()` method which returns settings widget for this symbol layer type.

La dernière étape consiste à ajouter la couche de symbole au registre et c'est terminé !

5.7.5 Créer ses propres moteurs de rendu

Il est parfois intéressant de créer une nouvelle implémentation de moteur de rendu si vous désirez personnaliser les règles de sélection des symboles utilisés pour l'affichage des entités. Voici quelques exemples d'utilisation: le symbole est déterminé par une combinaison de champs, la taille des symboles change selon l'échelle courante, etc.

Le code qui suit montre un moteur de rendu personnalisé simple qui crée deux symboles de marqueur et choisit au hasard l'un d'entre eux pour chaque entité.

```
import random
from qgis.core import QgsWkbTypes, QgsSymbol, QgsFeatureRenderer


class RandomRenderer(QgsFeatureRenderer):
  def __init__(self, syms=None):
    QgsFeatureRenderer.__init__(self, "RandomRenderer")
    self.syms = syms if syms else [QgsSymbol.defaultSymbol(QgsWkbTypes.
↪geometryType(QgsWkbTypes.Point))]
```

```
  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)

from qgis.gui import QgsRendererWidget
class RandomRendererWidget(QgsRendererWidget):
  def __init__(self, layer, style, renderer):
    QgsRendererWidget.__init__(self, layer, style)
    if renderer is None or renderer.type() != "RandomRenderer":
      self.r = RandomRenderer()
    else:
      self.r = renderer
    # setup UI
    self.btn1 = QgsColorButton()
    self.btn1.setColor(self.r.syms[0].color())
    self.vbox = QVBoxLayout()
    self.vbox.addWidget(self.btn1)
    self.setLayout(self.vbox)
    self.btn1.clicked.connect(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 of parent `QgsFeatureRenderer` class needs a renderer name (which has to be unique among renderers). The `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. The `usedAttributes()` method can return a list of field names that renderer expects to be present. Finally, the `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 `QgsRendererWidget`. The following sample code creates a button that allows user to set symbol of the first symbol

```
from qgis.gui import QgsRendererWidget, QgsColorButton

class RandomRendererWidget(QgsRendererWidget):
  def __init__(self, layer, style, renderer):
    QgsRendererWidget.__init__(self, layer, style)
    if renderer is None or renderer.type() != "RandomRenderer":
      self.r = RandomRenderer()
    else:
      self.r = renderer
```

```
    # setup UI
    self.btn1 = QgsColorButton()
    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 (`QgsStyle`) 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.

Le dernier élément qui manque concerne les métadonnées du moteur ainsi que son enregistrement dans le registre. Sans ces éléments, le chargement de couches avec le moteur de rendu ne sera pas possible et l'utilisateur ne pourra pas le sélectionner dans la liste des moteurs de rendus. Finissons notre exemple sur RandomRenderer:

```
from qgis.core import QgsRendererAbstractMetadata,QgsRendererRegistry,
↪QgsApplication

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

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

QgsApplication.rendererRegistry().addRenderer(RandomRendererMetadata())
```

De la même manière que pour les couches de symbole, le constructeur des métadonnées attend le nom du moteur de rendu, le nom visible pour les utilisateurs et optionnellement le nom des icônes du moteur de rendu. La méthode `createRenderer()` fait passer une instance de `QDomElement` qui peut être utilisée pour restaurer l'état du moteur de rendu en utilisant un arbre DOM. La méthode `createRendererWidget()` créé l'interface graphique de configuration. Elle n'est pas obligatoire et peut renvoyer *None* si le moteur de rendu n'a pas d'interface graphique.

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

```
QgsRendererAbstractMetadata.__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 (PyQt5 includes .qrc compiler for Python).

5.8 Sujets complémentaires

A FAIRE :

- création/modification des symboles
- working with style (`QgsStyle`)
- working with color ramps (`QgsColorRamp`)
- Explorer les couches de symboles et les registres de rendus

CHAPTER 6

Manipulation de la géométrie

The code snippets on this page need the following imports if you're outside the pyqgis console:

```
from qgis.core import (
  QgsGeometry,
  QgsPoint,
  QgsPointXY,
  QgsWkbTypes,
  QgsProject,
  QgsFeatureRequest,
  QgsDistanceArea
)
```

Points, linestrings and polygons that represent a spatial feature are commonly referred to as geometries. In QGIS they are represented with the `QgsGeometry` class.

Parfois, une entité correspond à une collection d'éléments géométriques simples (d'un seul tenant). Une telle géométrie est appelée multi-parties. Si elle ne contient qu'un seul type de géométrie, il s'agit de multi-points, de multi-lignes ou de multi-polygones. Par exemple, un pays constitué de plusieurs îles peut être représenté par un multi-polygone.

Les coordonnées des géométries peuvent être dans n'importe quel système de coordonnées de référence (SCR). Lorsqu'on accède aux entités d'une couche, les géométries correspondantes auront leurs coordonnées dans le SCR de la couche.

Description and specifications of all possible geometries construction and relationships are available in the OGC Simple Feature Access Standards for advanced details.

6.1 Construction de géométrie

PyQGIS provides several options for creating a geometry:

- à partir des coordonnées

```
gPnt = QgsGeometry.fromPointXY(QgsPointXY(1,1))
gLine = QgsGeometry.fromPolyline([QgsPoint(1, 1), QgsPoint(2, 2)])
gPolygon = QgsGeometry.fromPolygonXY([[QgsPointXY(1, 1),
    QgsPointXY(2, 2), QgsPointXY(2, 1)]])
```

  Coordinates are given using `QgsPoint` class or `QgsPointXY` class. The difference between these classes is that `QgsPoint` supports M and Z dimensions.

  A Polyline (Linestring) is represented by a list of points.

  A Polygon is represented by a list of linear rings (i.e. closed linestrings). The first ring is the outer ring (boundary), optional subsequent rings are holes in the polygon. Note that unlike some programs, QGIS will close the ring for you so there is no need to duplicate the first point as the last.

  Les géométries multi-parties sont d'un niveau plus complexe: les multipoints sont une succession de points, les multilignes une succession de lignes et les multipolygones une succession de polygones.

- depuis un Well-Known-Text (WKT)

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

- depuis un Well-Known-Binary (WKB)

```
g = QgsGeometry()
wkb = bytes.fromhex("010100000000000000000045400000000000001440")
g.fromWkb(wkb)

# print WKT representation of the geometry
print(g.asWkt())
```

6.2 Accéder à la Géométrie

First, you should find out the geometry type. The `wkbType()` method is the one to use. It returns a value from the `QgsWkbTypes.Type` enumeration.

```
gPnt.wkbType() == QgsWkbTypes.Point
# output: True
gLine.wkbType() == QgsWkbTypes.LineString
# output: True
gPolygon.wkbType() == QgsWkbTypes.Polygon
# output: True
gPolygon.wkbType() == QgsWkbTypes.MultiPolygon
# output: False
```

As an alternative, one can use the `type()` method which returns a value from the `QgsWkbTypes.GeometryType` enumeration.

You can use the `displayString()` function to get a human readable geometry type.

```
gPnt.wkbType()
# output: 1
QgsWkbTypes.displayString(gPnt.wkbType())
# output: 'Point'
```

There is also a helper function `isMultipart()` to find out whether a geometry is multipart or not.

To extract information from a geometry there are accessor functions for every vector type. Here's an example on how to use these accessors:

```
gPnt.asPoint()
# output: <QgsPointXY: POINT(1 1)>
gLine.asPolyline()
# output: [<QgsPointXY: POINT(1 1)>, <QgsPointXY: POINT(2 2)>]
gPolygon.asPolygon()
# output: [[<QgsPointXY: POINT(1 1)>, <QgsPointXY: POINT(2 2)>, <QgsPointXY:␣
↪POINT(2 1)>, <QgsPointXY: POINT(1 1)>]]
```

Note: The tuples (x,y) are not real tuples, they are `QgsPoint` objects, the values are accessible with `x()` and `y()` methods.

For multipart geometries there are similar accessor functions: `asMultiPoint()`, `asMultiPolyline()` and `asMultiPolygon()`.

6.3 Prédicats et opérations géométriques

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

Let's see an example that combines iterating over the features in a given layer and performing some geometric computations based on their geometries. The below code will compute and print the area and perimeter of each country in the `countries` layer within our tutorial QGIS project.

The following code assumes `layer` is a `QgsVectorLayer` object that has Polygon feature type.

```
# let's access the 'countries' layer
layer = QgsProject.instance().mapLayersByName('countries')[0]

# let's filter for countries that begin with Z, then get their features
query = '"name" LIKE \'Z%\''
features = layer.getFeatures(QgsFeatureRequest().setFilterExpression(query))

# now loop through the features, perform geometry computation and print the results
for f in features:
  geom = f.geometry()
  name = f.attribute('NAME')
  print(name)
  print('Area: ', geom.area())
  print('Perimeter: ', geom.length())
```

Now you have calculated and printed the areas and perimeters of the geometries. You may however quickly notice that the values are strange. That is because areas and perimeters don't take CRS into account when computed using the `area()` and `length()` methods from the `QgsGeometry` class. For a more powerful area and distance calculation, the `QgsDistanceArea` class can be used, which can perform ellipsoid based calculations:

The following code assumes `layer` is a `QgsVectorLayer` object that has Polygon feature type.

```
d = QgsDistanceArea()
d.setEllipsoid('WGS84')

layer = QgsProject.instance().mapLayersByName('countries')[0]

# let's filter for countries that begin with Z, then get their features
query = '"name" LIKE \'Z%\''
features = layer.getFeatures(QgsFeatureRequest().setFilterExpression(query))

for f in features:
  geom = f.geometry()
```

```
  name = f.attribute('NAME')
  print(name)
  print("Perimeter (m):", d.measurePerimeter(geom))
  print("Area (m2):", d.measureArea(geom))

  # let's calculate and print the area again, but this time in square kilometers
  print("Area (km2):", d.convertAreaMeasurement(d.measureArea(geom), QgsUnitTypes.
↪AreaSquareKilometers))
```

Alternatively, you may want to know the distance and bearing between two points.

```
d = QgsDistanceArea()
d.setEllipsoid('WGS84')

# Let's create two points.
# Santa claus is a workaholic and needs a summer break,
# lets see how far is Tenerife from his home
santa = QgsPointXY(25.847899, 66.543456)
tenerife = QgsPointXY(-16.5735, 28.0443)

print("Distance in meters: ", d.measureLine(santa, tenerife))
```

Vous trouverez de nombreux exemples d'algorithmes inclus dans QGIS et utiliser ces méthodes pour analyser et modifier les données vectorielles. Voici des liens vers le code de quelques-uns.

- Distance and area using the `QgsDistanceArea` class: Distance matrix algorithm
- Lines to polygons algorithm

CHAPTER 7

Support de projections

If you're outside the pyqgis console, the code snippets on this page need the following imports:

```
from qgis.core import (QgsCoordinateReferenceSystem,
                       QgsCoordinateTransform,
                       QgsProject,
                       QgsPointXY,
                       )
```

7.1 Système de coordonnées de référence

Coordinate reference systems (CRS) are encapsulated by the `QgsCoordinateReferenceSystem` class. Instances of this class can be created in several different ways:

- spécifier le SCR par son ID

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

  QGIS utilise trois identifiants différents pour chaque système de référence:

  - `PostgisCrsId` — Identifiants utilisés dans les bases de données PostGIS.
  - `InternalCrsId` — Identifiants utilisés dans la base de données QGIS.
  - `EpsgCrsId` — Identifiants définis par l'organisation EPSG.

  Sauf indication contraire dans le deuxième paramètre, le SRID de PostGIS est utilisé par défaut.

- spécifier le SCR par son 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)
assert crs.isValid()
```

- create invalid CRS and then use one of the `create*()` functions to initialize it. In the following example we use Proj4 string to initialize the projection

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

It's wise to check whether creation (i.e. lookup in the database) of the CRS has been successful: `isValid()` must return `True`.

Note that for initialization of spatial reference systems QGIS needs to look up appropriate values in its internal database `srs.db`. Thus in case you create an independent application you need to set paths correctly with `QgsApplication.setPrefixPath()` otherwise it will fail to find the database. If you are running the commands from QGIS python console or developing a plugin you do not care: everything is already set up for you.

Accessing spatial reference system information:

```
crs = QgsCoordinateReferenceSystem(4326)

print("QGIS CRS ID:", crs.srsid())
print("PostGIS SRID:", crs.postgisSrid())
print("Description:", crs.description())
print("Projection Acronym:", crs.projectionAcronym())
print("Ellipsoid Acronym:", crs.ellipsoidAcronym())
print("Proj4 String:", crs.toProj4())
# check whether it's geographic or projected coordinate system
print("Is geographic:", crs.isGeographic())
# check type of map units in this CRS (values defined in QGis::units enum)
print("Map units:", crs.mapUnits())
```

Output:

```
QGIS CRS ID: 3452
PostGIS SRID: 4326
Description: WGS 84
Projection Acronym: longlat
Ellipsoid Acronym: WGS84
Proj4 String: +proj=longlat +datum=WGS84 +no_defs
Is geographic: True
Map units: 6
```

7.2 CRS Transformation

You can do transformation between different spatial reference systems by using the `QgsCoordinateTransform` class. The easiest way to use it is to create a source and destination CRS and construct a `QgsCoordinateTransform` instance with them and the current project. Then just repeatedly call `transform()` function to do the transformation. By default it does forward transformation, but it is capable to do also inverse transformation.

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

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

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

Output:

```
Transformed point: <QgsPointXY: POINT(832713.79873844375833869 553423.
↪98688333143945783)>
Transformed back: <QgsPointXY: POINT(18 5)>
```

CHAPTER 8

Using the Map Canvas

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

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 always shows 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.

The map canvas is implemented with the `QgsMapCanvas` class in the `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 read the overview of the framework.

Whenever the map has been panned, zoomed in/out (or some other action that triggers a refresh), the map is rendered again within the current extent. The layers are rendered to an image (using the `QgsMapRendererJob` class) and that image is displayed on the canvas. The `QgsMapCanvas` 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 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.

Pour résumer, l'architecture du canevas de carte repose sur trois concepts:

- le canevas de carte — pour visualiser la carte
- map canvas items — additional items that can be displayed on the map canvas
- map tools — for interaction with the map canvas

8.1 Intégrer un canevas de carte

Le canevas de carte est un objet comme tous les autres objets Qt, on peut donc l'utiliser simplement en le créant et en l'affichant:

```
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 `pyuic5` 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.

Par défaut, le canevas de carte a un arrière-plan noir et n'utilise pas l'anticrénelage. Pour afficher un arrière-plan blanc et activer l'anticrénelage pour un rendu plus lisse:

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

(In case you are wondering, `Qt` comes from `PyQt.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 current project. Then we will set the canvas extent and set the list of layers for canvas

```
path_to_ports_layer = os.path.join(QgsProject.instance().homePath(), "data", "ports
↪", "ports.shp")

vlayer = QgsVectorLayer(path_to_ports_layer, "Ports layer", "ogr")
if not vlayer.isValid():
    print("Layer failed to load!")

# add layer to the registry
QgsProject.instance().addMapLayer(vlayer)

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

# set the map canvas layer set
canvas.setLayers([vlayer])
```

Après exécution de ces commandes, le canevas de carte devrait afficher la couche chargée.

8.2 Contour d'édition et symboles de sommets

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.

Pour afficher une polyligne:

```
r = QgsRubberBand(canvas, False)  # False = not a polygon
points = [QgsPoint(-100, 45), QgsPoint(10, 60), QgsPoint(120, 45)]
r.setToGeometry(QgsGeometry.fromPolyline(points), None)
```

Pour afficher un polygone:

```
r = QgsRubberBand(canvas, True)  # True = a polygon
points = [[QgsPointXY(-100, 35), QgsPointXY(10, 50), QgsPointXY(120, 35)]]
r.setToGeometry(QgsGeometry.fromPolygonXY(points), None)
```

Veuillez noter que les points d'un polygone ne sont pas stockés dans une liste. En fait, il s'agit d'une liste d'anneaux contenants les anneaux linéaires du polygones: le premier anneau est la limite extérieure, les autres (optionnels) anneaux correspondent aux trous dans le polygone.

Les contours d'édition peut être personnalisés pour changer leur couleur ou la taille de la ligne:

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

The canvas items are bound to the canvas scene. To temporarily hide them (and show them 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)
```

(en C++, il est possible de juste supprimer l'objet mais sous Python `del r` détruira juste la référence et l'objet existera toujours étant donné qu'il appartient au canevas).

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

You can use the vertex marker like this:

```
m = QgsVertexMarker(canvas)
m.setCenter(QgsPointXY(10,40))
```

This will draw a red cross on position **[10,45]**. 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, use the same methods as for rubber bands.

8.3 Utiliser les outils cartographiques avec le canevas

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 qgis.PyQt.QtWidgets import QAction, QMainWindow
from qgis.PyQt.QtCore import Qt

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.setLayers([layer])

        self.setCentralWidget(self.canvas)

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

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

        self.actionZoomIn.triggered.connect(self.zoomIn)
        self.actionZoomOut.triggered.connect(self.zoomOut)
        self.actionPan.triggered.connect(self.pan)

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

        # create the map tools
        self.toolPan = QgsMapToolPan(self.canvas)
        self.toolPan.setAction(self.actionPan)
        self.toolZoomIn = QgsMapToolZoom(self.canvas, False) # false = in
        self.toolZoomIn.setAction(self.actionZoomIn)
        self.toolZoomOut = QgsMapToolZoom(self.canvas, True) # true = out
        self.toolZoomOut.setAction(self.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 try the above code in the Python console editor. To invoke the canvas window, add the following lines to instantiate the `MyWnd` class. They will render the currently selected layer on the newly created canvas

```
w = MyWnd(iface.activeLayer())
w.show()
```

8.4 Ecrire des outils cartographiques personnalisés

You can write your custom tools, to implement a custom behavior 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.

Voici un exemple d'outil cartographique qui permet de définir une emprise rectangulaire en cliquant et en déplaçant

la souris sur le canevas. Lorsque le rectangle est dessiné, il exporte les coordonnées de ses limites dans la console. On utilise des éléments de contour d'édition décrits auparavant pour afficher le rectangle sélectionné au fur et à mesure de son dessin.

```
class RectangleMapTool(QgsMapToolEmitPoint):
  def __init__(self, canvas):
      self.canvas = canvas
      QgsMapToolEmitPoint.__init__(self, self.canvas)
      self.rubberBand = QgsRubberBand(self.canvas, True)
      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(True)

  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.deactivated.emit()
```

8.5 Ecrire des éléments de canevas de carte personnalisés

A FAIRE : Comment créer un objet de canevas de carte ?

```
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

Rendu cartographique et Impression

The code snippets on this page needs the following imports:

```
import os
```


There are generally two approaches when input data should be rendered as a map: either do it quick way using *QgsMapRendererJob* or produce more fine-tuned output by composing the map with the `QgsLayout` class.

9.1 Rendu simple

The rendering is done creating a `QgsMapSettings` object to define the rendering options, and then constructing a `QgsMapRendererJob` with those options. The latter is then used to create the resulting image.

Here's an example:

```
image_location = os.path.join(QgsProject.instance().homePath(), "render.png")

# e.g. vlayer = iface.activeLayer()
vlayer = QgsProject.instance().mapLayersByName("countries")[0]
options = QgsMapSettings()
options.setLayers([vlayer])
options.setBackgroundColor(QColor(255, 255, 255))
options.setOutputSize(QSize(800, 600))
options.setExtent(vlayer.extent())

render = QgsMapRendererParallelJob(options)

def finished():
    img = render.renderedImage()
```

```
    # save the image; e.g. img.save("/Users/myuser/render.png","png")
    img.save(image_location, "png")
    print("saved")

render.finished.connect(finished)

render.start()
```

9.2 Rendu des couches ayant différents SCR

If you have more than one layer and they have a different CRS, the simple example above will probably not work: to get the right values from the extent calculations you have to explicitly set the destination CRS

```
settings.setLayers(layers)
render.setDestinationCrs(layers[0].crs())
```

9.3 Output using print layout

Print layout is a very handy tool if you would like to do a more sophisticated output than the simple rendering shown above. It is possible to create complex map layouts consisting of map views, labels, legend, tables and other elements that are usually present on paper maps. The layouts can be then exported to PDF, raster images or directly printed on a printer.

The layout consists of a bunch of classes. They all belong to the core library. QGIS application has a convenient GUI for placement of the elements, though it is not available in the GUI library. If you are not familiar with Qt Graphics View framework, then you are encouraged to check the documentation now, because the layout is based on it.

The central class of the layout is the `QgsLayout` class, which is derived from the Qt `QGraphicsScene` class. Let us create an instance of it:

```
p = QgsProject()
layout = QgsLayout(p)
layout.initializeDefaults()
```

Now we can add various elements (map, label, ...) to the layout. All these objects are represented by classes that inherit from the base `QgsLayoutItem` class.

Here's a description of some of the main layout items that can be added to a layout.

- carte — cet élément indique aux bibliothèques l'emplacement de la carte. Nous créons ici une carte et l'étirons sur toute la taille de la page

  ```
  map = QgsLayoutItemMap(layout)
  layout.addItem(map)
  ```

- étiquette — permet d'afficher des étiquettes. Il est possible d'en modifier la police, la couleur, l'alignement et les marges:

  ```
  label = QgsLayoutItemLabel(layout)
  label.setText("Hello world")
  label.adjustSizeToText()
  layout.addItem(label)
  ```

- légende

```
legend = QgsLayoutItemLegend(layout)
legend.setLinkedMap(map) # map is an instance of QgsLayoutItemMap
layout.addItem(legend)
```

- Échelle graphique

```
item = QgsLayoutItemScaleBar(layout)
item.setStyle('Numeric') # optionally modify the style
item.setLinkedMap(map) # map is an instance of QgsLayoutItemMap
item.applyDefaultSize()
layout.addItem(item)
```

- flèche
- image
- Forme simple
- Forme basée sur les nœuds

```
polygon = QPolygonF()
polygon.append(QPointF(0.0, 0.0))
polygon.append(QPointF(100.0, 0.0))
polygon.append(QPointF(200.0, 100.0))
polygon.append(QPointF(100.0, 200.0))

polygonItem = QgsLayoutItemPolygon(polygon, layout)
layout.addItem(polygonItem)

props = {}
props["color"] = "green"
props["style"] = "solid"
props["style_border"] = "solid"
props["color_border"] = "black"
props["width_border"] = "10.0"
props["joinstyle"] = "miter"

symbol = QgsFillSymbol.createSimple(props)
polygonItem.setSymbol(symbol)
```

- table

Once an item is added to the layout, it can be moved and resized:

```
item.attemptMove(QgsLayoutPoint(1.4, 1.8, QgsUnitTypes.LayoutCentimeters))
item.attemptResize(QgsLayoutSize(2.8, 2.2, QgsUnitTypes.LayoutCentimeters))
```

A frame is drawn around each item by default. You can remove it as follows:

```
# for a composer label
label.setFrameEnabled(False)
```

Besides creating the layout items by hand, QGIS has support for layout templates which are essentially compositions with all their items saved to a .qpt file (with XML syntax).

Once the composition is ready (the layout items have been created and added to the composition), we can proceed to produce a raster and/or vector output.

9.3.1 Exporting the layout

To export a layout, the `QgsLayoutExporter` class must be used.

```
pdf_path = os.path.join(QgsProject.instance().homePath(), "output.pdf")

exporter = QgsLayoutExporter(layout)
exporter.exportToPdf(pdf_path, QgsLayoutExporter.PdfExportSettings())
```

Use the `exportToImage()` in case you want to export to an image instead of a PDF file.

The code snippets on this page needs the following imports if you're outside the pyqgis console:

```
from qgis.core import (
   QgsExpression,
   QgsExpressionContext,
   QgsFeature,
   QgsFeatureRequest,
   QgsField,
   QgsFields,
   QgsVectorLayer
)
```

CHAPTER 10

Expressions, Filtrage et Calcul de valeurs

QGIS propose quelques fonctionnalités pour faire de l'analyse syntaxique d'expressions semblable au SQL. Seulement un petit sous-ensemble des syntaxes SQL est géré. Les expressions peuvent être évaluées comme des prédicats booléens (retournant Vrai ou Faux) ou comme des fonctions (retournant une valeur scalaire). Voir vector_expressions dans le manuel Utilisateur pour une liste complète des fonctions disponibles.

Trois types basiques sont supportés :

- nombre — aussi bien les nombres entiers que décimaux, par exemple `123`, `3.14`
- texte — ils doivent être entre guillemets simples: `'hello world'`
- référence de colonne — lors de l'évaluation, la référence est remplacée par la valeur réelle du champ. Les noms ne sont pas échappés.

Les opérations suivantes sont disponibles:

- opérateurs arithmétiques: `+`, `-`, `*`, `/`, `^`
- parenthèses: pour faire respecter la précédence des opérateurs: `(1 + 1) * 3`
- les unaires plus et moins: `-12`, `+5`
- fonctions mathématiques: `sqrt`, `sin`, `cos`, `tan`, `asin`, `acos`, `atan`
- fonctions de conversion : `to_int`, `to_real`, `to_string`, `to_date`
- fonctions géométriques: `$area`, `$length`
- Fonctions de manipulation de géométries : `$x`, `$y`, `$geometry`, `num_geometries`, `centroid`

Et les prédicats suivants sont pris en charge:

- comparaison: =, !=, >, >=, <, <=
- comparaison partielle: `LIKE` (avec % ou _), ~ (expressions régulières)
- prédicats logiques: `AND`, `OR`, `NOT`
- Vérification de la valeur NULL: `IS NULL`, `IS NOT NULL`

Exemples de prédicats:

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

Exemples d'expressions scalaires:

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

10.1 Analyse syntaxique d'expressions

```
exp = QgsExpression('1 + 1 = 2')
assert(not exp.hasParserError())

exp = QgsExpression('1 + 1 = ')
assert(exp.hasParserError())

assert(exp.parserErrorString() == '\nsyntax error, unexpected $end')
```

10.2 Évaluation des expressions

10.2.1 Expressions basiques

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

10.2.2 Expressions avec entités

The following example will evaluate the given expression against a feature. A `QgsExpressionContext` object has to be created and passed, to allow the expression to access the feature field values. « Column » is the name of the field in the layer.

```
fields = QgsFields()
field = QgsField('Column')
fields.append(field)
feature = QgsFeature()
feature.setFields(fields)
feature.setAttribute(0, 99)
exp = QgsExpression('Column')
context = QgsExpressionContext()
context.setFeature(feature)
assert(exp.evaluate(context) == 99)
```

10.2.3 Gestion des erreurs

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

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

10.3 Exemples

L'exemple suivant peut être utilisé pour filtrer une couche et ne renverra que les entités qui correspondent au prédicat.

```
layer = QgsVectorLayer("Point?field=Test:integer",
                           "addfeat", "memory")

layer.startEditing()

for i in range(10):
    feature = QgsFeature()
    feature.setAttributes([i])
    assert(layer.addFeature(feature))
layer.commitChanges()

expression = 'Test >= 3'
request = QgsFeatureRequest().setFilterExpression(expression)

matches = 0
for f in layer.getFeatures(request):
   matches += 1

assert(matches == 7)
```

The code snippets on this page needs the following imports if you're outside the pyqgis console:

```
from qgis.core import (
  QgsProject,
  QgsSettings,
  QgsVectorLayer
)
```

CHAPTER 11

Lecture et sauvegarde de configurations

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

Il est souvent utile pour une extension de sauvegarder des variables pour éviter à l'utilisateur de saisir à nouveau leur valeur ou de faire une nouvelle sélection à chaque lancement de l'extension.

Ces variables peuvent être sauvegardées et récupérées grâce à Qt et à l'API QGIS. Pour chaque variable, vous devez fournir une clé qui sera utilisée pour y accéder — pour la couleur préférée de l'utilisateur, vous pourriez utiliser la clé « couleur_favorite » ou toute autre chaîne de caractères explicite. Nous vous recommandons d'utiliser une convention pour nommer les clés.

We can differentiate between several types of settings:

- **global settings** — they are bound to the user at a particular machine. QGIS itself stores a lot of global settings, for example, main window size or default snapping tolerance. Settings are handled using the `QgsSettings` class. The `setValue()` and `value()` methods from this class provide

  Here you can see an example of how these methods are used.

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

def read():
  s = QgsSettings()
  mytext = s.value("myplugin/mytext", "default text")
  myint  = s.value("myplugin/myint", 123)
  myreal = s.value("myplugin/myreal", 2.71)
  nonexistent = s.value("myplugin/nonexistent", None)
  print(mytext)
  print(myint)
  print(myreal)
  print(nonexistent)
```

The second parameter of the `value()` method is optional and specifies the default value that is returned if there is no previous value set for the passed setting name.

- **project settings** — vary between different projects and therefore they are connected with a project file. Map canvas background color or destination coordinate reference system (CRS) are examples — white background and WGS84 might be suitable for one project, while yellow background and UTM projection are better for another one.

  An example of usage follows.

```
  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 (returns a tuple with the value, and a status boolean
  # which communicates whether the value retrieved could be converted to␣
↪its type,
  # in these cases a string, an integer, a double and a boolean␣
↪respectively)
  mytext, type_conversion_ok = proj.readEntry("myplugin", "mytext",
↪"default text")
  myint, type_conversion_ok = proj.readNumEntry("myplugin", "myint", 123)
  mydouble, type_conversion_ok = proj.readDoubleEntry("myplugin",
↪"mydouble", 123)
  mybool, type_conversion_ok = proj.readBoolEntry("myplugin", "mybool",␣
↪123)

As you can see, the :meth:`writeEntry() <qgis.core.QgsProject.writeEntry>
↪` method is used for all data types, but
several methods exist for reading the setting value back, and the
corresponding one has to be selected for each data type.
```

- **map layer settings** — these settings are related to a particular instance of a map layer with a project. They are *not* connected with underlying data source of a layer, so if you create two map layer instances of one shapefile, they will not share the settings. The settings are stored inside the project file, so if the user opens the project again, the layer-related settings will be there again. The value for a given setting is retrieved using the `customProperty()` method, and can be set using the `setCustomProperty()` one.

```
vlayer = QgsVectorLayer()
# save a value
vlayer.setCustomProperty("mytext", "hello world")

# read the value again (returning "default text" if not found)
mytext = vlayer.customProperty("mytext", "default text")
```

CHAPTER 12

Communiquer avec l'utilisateur

Cette section montre quelques méthodes et éléments qui devraient être employés pour communiquer avec l'utilisateur dans l'objectif de conserver une certaine constance dans l'interface utilisateur

12.1 Showing messages. The QgsMessageBar class

Utiliser des boîtes à message est généralement une mauvaise idée du point de vue de l'expérience utilisateur. Pour afficher une information simple sur une seule ligne ou des messages d'avertissement ou d'erreur, la barre de message QGIS est généralement une meilleure option.

En utilisant la référence vers l'objet d'interface QGis, vous pouvez afficher un message dans la barre de message à l'aide du code suivant

```
from qgis.core import Qgis
iface.messageBar().pushMessage("Error", "I'm sorry Dave, I'm afraid I can't do that
↪", level=Qgis.Critical)
```

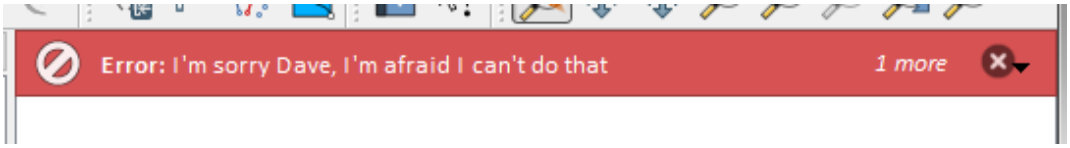


Figure 12.1: Barre de message de QGIS

Vous pouvez spécifier une durée pour que l'affichage soit limité dans le temps.

```
iface.messageBar().pushMessage("Ooops", "The plugin is not working as it should",␣
↪level=Qgis.Critical, duration=3)
```

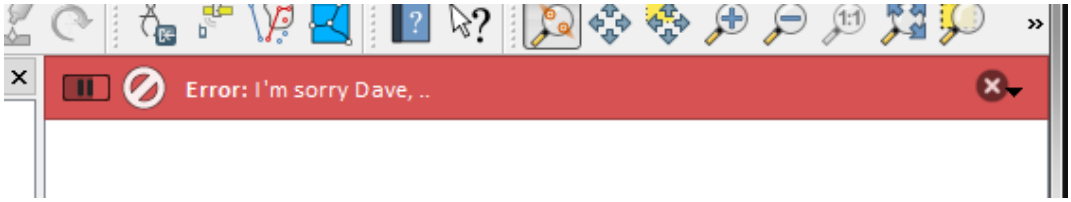


Figure 12.2: Barre de message de Qgis avec décompte

The examples above show an error bar, but the `level` parameter can be used to creating warning messages or info messages, using the `Qgis.MessageLevel` enumeration. You can use up to 4 different levels:

0. Info
1. Warning
2. Critical
3. Success

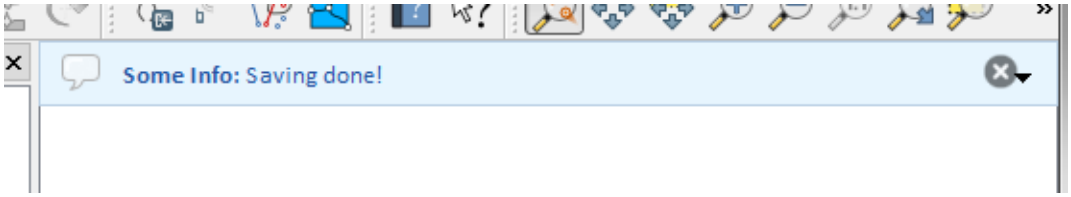


Figure 12.3: Barre de message QGis (info)

Des Widgets peuvent être ajoutés à la barre de message comme par exemple un bouton pour montrer davantage d'information

```
def showError():
    pass

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, Qgis.Warning)
```

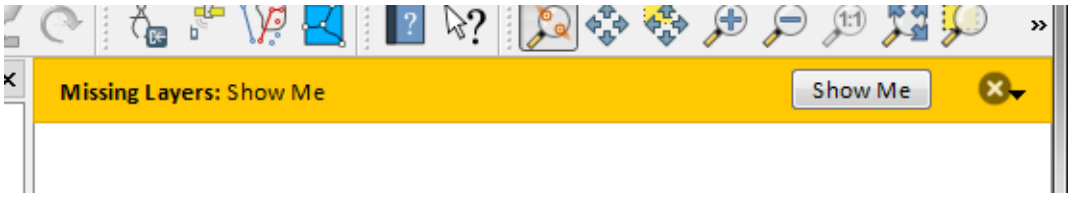


Figure 12.4: Barre de message QGis avec un bouton

Vous pouvez également utiliser une barre de message au sein de votre propre boîte de dialogue afin de ne pas afficher de boîte à message ou bien s'il n'y pas d'intérêt de l'afficher dans la fenêtre principale 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=Qgis.Info)

myDlg = MyDialog()
myDlg.show()
```

Figure 12.5: Barre de message QGis avec une boîte de dialogue personnalisée

12.2 Afficher la progression

Les barres de progression peuvent également être insérées dans la barre de message QGis car, comme nous l'avons déjà vu, cette dernière accepte les widgets. Voici un exemple que vous pouvez utilisez dans la console.

```
import time
from qgis.PyQt.QtWidgets import QProgressBar
from qgis.PyQt.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, Qgis.Info)

for i in range(10):
    time.sleep(1)
    progress.setValue(i + 1)

iface.messageBar().clearWidgets()
```

Also, you can use the built-in status bar to report progress, as in the next example:

```
vlayer = QgsProject.instance().mapLayersByName("countries")[0]

count = vlayer.featureCount()
features = vlayer.getFeatures()

for i, feature in enumerate(features):
    # do something time-consuming here
    print('') # printing should give enough time to present the progress

    percent = i / float(count) * 100
    # iface.mainWindow().statusBar().showMessage("Processed {} %".
↪format(int(percent)))
    iface.statusBarIface().showMessage("Processed {} %".format(int(percent)))

iface.statusBarIface().clearMessage()
```

12.3 Journal

Vous pouvez utiliser le système de journal de QGis pour enregistrer toute information à conserver sur l'exécution de votre code.

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

Avertissement: Use of the Python `print` statement is unsafe to do in any code which may be multithreaded. This includes **expression functions**, **renderers**, **symbol layers** and **Processing algorithms** (amongst others). In these cases you should always use thread safe classes (`QgsLogger` or `QgsMessageLog`) instead.

Note: You can see the output of the `QgsMessageLog` in the log_message_panel

Note:

- `QgsLogger` is for messages for debugging / developers (i.e. you suspect they are triggered by some broken code)
- `QgsMessageLog` is for messages to investigate issues by sysadmins (e.g. to help a sysadmin to fix configurations)

CHAPTER 13

Infrastructure d'authentification

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

13.1 Introduction

Les infrastructures d'authentification de la référence utilisateur peuvent être lu dans le manuel d'utilisateur le paragraphe « authentication_overview .

Ce chapitre décrit les les bonnes pratiques de développement pour l'utilisation du système d'authentification.

Most of the following snippets are derived from the code of Geoserver Explorer plugin and its tests. This is the first plugin that used Authentication infrastructure. The plugin code and its tests can be found at this link. Other good code reference can be read from the authentication infrastructure tests code

13.2 Glossaire

Voici quelques définitions des principaux éléments étudiés dans ce chapitre.

Mot de passe principal Mot de passe permettant l'accès et le décryptage des informations stockées dans la base de données d'authentification de QGIS.

Base de données d'authentification A *Master Password* crypted sqlite db `qgis-auth.db` where *Authentication Configuration* are stored. e.g user/password, personal certificates and keys, Certificate Authorities

Base de données d'authentification *Base de données d'authentification*

Authentication Configuration A set of authentication data depending on *Authentication Method*. e.g Basic authentication method stores the couple of user/password.

Authentication config *Authentication Configuration*

Méthode d'authentification Une méthode pour s'authentifier. Chaque méthode a son propre protocole utilisé pour accorder le statut "authentifié". Chaque méthode est mise à disposition comme une librairie chargée dynamiquement pendant la phase d'initialisation de l'infrastructure d'authentification de QGIS.

13.3 QgsAuthManager the entry point

The `QgsAuthManager` singleton is the entry point to use the credentials stored in the QGIS encrypted *Authentication DB*, i.e. the `qgis-auth.db` file under the active user profile folder.

This class takes care of the user interaction: by asking to set master password or by transparently using it to access crypted stored info.

13.3.1 Init the manager and set the master password

The following snippet gives an example to set master password to open the access to the authentication settings. Code comments are important to understand the snippet.

```
authMgr = QgsAuthManager.instance()
# check if QgsAuthManager has been already initialized... a side effect
# of the QgsAuthManager.init() is that AuthDbPath is set.
# QgsAuthManager.init() is executed during QGIS application init and hence
# you do not normally need to call it directly.
if authMgr.authenticationDbPath():
    # already initilised => we are inside a QGIS app.
    if authMgr.masterPasswordIsSet():
        msg = 'Authentication master password not recognized'
        assert authMgr.masterPasswordSame( "your master password" ), msg
    else:
        msg = 'Master password could not be set'
        # The verify parameter check if the hash of the password was
        # already saved in the authentication db
```

```
        assert authMgr.setMasterPassword( "your master password",
                                          verify=True), msg
else:
    # outside qgis, e.g. in a testing environment => setup env var before
    # db init
    os.environ['QGIS_AUTH_DB_DIR_PATH'] = "/path/where/located/qgis-auth.db"
    msg = 'Master password could not be set'
    assert authMgr.setMasterPassword("your master password", True), msg
    authMgr.init( "/path/where/located/qgis-auth.db" )
```

13.3.2 Populate authdb with a new Authentication Configuration entry

Any stored credential is a *Authentication Configuration* instance of the `QgsAuthMethodConfig` class accessed using a unique string like the following one:

```
authcfg = 'fm1s770'
```

that string is generated automatically when creating an entry using QGIS API or GUI.

`QgsAuthMethodConfig` is the base class for any *Authentication Method*. Any Authentication Method sets a configuration hash map where authentication informations will be stored. Hereafter an useful snippet to store PKI-path credentials for an hypothetic alice user:

```
authMgr = QgsAuthManager.instance()
# set alice PKI data
p_config = QgsAuthMethodConfig()
p_config.setName("alice")
p_config.setMethod("PKI-Paths")
p_config.setUri("https://example.com")
p_config.setConfig("certpath", "path/to/alice-cert.pem" ))
p_config.setConfig("keypath", "path/to/alice-key.pem" ))
# check if method parameters are correctly set
assert p_config.isValid()

# register alice data in authdb returning the ``authcfg`` of the stored
# configuration
authMgr.storeAuthenticationConfig(p_config)
newAuthCfgId = p_config.id()
assert (newAuthCfgId)
```

Available Authentication methods

*Authentication Method*s are loaded dynamically during authentication manager init. The list of Authentication method can vary with QGIS evolution, but the original list of available methods is:

1. `Basic` User and password authentication
2. `Identity-Cert` Identity certificate authentication
3. `PKI-Paths` PKI paths authentication
4. `PKI-PKCS#12` PKI PKCS#12 authentication

The above strings are that identify authentication methods in the QGIS authentication system. In Development section is described how to create a new c++ *Authentication Method*.

Populate Authorities

```
authMgr = QgsAuthManager.instance()
# add authorities
cacerts = QSslCertificate.fromPath( "/path/to/ca_chains.pem" )
assert cacerts is not None
# store CA
authMgr.storeCertAuthorities(cacerts)
# and rebuild CA caches
authMgr.rebuildCaCertsCache()
authMgr.rebuildTrustedCaCertsCache()
```

Avertissement: Due to QT4/OpenSSL interface limitation, updated cached CA are exposed to OpenSsl only almost a minute later. Hope this will be solved in QT5 authentication infrastructure.

Manage PKI bundles with QgsPkiBundle

A convenience class to pack PKI bundles composed on SslCert, SslKey and CA chain is the `QgsPkiBundle` class. Hereafter a snippet to get password protected:

```
# add alice cert in case of key with pwd
boundle = QgsPkiBundle.fromPemPaths( "/path/to/alice-cert.pem",
                                     "/path/to/alice-key_w-pass.pem",
                                     "unlock_pwd",
                                     "list_of_CAs_to_bundle" )
assert boundle is not None
assert boundle.isValid()
```

Refer to `QgsPkiBundle` class documentation to extract cert/key/CAs from the bundle.

13.3.3 Remove entry from authdb

We can remove an entry from *Authentication Database* using it's `authcfg` identifier with the following snippet:

```
authMgr = QgsAuthManager.instance()
authMgr.removeAuthenticationConfig( "authCfg_Id_to_remove" )
```

13.3.4 Leave authcfg expansion to QgsAuthManager

The best way to use an *Authentication Config* stored in the *Authentication DB* is referring it with the unique identifier `authcfg`. Expanding, means convert it from an identifier to a complete set of credentials. The best practice to use stored *Authentication Config*s, is to leave it managed automatically by the Authentication manager. The common use of a stored configuration is to connect to an authentication enabled service like a WMS or WFS or to a DB connection.

Note: Take into account that not all QGIS data providers are integrated with the Authentication infrastructure. Each authentication method, derived from the base class `QgsAuthMethod` and support a different set of Providers. For example the `certIdentity ()` method supports the following list of providers:

```
In [19]: authM = QgsAuthManager.instance()
In [20]: authM.authMethod("Identity-Cert").supportedDataProviders()
Out[20]: [u'ows', u'wfs', u'wcs', u'wms', u'postgres']
```

For example, to access a WMS service using stored credentials identified with `authcfg = 'fm1s770'`, we just have to use the `authcfg` in the data source URL like in the following snippet:

```
authCfg = 'fm1s770'
quri = QgsDataSourceURI()
quri.setParam("layers", 'usa:states')
quri.setParam("styles", '')
quri.setParam("format", 'image/png')
quri.setParam("crs", 'EPSG:4326')
quri.setParam("dpiMode", '7')
quri.setParam("featureCount", '10')
quri.setParam("authcfg", authCfg)    # <---- here my authCfg url parameter
quri.setParam("contextualWMSLegend", '0')
quri.setParam("url", 'https://my_auth_enabled_server_ip/wms')
rlayer = QgsRasterLayer(quri.encodedUri(), 'states', 'wms')
```

In the upper case, the `wms` provider will take care to expand `authcfg` URI parameter with credential just before setting the HTTP connection.

Avertissement: The developer would have to leave `authcfg` expansion to the `QgsAuthManager`, in this way he will be sure that expansion is not done too early.

Usually an URI string, built using the `QgsDataSourceURI` class, is used to set a data source in the following way:

```
rlayer = QgsRasterLayer( quri.uri(False), 'states', 'wms')
```

Note: The `False` parameter is important to avoid URI complete expansion of the `authcfg` id present in the URI.

PKI examples with other data providers

Other example can be read directly in the QGIS tests upstream as in test_authmanager_pki_ows or test_authmanager_pki_postgres.

13.4 Adapt plugins to use Authentication infrastructure

Many third party plugins are using httplib2 to create HTTP connections instead of integrating with `QgsNetworkAccessManager` and its related Authentication Infrastructure integration. To facilitate this integration an helper python function has been created called `NetworkAccessManager`. Its code can be found here.

This helper class can be used as in the following snippet:

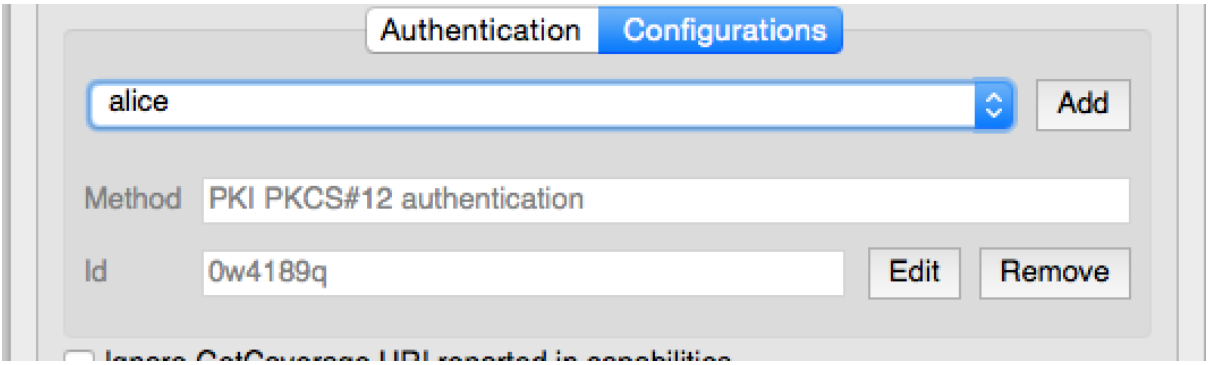
```
http = NetworkAccessManager(authid="my_authCfg", exception_class=My_
↪FailedRequestError)
try:
  response, content = http.request( "my_rest_url" )
except My_FailedRequestError, e:
  # Handle exception
  pass
```

13.5 Authentication GUIs

In this paragraph are listed the available GUIs useful to integrate authentication infrastructure in custom interfaces.

13.5.1 GUI to select credentials

If it's necessary to select a *Authentication Configuration* from the set stored in the *Authentication DB* it is available in the GUI class *QgsAuthConfigSelect <qgis.gui.QgsAuthConfigSelect>*.



and can be used as in the following snippet:

```
# create the instance of the QgsAuthConfigSelect GUI hierarchically linked to
# the widget referred with `parent`
gui = QgsAuthConfigSelect( parent, "postgres" )
# add the above created gui in a new tab of the interface where the
# GUI has to be integrated
tabGui.insertTab( 1, gui, "Configurations" )
```

The above example is taken from the QGIS source code The second parameter of the GUI constructor refers to data provider type. The parameter is used to restrict the compatible *Authentication Method*s with the specified provider.

13.5.2 Authentication Editor GUI

The complete GUI used to manage credentials, authorities and to access to Authentication utilities is managed by the `QgsAuthEditorWidgets` class.

and can be used as in the following snippet:

```
# create the instance of the QgsAuthEditorWidgets GUI hierarchically linked to
# the widget referred with `parent`
gui = QgsAuthConfigSelect( parent )
gui.show()
```

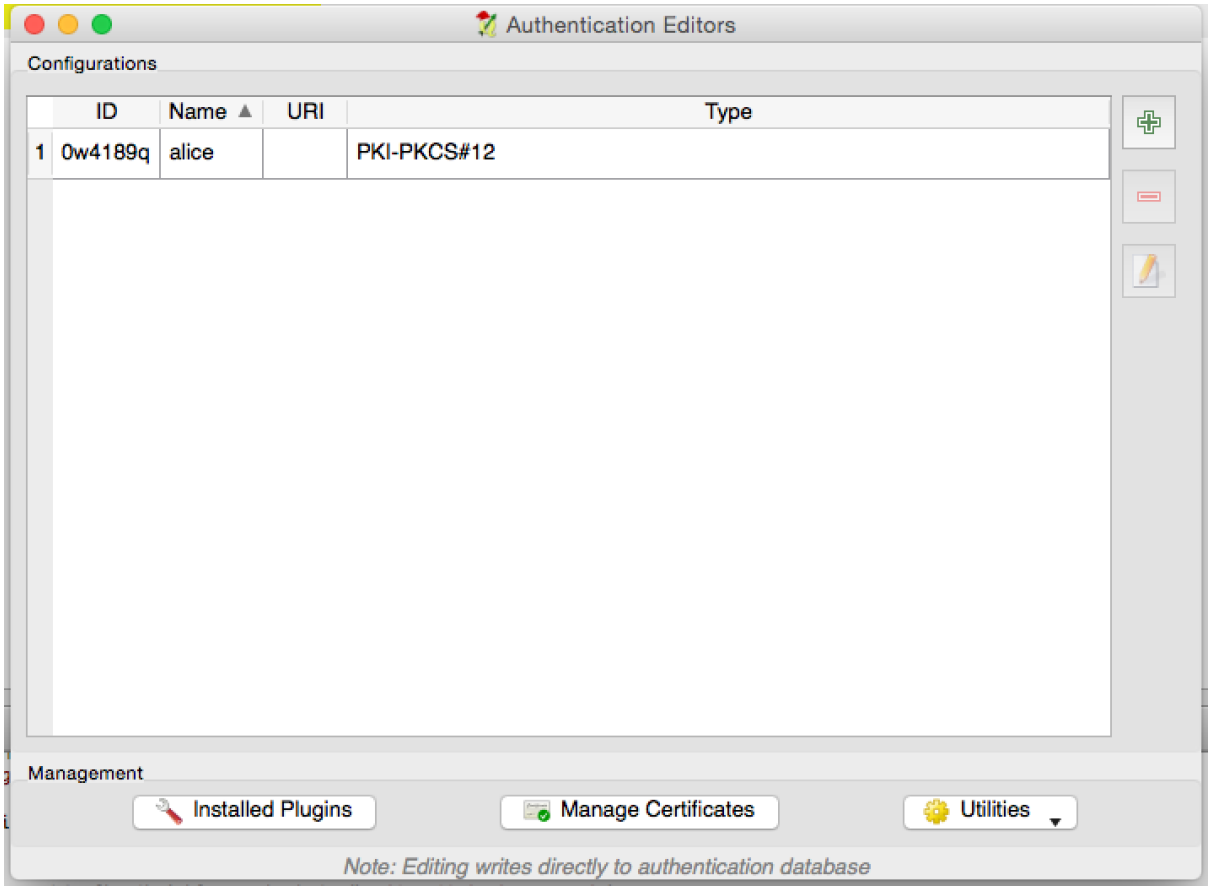
an integrated example can be found in the related test

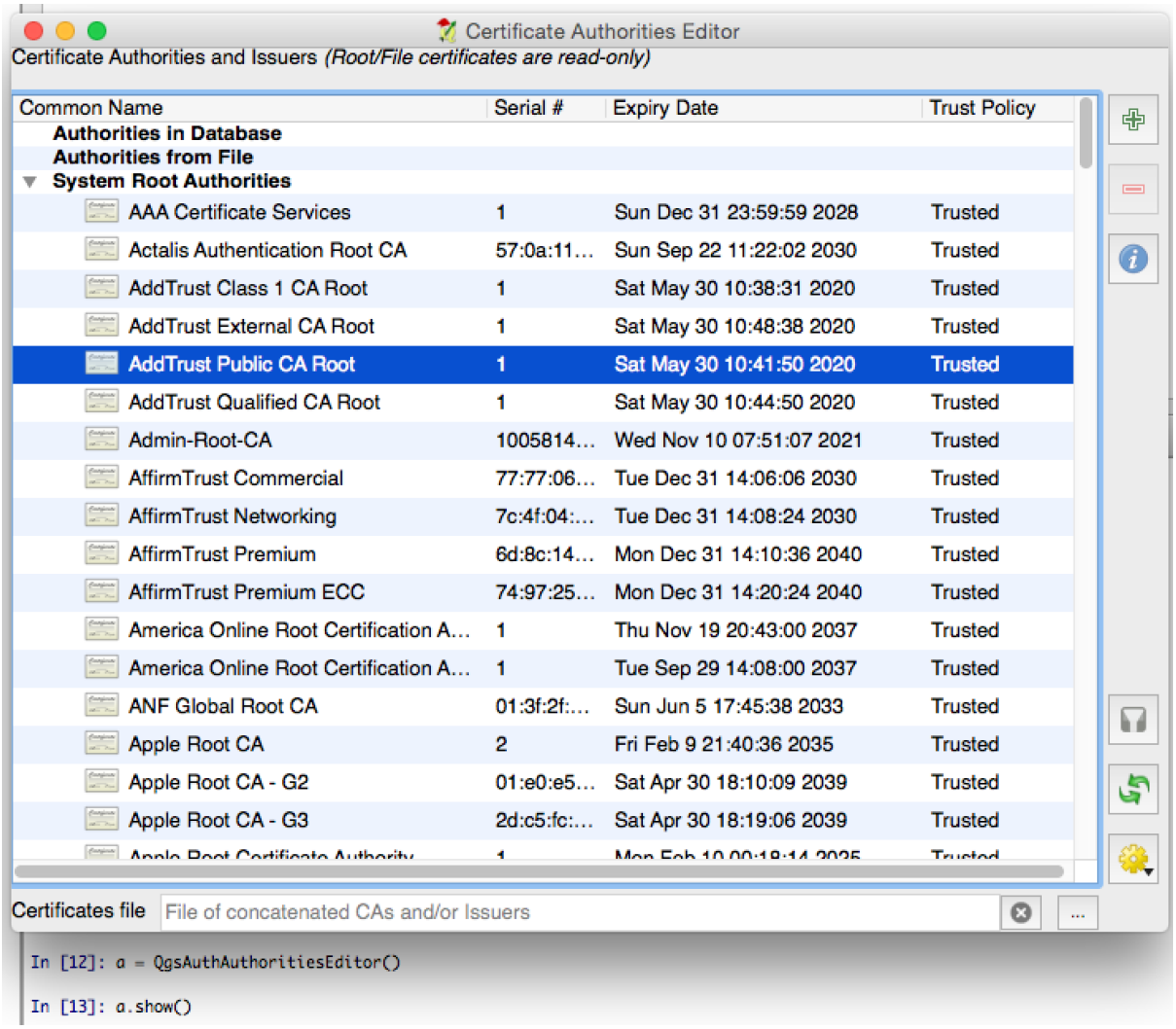
13.5.3 Authorities Editor GUI

A GUI used to manage only authorities is managed by the *QgsAuthAuthoritiesEditor <qgis.gui.QgsAuthAuthoritiesEditor>* class.

and can be used as in the following snippet:

```
# create the instance of the QgsAuthAuthoritiesEditor GUI hierarchically
#  linked to the widget referred with `parent`
gui = QgsAuthAuthoritiesEditor( parent )
gui.show()
```


Authentication Editors
Configurations
ID
Name
URI
Type
1
0w4189q
alice
PKI-PKCS#12
Management
Installed Plugins
Manage Certificates
Utilities
Note: Editing writes directly to authentication database


Certificate Authorities Editor
Certificate Authorities and Issuers (Root/File certificates are read-only)
Common Name
Serial #
Expiry Date
Trust Policy
Authorities in Database
Authorities from File
System Root Authorities
AAA Certificate Services 1 Sun Dec 31 23:59:59 2028 Trusted
Actalis Authentication Root CA 57:0a:11… Sun Sep 22 11:22:02 2030 Trusted
AddTrust Class 1 CA Root 1 Sat May 30 10:38:31 2020 Trusted
AddTrust External CA Root 1 Sat May 30 10:48:38 2020 Trusted
AddTrust Public CA Root 1 Sat May 30 10:41:50 2020 Trusted
AddTrust Qualified CA Root 1 Sat May 30 10:44:50 2020 Trusted
Admin-Root-CA 1005814… Wed Nov 10 07:51:07 2021 Trusted
AffirmTrust Commercial 77:77:06… Tue Dec 31 14:06:06 2030 Trusted
AffirmTrust Networking 7c:4f:04:… Tue Dec 31 14:08:24 2030 Trusted
AffirmTrust Premium 6d:8c:14… Mon Dec 31 14:10:36 2040 Trusted
AffirmTrust Premium ECC 74:97:25… Mon Dec 31 14:20:24 2040 Trusted
America Online Root Certification A… 1 Thu Nov 19 20:43:00 2037 Trusted
America Online Root Certification A… 1 Tue Sep 29 14:08:00 2037 Trusted
ANF Global Root CA 01:3f:2f:… Sun Jun 5 17:45:38 2033 Trusted
Apple Root CA 2 Fri Feb 9 21:40:36 2035 Trusted
Apple Root CA - G2 01:e0:e5… Sat Apr 30 18:10:09 2039 Trusted
Apple Root CA - G3 2d:c5:fc:… Sat Apr 30 18:19:06 2039 Trusted
Certificates file
File of concatenated CAs and/or Issuers
...
In [12]: a = QgsAuthAuthoritiesEditor()
In [13]: a.show()

CHAPTER 14

Tasks - doing heavy work in the background

14.1 Introduction

Background processing using threads is a way to maintain a responsive user interface when heavy processing is going on. Tasks can be used to achieve threading in QGIS.

A task (`QgsTask`) is a container for the code to be performed in the background, and the task manager (`QgsTaskManager`) is used to control the running of the tasks. These classes simplify background processing in QGIS by providing mechanisms for signaling, progress reporting and access to the status for background processes. Tasks can be grouped using subtasks.

The global task manager (found with `QgsApplication.taskManager()`) is normally used. This means that your tasks may not be the only tasks that are controlled by the task manager.

There are several ways to create a QGIS task:

- Create your own task by extending `QgsTask`

```
class SpecialisedTask(QgsTask):
```

- Create a task from a function

```
QgsTask.fromFunction(u'heavy function', heavyFunction,
                     onfinished=workdone)
```

- Create a task from a processing algorithm

```
QgsProcessingAlgRunnerTask(u'native:buffer', params, context,
                           feedback)
```

Avertissement: Any background task (regardless of how it is created) must NEVER perform any GUI based operations, such as creating new widgets or interacting with existing widgets. Qt widgets must only be accessed or modified from the main thread. Attempting to use them from background threads will result in crashes.

Dependencies between tasks can be described using the `addSubTask` function of `QgsTask`. When a dependency is stated, the task manager will automatically determine how these dependencies will be executed. Wherever possible dependencies will be executed in parallel in order to satisfy them as quickly as possible. If a task

on which another task depends is canceled, the dependent task will also be canceled. Circular dependencies can make deadlocks possible, so be careful.

If a task depends on a layer being available, this can be stated using the `setDependentLayers` function of `QgsTask`. If a layer on which a task depends is not available, the task will be canceled.

Once the task has been created it can be scheduled for running using the `addTask` function of the task manager. Adding a task to the manager automatically transfers ownership of that task to the manager, and the manager will cleanup and delete tasks after they have executed. The scheduling of the tasks is influenced by the task priority, which is set in `addTask`.

The status of tasks can be monitored using `QgsTask` and `QgsTaskManager` signals and functions.

14.2 Examples

14.2.1 Extending QgsTask

In this example `RandomIntegerSumTask` extends `QgsTask` and will generate 100 random integers between 0 and 500 during a specified period of time. If the random number is 42, the task is aborted and an exception is raised. Several instances of `RandomIntegerSumTask` (with subtasks) are generated and added to the task manager, demonstrating two types of dependencies.

```
import random
from time import sleep

from qgis.core import (
    QgsApplication, QgsTask, QgsMessageLog,
    )

MESSAGE_CATEGORY = 'RandomIntegerSumTask'

class RandomIntegerSumTask(QgsTask):
    """This shows how to subclass QgsTask"""
    def __init__(self, description, duration):
        super().__init__(description, QgsTask.CanCancel)
        self.duration = duration
        self.total = 0
        self.iterations = 0
        self.exception = None
    def run(self):
        """Here you implement your heavy lifting.
        Should periodically test for isCanceled() to gracefully
        abort.
        This method MUST return True or False.
        Raising exceptions will crash QGIS, so we handle them
        internally and raise them in self.finished
        """
        QgsMessageLog.logMessage('Started task "{}"'.format(
                                    self.description()),
                                 MESSAGE_CATEGORY, Qgis.Info)
        wait_time = self.duration / 100
        for i in range(100):
            sleep(wait_time)
            # use setProgress to report progress
            self.setProgress(i)
            arandominteger = random.randint(0, 500)
            self.total += arandominteger
            self.iterations += 1
            # check isCanceled() to handle cancellation
            if self.isCanceled():
                return False
```

```
            # simulate exceptions to show how to abort task
            if arandominteger == 42:
                # DO NOT raise Exception('bad value!')
                # this would crash QGIS
                self.exception = Exception('bad value!')
                return False
        return True
    def finished(self, result):
        """
        This function is automatically called when the task has
        completed (successfully or not).
        You implement finished() to do whatever follow-up stuff
        should happen after the task is complete.
        finished is always called from the main thread, so it's safe
        to do GUI operations and raise Python exceptions here.
        result is the return value from self.run.
        """
        if result:
            QgsMessageLog.logMessage(
                'Task "{name}" completed\n' \
                'Total: {total} (with {iterations} '\
              'iterations)'.format(
                  name=self.description(),
                  total=self.total,
                  iterations=self.iterations),
              MESSAGE_CATEGORY, Qgis.Success)
        else:
            if self.exception is None:
                QgsMessageLog.logMessage(
                    'Task "{name}" not successful but without '\
                    'exception (probably the task was manually '\
                    'canceled by the user)'.format(
                        name=self.description()),
                    MESSAGE_CATEGORY, Qgis.Warning)
            else:
                QgsMessageLog.logMessage(
                    'Task "{name}" Exception: {exception}'.format(
                        name=self.description(),
                        exception=self.exception),
                    MESSAGE_CATEGORY, Qgis.Critical)
                raise self.exception
    def cancel(self):
        QgsMessageLog.logMessage(
            'Task "{name}" was canceled'.format(
                name=self.description()),
            MESSAGE_CATEGORY, Qgis.Info)
        super().cancel()


longtask = RandomIntegerSumTask('waste cpu long', 20)
shorttask = RandomIntegerSumTask('waste cpu short', 10)
minitask = RandomIntegerSumTask('waste cpu mini', 5)
shortsubtask = RandomIntegerSumTask('waste cpu subtask short', 5)
longsubtask = RandomIntegerSumTask('waste cpu subtask long', 10)
shortestsubtask = RandomIntegerSumTask('waste cpu subtask shortest', 4)

# Add a subtask (shortsubtask) to shorttask that must run after
# minitask and longtask has finished
shorttask.addSubTask(shortsubtask, [minitask, longtask])
# Add a subtask (longsubtask) to longtask that must be run
# before the parent task
longtask.addSubTask(longsubtask, [], QgsTask.ParentDependsOnSubTask)
# Add a subtask (shortestsubtask) to longtask
```

```
longtask.addSubTask(shortestsubtask)

QgsApplication.taskManager().addTask(longtask)
QgsApplication.taskManager().addTask(shorttask)
QgsApplication.taskManager().addTask(minitask)
```

14.2.2 Task from function

Create a task from a function (`doSomething` in this example). The first parameter of the function will hold the `QgsTask` for the function. An important (named) parameter is `on_finished`, that specifies a function that will be called when the task has completed. The `doSomething` function in this example has an additional named parameter `wait_time`.

```
import random
from time import sleep

MESSAGE_CATEGORY = 'TaskFromFunction'

def doSomething(task, wait_time):
    """
    Raises an exception to abort the task.
    Returns a result if success.
    The result will be passed, together with the exception (None in
    the case of success), to the on_finished method.
    If there is an exception, there will be no result.
    """
    QgsMessageLog.logMessage('Started task {}'.format(task.description()),
                             MESSAGE_CATEGORY, Qgis.Info)
    wait_time = wait_time / 100
    total = 0
    iterations = 0
    for i in range(100):
        sleep(wait_time)
        # use task.setProgress to report progress
        task.setProgress(i)
        arandominteger = random.randint(0, 500)
        total += arandominteger
        iterations += 1
        # check task.isCanceled() to handle cancellation
        if task.isCanceled():
            stopped(task)
            return None
        # raise an exception to abort the task
        if arandominteger == 42:
            raise Exception('bad value!')
    return {'total': total, 'iterations': iterations,
            'task': task.description()}

def stopped(task):
    QgsMessageLog.logMessage(
        'Task "{name}" was canceled'.format(
            name=task.description()),
        MESSAGE_CATEGORY, Qgis.Info)

def completed(exception, result=None):
    """This is called when doSomething is finished.
    Exception is not None if doSomething raises an exception.
    result is the return value of doSomething."""
    if exception is None:
        if result is None:
            QgsMessageLog.logMessage(
```

```
                'Completed with no exception and no result '\
                '(probably manually canceled by the user)',
                MESSAGE_CATEGORY, Qgis.Warning)
        else:
            QgsMessageLog.logMessage(
                'Task {name} completed\n'
                'Total: {total} ( with {iterations} '
                'iterations)'.format(
                    name=result['task'],
                    total=result['total'],
                    iterations=result['iterations']),
                MESSAGE_CATEGORY, Qgis.Info)
    else:
        QgsMessageLog.logMessage("Exception: {}".format(exception),
                                 MESSAGE_CATEGORY, Qgis.Critical)
        raise exception

# Creae a few tasks
task1 = QgsTask.fromFunction(u'Waste cpu 1', doSomething,
                             on_finished=completed, wait_time=4)
task2 = QgsTask.fromFunction(u'Waste cpu 2', dosomething,
                             on_finished=completed, wait_time=3)
QgsApplication.taskManager().addTask(task1)
QgsApplication.taskManager().addTask(task2)
```

14.2.3 Task from a processing algorithm

Create a task that uses the algorithm qgis:randompointsinextent to generate 50000 random points inside a specified extent. The result is added to the project in a safe way.

```
from functools import partial
from qgis.core import (QgsTaskManager, QgsMessageLog,
                       QgsProcessingAlgRunnerTask, QgsApplication,
                       QgsProcessingContext, QgsProcessingFeedback,
                       QgsProject)

MESSAGE_CATEGORY = 'AlgRunnerTask'

def task_finished(context, successful, results):
    if not successful:
        QgsMessageLog.logMessage('Task finished unsucessfully',
                                 MESSAGE_CATEGORY, Qgis.Warning)
    output_layer = context.getMapLayer(results['OUTPUT'])
    # because getMapLayer doesn't transfer ownership, the layer will
    # be deleted when context goes out of scope and you'll get a
    # crash.
    # takeMapLayer transfers ownership so it's then safe to add it
    # to the project and give the project ownership.
    if output_layer and output_layer.isValid():
        QgsProject.instance().addMapLayer(
             context.takeResultLayer(output_layer.id()))

alg = QgsApplication.processingRegistry().algorithmById(
                                    u'qgis:randompointsinextent')
context = QgsProcessingContext()
feedback = QgsProcessingFeedback()
params = {
    'EXTENT': '0.0,10.0,40,50 [EPSG:4326]',
    'MIN_DISTANCE': 0.0,
    'POINTS_NUMBER': 50000,
    'TARGET_CRS': 'EPSG:4326',
```

```
    'OUTPUT': 'memory:My random points'
}
task = QgsProcessingAlgRunnerTask(alg, params, context, feedback)
task.executed.connect(partial(task_finished, context))
QgsApplication.taskManager().addTask(task)
```

See also: https://www.opengis.ch/2018/06/22/threads-in-pyqgis3/.

CHAPTER 15

Développer des extensions Python

15.1 Structuring Python Plugins

In order to create a plugin, here are some steps to follow:

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*: The essentials: a starting point `__init__.py`; fill in the *Plugin metadata* `metadata.txt`. Then implement your own design. A main Python plugin body e.g. `mainplugin.py`. Probably 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 ».

15.1.1 Writing a plugin

Since the introduction of Python plugins in QGIS, a number of plugins have appeared. The QGIS team maintains an *Official Python plugin repository*. You can use their source to learn more about programming with PyQGIS or find out whether you are duplicating development effort.

Plugin files

Here's the directory structure of our example plugin

```
PYTHON_PLUGINS_PATH/
  MyPlugin/
    __init__.py     --> *required*
    mainPlugin.py   --> *core code*
    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` = Contains general info, version, name and some other metadata used by plugins website and plugin infrastructure.

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

There is a QGIS plugin called Plugin Builder 3 that creates a plugin template for QGIS and doesn't require an internet connection. This is the recommended option, as it produces 3.x compatible sources.

Avertissement: 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*

15.1.2 Plugin content

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

Plugin metadata

First, the 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.

Important: 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	True	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, only shown on the website to logged in users, but visible in the Plugin Manager after the plugin is installed
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	True	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) of a web friendly image (PNG, JPEG)
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
```

Note: 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=3.0
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
tracker=http://bugs.itopen.it
repository=http://www.itopen.it/repo
; 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=https://www.itopen.it
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=3.99
```

__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 into QGIS. It receives a reference to the instance of `QgisInterface` and must return an object 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
```

mainPlugin.py

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

```
from qgis.PyQt.QtGui import *
from qgis.PyQt.QtWidgets import *

# initialize Qt resources from file resources.py
from . 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.mainWindow())
    self.action.setObjectName("testAction")
    self.action.setWhatsThis("Configuration for test plugin")
    self.action.setStatusTip("This is status tip")
    self.action.triggered.connect(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
    self.iface.mapCanvas().renderComplete.connect(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
    self.iface.mapCanvas().renderComplete.disconnect(self.renderTest)

  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.mainWindow())
    self.action.setObjectName("testAction")
    self.action.setWhatsThis("Configuration for test plugin")
    self.action.setStatusTip("This is status tip")
    self.action.triggered.connect(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.

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 **`pyrcc5`** command:

```
pyrcc5 -o resources.py resources.qrc
```

Note: In Windows environments, attempting to run the **`pyrcc5`** from Command Prompt or Powershell will probably result in the error « Windows cannot access the specified device, path, or file [...] ». The easiest solution is probably to use the OSGeo4W Shell but if you are comfortable modifying the PATH environment variable or specifiying the path to the executable explicitly you should be able to find it at `<Your QGIS Install Directory>\bin\pyrcc5.exe`.

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 into your QGIS installation.

15.1.3 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.

15.1.4 Translation

With a few steps you can set up the environment for the plugin localization so that depending on the locale settings of your computer the plugin will be loaded in different languages.

Software requirements

The easiest way to create and manage all the translation files is to install Qt Linguist. In a Debian-based GNU/Linux environment you can install it typing:

```
sudo apt-get install qttools5-dev-tools
```

Files and directory

When you create the plugin you will find the `i18n` folder within the main plugin directory.

All the translation files have to be within this directory.

.pro file

First you should create a `.pro` file, that is a *project* file that can be managed by **Qt Linguist**.

In this `.pro` file you have to specify all the files and forms you want to translate. This file is used to set up the localization files and variables. A possible project file, matching the structure of our *example plugin*:

```
FORMS = ../form.ui
SOURCES = ../your_plugin.py
TRANSLATIONS = your_plugin_it.ts
```

Your plugin might follow a more complex structure, and it might be distributed across several files. If this is the case, keep in mind that `pylupdate5`, the program we use to read the `.pro` file and update the translatable string, does not expand wild card characters, so you need to place every file explicitly in the `.pro` file. Your project file might then look like something like this:

```
FORMS = ../ui/about.ui ../ui/feedback.ui \
        ../ui/main_dialog.ui
SOURCES = ../your_plugin.py ../computation.py \
          ../utils.py
```

Furthermore, the `your_plugin.py` file is the file that *calls* all the menu and sub-menus of your plugin in the QGIS toolbar and you want to translate them all.

Finally with the *TRANSLATIONS* variable you can specify the translation languages you want.

Avertissement: Be sure to name the `ts` file like `your_plugin_ + language + .ts` otherwise the language loading will fail! Use the 2 letter shortcut for the language (**it** for Italian, **de** for German, etc...)

.ts file

Once you have created the `.pro` you are ready to generate the `.ts` file(s) for the language(s) of your plugin.

Open a terminal, go to `your_plugin/i18n` directory and type:

```
pylupdate5 your_plugin.pro
```

you should see the `your_plugin_language.ts` file(s).

Open the `.ts` file with **Qt Linguist** and start to translate.

.qm file

When you finish to translate your plugin (if some strings are not completed the source language for those strings will be used) you have to create the `.qm` file (the compiled `.ts` file that will be used by QGIS).

Just open a terminal cd in `your_plugin/i18n` directory and type:

```
lrelease your_plugin.ts
```

now, in the `i18n` directory you will see the `your_plugin.qm` file(s).

Translate using Makefile

Alternatively you can use the makefile to extract messages from python code and Qt dialogs, if you created your plugin with Plugin Builder. At the beginning of the Makefile there is a LOCALES variable:

```
LOCALES = en
```

Add the abbreviation of the language to this variable, for example for Hungarian language:

```
LOCALES = en hu
```

Now you can generate or update the `hu.ts` file (and the `en.ts` too) from the sources by:

```
make transup
```

After this, you have updated `.ts` file for all languages set in the LOCALES variable. Use **Qt Linguist** to translate the program messages. Finishing the translation the `.qm` files can be created by the transcompile:

```
make transcompile
```

You have to distribute `.ts` files with your plugin.

Load the plugin

In order to see the translation of your plugin just open QGIS, change the language (*Settings* → *Options* → *Language*) and restart QGIS.

You should see your plugin in the correct language.

Avertissement: If you change something in your plugin (new UIs, new menu, etc..) you have to **generate again** the update version of both `.ts` and `.qm` file, so run again the command of above.

15.1.5 Tips and Tricks

Plugin Reloader

During development of your plugin you will frequently need to reload it in QGIS for testing. This is very easy using the Plugin Reloader plugin. You can find it as an experimental plugin with the Plugin Manager.

Accessing Plugins

You can access all the classes of installed plugins from within QGIS using python, which can be handy for debugging purposes.:

```
my_plugin = qgis.utils.plugins['My Plugin']
```

Log Messages

Plugins have their own tab within the log_message_panel.

Share your plugin

QGIS is hosting hundreds of plugins in the plugin repository. Consider sharing yours! It will extend the possibilities of QGIS and people will be able to learn from your code. All hosted plugins can be found and installed from within QGIS with the Plugin Manager.

Information and requirements are here: plugins.qgis.org.

15.2 Code Snippets

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

This section features code snippets to facilitate plugin development.

15.2.1 How to call a method by a key shortcut

In the plug-in add to the `initGui()`

```
self.keyAction = QAction("Test Plugin", self.iface.mainWindow())
self.iface.registerMainWindowAction(self.keyAction, "F7") # action1 triggered by␣
↪F7 key
self.iface.addPluginToMenu("&Test plugins", self.keyAction)
QObject.connect(self.keyAction, SIGNAL("triggered()"),self.keyActionF7)
```

To `unload()` add

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

The method that is called when F7 is pressed

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

15.2.2 How to toggle Layers

Since QGIS 2.4 there is new layer tree API that allows direct access to the layer tree in the legend. Here is an example how to toggle visibility of the active layer

```
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)
```

15.2.3 How to access attribute table of selected features

```
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 from current layer")
  else:
    QMessageBox.critical(self.iface.mainWindow(), "Error", "Please select a layer")
```

The method requires one parameter (the new value for the attribute field of the selected feature(s)) and can be called by

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

15.3 Using Plugin Layers

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

If your plugin uses its own methods to render a map layer, writing your own layer type based on QgsPluginLayer might be the best way to implement that.

TODO: Check correctness and elaborate on good use cases for QgsPluginLayer, ...

15.3.1 Subclassing QgsPluginLayer

Below is an example of a minimal QgsPluginLayer implementation. It is an excerpt of the Watermark example plugin

```
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
```

Methods for reading and writing specific information to the project file can also be added

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

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

When loading a project containing such a layer, a factory class is needed

```
class WatermarkPluginLayerType(QgsPluginLayerType):

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

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

You can also add code for displaying custom information in the layer properties

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

15.4 IDE settings for writing and debugging plugins

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

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.

15.4.1 A note on configuring your IDE on Windows

On Linux there is no additional configuration needed to develop plugins. 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 OSGeo4W 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 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 than 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 `qgis_core.dll` resides in. Normally this is `C:\OSGeo4W\apps\qgis\bin`, 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
```

15.4.2 Debugging using Eclipse and PyDev

Installation

To use Eclipse, make sure you have installed the following

- Eclipse
- Aptana Studio 3 Plugin or PyDev
- QGIS 2.x

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* → *Manage and Install 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.

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.

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.

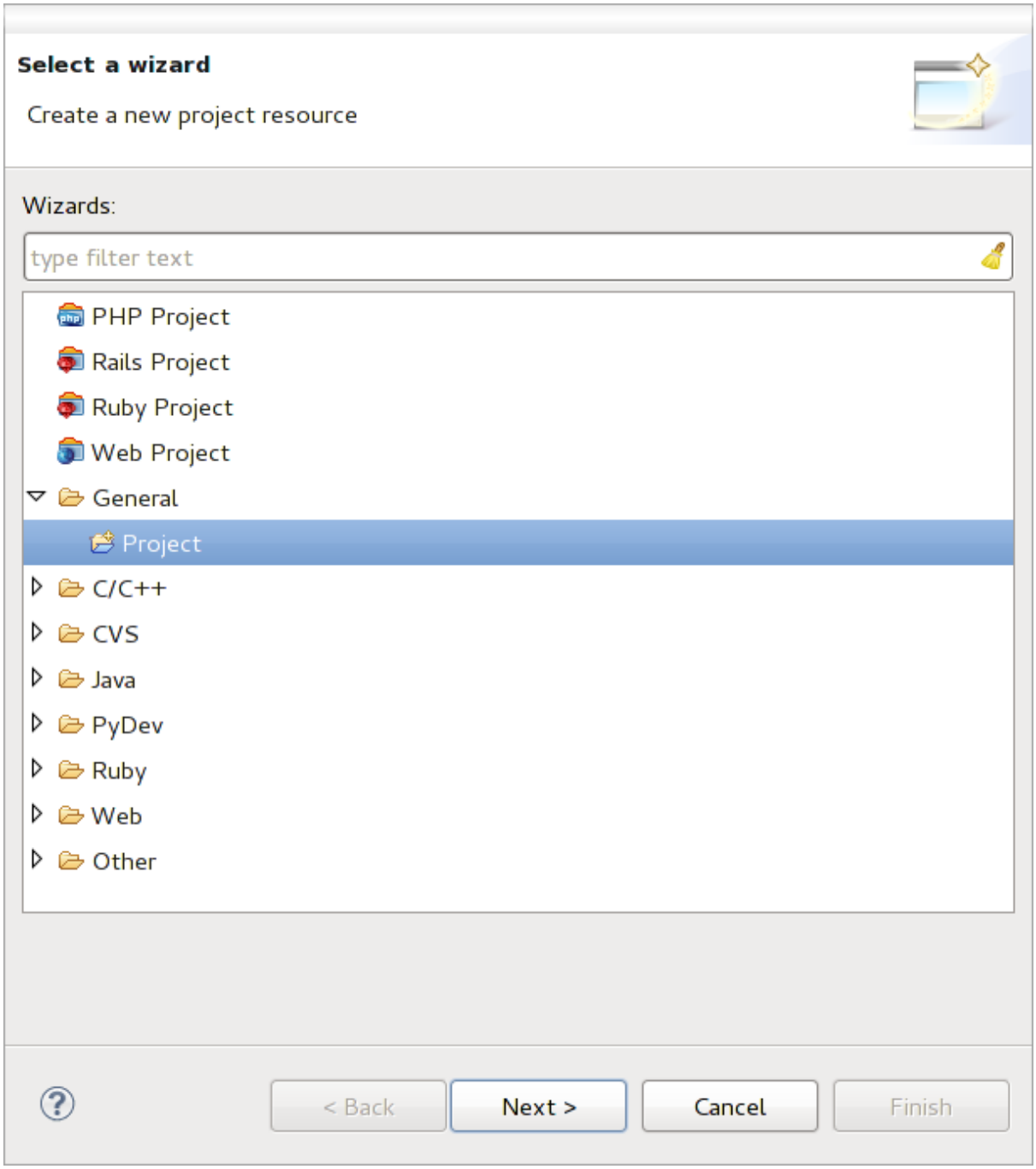


Figure 15.1: Eclipse project

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).

```
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 15.2: Breakpoint

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.

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.

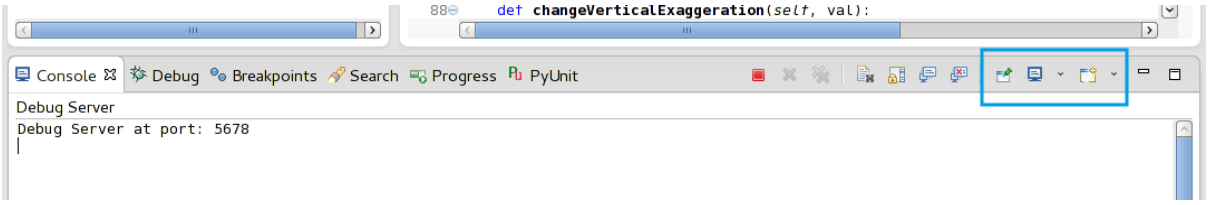


Figure 15.3: PyDev Debug Console

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.

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

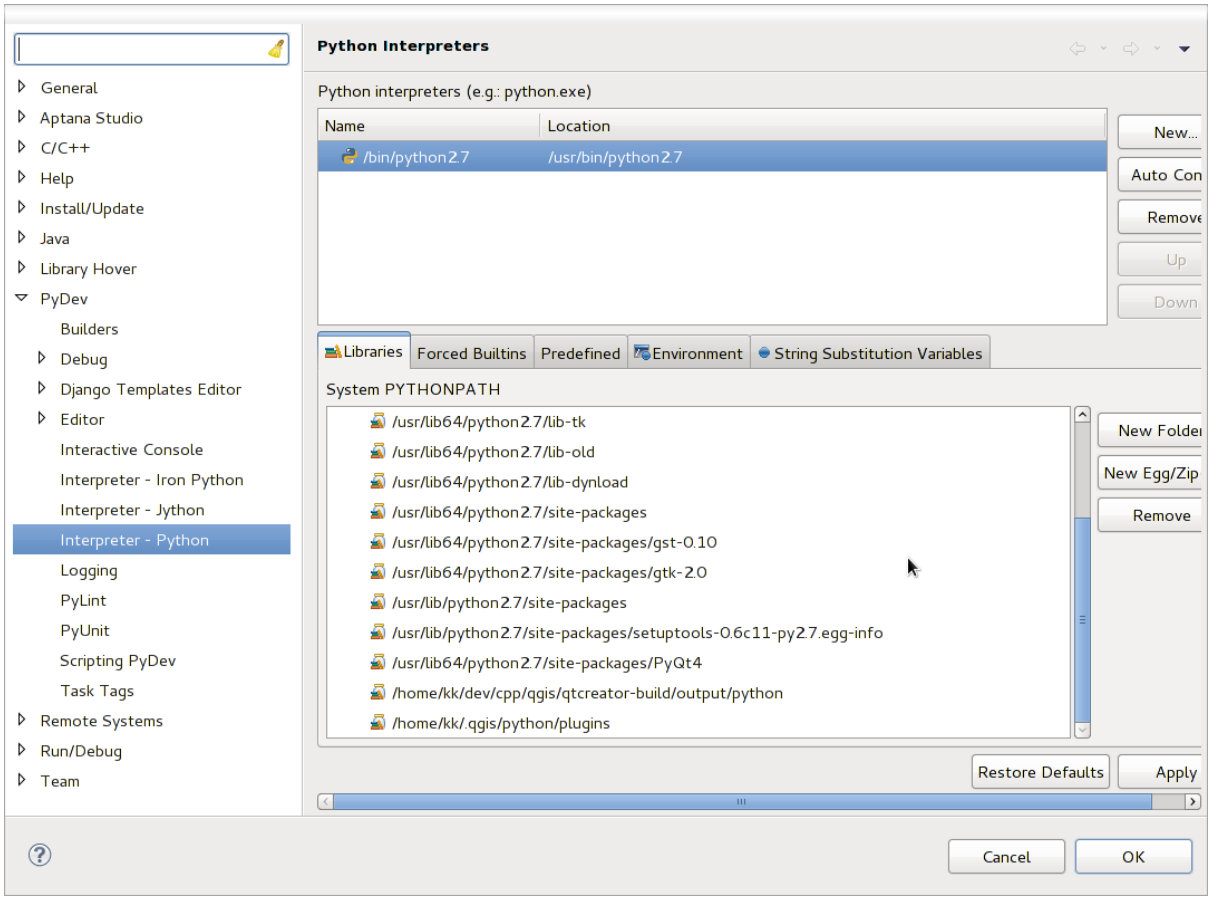


Figure 15.4: PyDev Debug Console

`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 `~/.qgis2/python/plugins`).

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.

15.4.3 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 macOS do:

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

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

TODO: Add testing information

15.5 Releasing your plugin

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

– *Plugin structure*

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 also find 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.

Please take special care to the following suggestions:

15.5.1 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

15.5.2 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.

15.5.3 Official Python plugin repository

You can find the *official* Python plugin repository at https://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

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.

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*.

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

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
```

Il est possible de créer des extensions dans le langage de programmation Python. Comparé aux extensions classiques développées en C++, celles-ci devraient être plus faciles à écrire, comprendre, maintenir et distribuer du fait du caractère dynamique du langage python.

Les extensions Python sont listées avec les extensions C++ dans le gestionnaire d'extension. Elles sont récupérées depuis le dossier ~/(UserProfile)/python/plugins et les chemins suivants:

- UNIX/Mac: (qgis_prefix)/share/qgis/python/plugins
- Windows: (qgis_prefix)/python/plugins

Pour savoir à quoi correspondent ~ et (UserProfile), veuillez vous référer à core_and_external_plugins.

Note: En configurant QGIS_PLUGINPATH avec un chemin d'accès vers un répertoire existant, vous pouvez ajouter ce répertoire à la liste des chemins parcourus pour trouver les extensions.

CHAPTER 16

Créer une extensions Processing

Suivant le type d'extension que vous voulez développer, il sera parfois plus judicieux d'ajouter sa fonctionnalité sous forme d'un algorithme Processing (ou un ensemble d'algorithmes). Cela vous apportera une meilleure intégration au sein de QGIS, des fonctionnalités supplémentaires (puisqu'elle pourra être également lancée dans les composants de Processing comme le modeleur ou l'interface de traitements par lots), ainsi qu'un temps de développement plus court (puisque Processing va gérer une grande partie du travail).

To distribute those algorithms, you should create a new plugin that adds them to the Processing Toolbox. The plugin should contain an algorithm provider, which has to be registered when the plugin is instantiated.

To create a plugin from scratch which contains an algorithm provider, you can follow these steps using the Plugin Builder:

- Installez l'extension Plugin Builder
- Créez une nouvelle extension à l'aide de Plugin Builder. Lorsque l'application vous demande le modèle à utiliser, sélectionnez « Processing Provider ».
- L'extension créée contient un fournisseur disposant d'un seul algorithme. Les fichiers du fournisseur et de l'algorithme sont correctement commentés et contiennent de l'information sur comment modifier le fournisseur et comment ajouter de nouveaux algorithmes. S'y référerer pour plus d'informations.

If you want to add your existing plugin to Processing, you need to add some code.

In your `metadata.txt`, you need to add a variable:

```
hasProcessingProvider=yes
```

In the Python file where your plugin is setup with the `initGui` method, you need to adapt some lines like this:

```
from qgis.core import QgsApplication
from .processing_provider import Provider


class YourPluginName():

    def __init__(self):
        self.provider = None

    def initProcessing(self):
        self.provider = Provider()
        QgsApplication.processingRegistry().addProvider(self.provider)
```

```
    def initGui(self):
        self.initProcessing()

    def unload(self):
        QgsApplication.processingRegistry().removeProvider(self.provider)
```

You can create a folder `processing_provider` with three files in it:

- `__init__.py` with nothing in it. This is necessary to make a valid Python package.
- `provider.py` which will create the Processing provider and expose your algorithms.

```
from qgis.core import QgsProcessingProvider

from .example_processing_algorithm import ExampleProcessingAlgorithm


class Provider(QgsProcessingProvider):

    def loadAlgorithms(self, *args, **kwargs):
        self.addAlgorithm(ExampleProcessingAlgorithm())
        # add additional algorithms here
        # self.addAlgorithm(MyOtherAlgorithm())

    def id(self, *args, **kwargs):
        """The ID of your plugin, used for identifying the provider.

        This string should be a unique, short, character only string,
        eg "qgis" or "gdal". This string should not be localised.
        """
        return 'yourplugin'

    def name(self, *args, **kwargs):
        """The human friendly name of your plugin in Processing.

        This string should be as short as possible (e.g. "Lastools", not
        "Lastools version 1.0.1 64-bit") and localised.
        """
        return self.tr('Your plugin')

    def icon(self):
        """Should return a QIcon which is used for your provider inside
        the Processing toolbox.
        """
        return QgsProcessingProvider.icon(self)
```

- `example_processing_algorithm.py` which contains the example algorithm file. Copy/paste the content of the script template: https://github.com/qgis/QGIS/blob/master/python/plugins/processing/script/ScriptTemplate.py

Now you can reload your plugin in QGIS and you should see your example script in the Processing toolbox and modeler.

CHAPTER 17

Bibliothèque d'analyse de réseau

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

Depuis la révision ee19294562 (QGIS >= 1.8), la nouvelle bibliothèque d'analyse de réseau a été ajoutée à la bibliothèque principale d'analyse de QGIS. La bibliothèque :

- créé un graphe mathématique à partir de données géographiques (couches vecteurs de polylignes)
- implémente des méthodes simples de la théorie des graphes (pour l'instant, uniquement avec l'algorithme Dijkstra).

La bibliothèque d'analyse de réseau a été créée en exportant les fonctions de l'extension principale RoadGraph. Vous pouvez en utiliser les méthodes dans des extensions ou directement dans la console Python.

17.1 Information générale

Voici un résumé d'un cas d'utilisation typique:

1. créer un graphe depuis les données géographiques (en utilisant une couche vecteur de polylignes)
2. lancer une analyse de graphe
3. utiliser les résultats d'analyse (pour les visualiser par exemple)

17.2 Construire un graphe

La première chose à faire est de préparer les données d'entrée, c'est à dire de convertir une couche vecteur en graphe. Les actions suivantes utiliseront ce graphe et non la couche.

Comme source de données, on peut utiliser n'importe quelle couche vecteur de polylignes. Les nœuds des polylignes deviendront les sommets du graphe et les segments des polylignes seront les arcs du graphes. Si plusieurs nœuds ont les mêmes coordonnées alors ils composent le même sommet de graphe. Ainsi, deux lignes qui ont en commun un même nœud sont connectées ensemble.

Pendant la création d'un graphe, il est possible de « forcer » (« lier ») l'ajout d'un ou de plusieurs points additionnels à la couche vecteur d'entrée. Pour chaque point additionnel, un lien sera créé: le sommet du graphe le plus proche ou l'arc de graphe le plus proche. Dans le cas final, l'arc sera séparé en deux et un nouveau sommet sera ajouté.

Les attributs de la couche vecteur et la longueur d'un segment peuvent être utilisés comme propriétés du segment.

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.

Il est temps de plonger dans le processus.

D'abord, nous devrions importer le module networkanalysis pour utiliser la bibliothèque

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

Ensuite, quelques exemples pour créer un directeur

```
# 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)
```

Pour construire un directeur, il faut lui fournir une couche vecteur qui sera utilisée comme source pour la structure du graphe ainsi que des informations sur les mouvements permis sur chaque segment de route (sens unique ou déplacement bidirectionnel, direct ou inversé). L'appel au directeur se fait de la manière suivante

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

Voici la liste complète de la signification de ces paramètres:

- `vl` — couche vecteur utilisée pour construire le graphe
- `directionFieldId` — index du champ de la table d'attribut où est stocké l'information sur la direction de la route. Si `-1` est utilisé, cette information n'est pas utilisée. Un entier.

- `directDirectionValue` — valeur du champ utilisé pour les routes avec une direction directe (déplacement du premier point de la ligne au dernier). Une chaîne de caractères.
- `reverseDirectionValue` — valeur du champ utilisé pour les routes avec une direction inverse (déplacement du dernier point de la ligne au premier). Une chaîne de caractères.
- `bothDirectionValue` — valeur du champ utilisé pour les routes bidirectionelles (pour ces routes, on peut se déplacer du premier point au dernier et du dernier au premier). Une chaîne de caractères.
- `defaultDirection` — direction par défaut de la route. Cette valeur sera utilisée pour les routes où le champ `directionFieldId` n'est pas paramétré ou qui a une valeur différente des trois valeurs précédentes. Un entier ``1` indique une direction directe, `2` indique une direction inverse et `3` indique les deux directions.

Il est ensuite impératif de créer une stratégie de calcul des propriétés des arcs:

```
properter = QgsDistanceArcProperter()
```

Et d'informer le directeur à propos de cette stratégie:

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

Nous pouvons maintenant utiliser le constructeur qui créera le graphe. Le constructeur de la classe QgsGraphBuilder utilise plusieurs arguments:

- crs — système de coordonnées de référence à utiliser. Argument obligatoire.
- otfEnabled — utiliser ou non la projection « à la volée ». La valeur par défaut est const:*True* (oui, utiliser OTF).
- topologyTolerance — la tolérance topologique. La valeur par défaut est 0.
- ellipsoidID — ellipsoïde à utiliser. Par défaut « WGS84 ».

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

Nous pouvons également définir plusieurs points qui seront utilisés dans l'analyse, par exemple:

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

Maintenant que tout est en place, nous pouvons construire le graphe et lier ces points dessus:

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

La construction du graphe peut prendre du temps (qui dépend du nombre d'entités dans la couche et de la taille de la couche). `tiedPoints` est une liste qui contient les coordonnées des points liés. Lorsque l'opération de construction est terminée, nous pouvons récupérer le graphe et l'utiliser pour l'analyse:

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

Avec le code qui suit, nous pouvons récupérer les index des arcs de nos points:

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

17.3 Analyse de graphe

L'analyse de graphe est utilisée pour trouver des réponses aux deux questions: quels arcs sont connectés et comment trouver le plus court chemin ? Pour résoudre ces problèmes la bibliothèque d'analyse de graphe fournit l'algorithme de Dijkstra.

L'algorithme de Dijkstra trouve le plus court chemin entre un des arcs du graphe par rapport à tous les autres en tenant compte des paramètres d'optimisation. Ces résultats peuvent être représentés comme un arbre du chemin le plus court.

L'arbre du plus court chemin est un graphe pondéré de direction (plus précisément un arbre) qui dispose des propriétés suivantes:

- Seul un arc n'a pas d'arcs entrants: la racine de l'arbre.
- Tous les autres arcs n'ont qu'un seul arc entrant.
- Si un arc B est atteignable depuis l'arc A alors le chemin de A vers B est le seul chemin disponible et il est le chemin optimal (le plus court) sur ce graphe.

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.

La méthode `shortestTree()` est utile lorsque vous voulez approcher l'arbre du chemin le plus court. Elle créé toujours un nouvel objet de graphe (QgsGraph) et elle accepte trois variables:

- source — graphe en entrée
- startVertexIdx — index du point sur l'arbre (la racine de l'arbre)
- criterionNum — nombre de propriétés d'arc à utiliser (en partant de 0).

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

La méthode `dijkstra()` dispose des mêmes arguments mais retourne deux tableaux. Dans le premier, l'élément i contient l'index de l'arc à suivre ou -1 s'il n'y a pas d'arc à suivre. Dans le second tableau, l'élément i contient la distance depuis la racine de l'arbre jusqu'au sommet i ou la valeur DOUBLE_MAX si le sommet est inaccessible depuis la racine.

```
(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 qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *
from qgis.PyQt.QtCore import *
from qgis.PyQt.QtGui 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
```

Même chose mais en utilisant la méthode `dijkstra()`.

```
from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *
from qgis.PyQt.QtCore import *
from qgis.PyQt.QtGui 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())
```

17.3.1 Trouver les chemins les plus courts

Pour trouver le chemin optimal entre deux points, on peut utiliser l'approche suivante. Les deux points (départ en A et arrivée en B) sont « liés » au graphe lors de sa construction. En utilisant les méthodes `shortestTree()` ou `dijkstra()`, nous construisons alors l'arbre du chemin le plus court avec une racine qui démarre par le point A. Dans le même arbre, nous trouvons notre point B et commençons à traverser l'arbre du point B vers le point A. L'algorithme complet peut être écrit de la façon suivante

```
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
```

A ce niveau, nous avons le chemin, sous la forme d'une liste inversée d'arcs (les arcs sont listés dans un ordre inversé, depuis le point de la fin vers le point de démarrage) qui seront traversés lors de l'évolution sur le chemin.

Voici le code d'exemple pour la console Python de QGIS qui utilise la méthode `shortestTree()` (vous devrez sélectionner la couche de polylignes dans la légende et remplacer les coordonnées dans le code par les vôtres):

```
from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *
from qgis.PyQt.QtCore import *
from qgis.PyQt.QtGui 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)
```

Et voici le même exemple mais avec la méthode `dijkstra()`:

```
from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *
from qgis.PyQt.QtCore import *
from qgis.PyQt.QtGui 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)
```

17.3.2 Surfaces de disponibilité

La surface de disponibilité d'un arc A est le sous-ensemble des arcs du graphe qui sont accessibles à partir de l'arc A et où le coût des chemins à partir de A vers ces arcs ne dépasse pas une certaine valeur.

Plus clairement, cela peut être illustré par l'exemple suivant: « Il y a une caserne de pompiers. Quelles parties de la ville peuvent être atteintes par un camion de pompier en 5 minutes ? 10 minutes ? 15 minutes ? » La réponse à ces questions correspond aux surface de disponibilité de la caserne de pompiers.

Pour trouver les surfaces de disponibilité, nous pouvons utiliser la méthode `dijkstra()` de la classe `QgsGraphAnalyzer`. Elle suffit à comparer les éléments du tableau de coût avec une valeur prédéfinie. si le coût[i] est inférieur ou égal à la valeur prédéfinie, alors l'arc i est à l'intérieur de la surface de disponibilité, sinon il est situé en dehors.

Un problème plus difficile à régler est d'obtenir les frontières de la surface de disponibilité. La frontière inférieure est constituée par l'ensemble des arcs qui sont toujours accessibles et la frontière supérieure est composée des arcs qui ne sont pas accessibles. En fait, c'est très simple: c'est la limite de disponibilité des arcs de l'arbre du plus court chemin pour lesquels l'arc source de l'arc est accessible et l'arc cible ne l'est pas.

Voici un exemple:

```
from qgis.core import *
from qgis.gui import *
from qgis.networkanalysis import *
from qgis.PyQt.QtCore import *
from qgis.PyQt.QtGui 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))
```

CHAPTER 18

Extensions Python pour QGIS Server

Avertissement: *Despite our constant efforts, information beyond this line may not be updated for QGIS 3. Refer to https://qgis.org/pyqgis/master for the python API documentation or, give a hand to update the chapters you know about. Thanks.*

- *allowToEdit*
- *cacheKey*

Python plugins can also run on QGIS Server (see label_qgisserver):

- By using the *server interface* (`QgsServerInterface`) a Python plugin running on the server can alter the behavior of existing core services (**WMS**, **WFS** etc.).
- With the *server filter interface* (`QgsServerFilter`) you can change the input parameters, change the generated output or even provide new services.
- With the *access control interface* (`QgsAccessControlFilter`) you can apply some access restriction per requests.

18.1 Architecture des extensions de filtre serveur

Server python plugins are loaded once when the FCGI application starts. They register one or more `QgsServerFilter` (from this point, you might find useful a quick look to the server plugins API docs). Each filter should implement at least one of three callbacks:

- `requestReady()`
- `responseComplete()`
- `sendResponse()`

Tous les filtres ont accès à l'objet de requête/réponse (`QgsRequestHandler`) et peuvent manipuler toutes les propriétés (entrée/sortie) et déclencher des exceptions (à l'aide d'une méthode un peu particulière comme nous le verrons ci-dessous).

Voici un pseudo-code présentant une session serveur typique et quand les fonctions de retour des filtres sont appelées:

- **Récupérer la requête entrante**
  - Créer un gestionnaire de requête GET/POST/SOAP.
  - Passer la requête à une instance de la classe `QgsServerInterface`.
  - Appeler la fonction `requestReady()` des filtres d'extension.
  - **S'il n'y a pas de réponse**
    - **Si SERVICE vaut WMS/WFS/WCS.**
      - **Créer un serveur WMS/WFS/WCS.**

        Appeler la fonction du serveur `executeRequest()` et appeler la fonction des filtres d'extension `sendResponse()` lors de l'envoi du flux vers la sortie ou alors conserver le flux binaire et le type de contenu dans le gestionnaire de requête.
    - Appeler la fonction `responseComplete()` des filtres d'extension.
  - Appeler la fonction `sendResponse()` des filtres d'extension.
  - Demander au gestionnaire d'émettre la réponse.

Les paragraphes qui suivent décrivent les fonctions de rappel disponibles en détails.

18.1.1 requestReady

Cette fonction est appelée lorsque la requête est prêt: l'URL entrante et ses données ont été analysées et juste avant de passer la main aux services principaux (WMS, WFS, etc.), c'est le point où vous pouvez manipuler l'entrée et dérouler des actions telles que:

- l'authentification/l'autorisation
- les redirections
- l'ajout/suppression de certains paramètres (les noms de type par exemple)
- le déclenchement d'exceptions

Vous pouvez également substituer l'intégralité d'un service principal en modifiant le paramètre **SERVICE** et complètement outrepasser le service (ce qui n'a pas beaucoup d'intérêt).

18.1.2 sendResponse

Cette fonction est appelée lorsque la sortie est envoyée vers la sortie **FCGI** ''stdout''(et ainsi, vers le client); cette action est habituellement réalisée après la fin du traitement des services principaux et après que le signal responseComplete ait été appelé. Dans un certain nombre de rares cas, le contenu XML peut devenir si volumineux qu'il a fallu implémenter une gestion de flux XML (GetFeature pour WFS est l'une d'entre elles) et dans ce cas, `sendResponse()` est appelée plusieurs fois avant que la réponse soit complète (et avant que `responseComplete()` soit appelée). La conséquence naturelle est que `sendResponse()` est normalement appelée une fois mais peut, exceptionnellement, être appelée plusieurs fois et dans ce cas (et uniquement dans ce cas), elle est appelée avant `responseComplete()`.

`sendResponse()` est le meilleur moment pour la manipulation directe des sorties des services principaux et alors que la fonction `responseComplete()` est généralement une option, `sendResponse()` est la seule option viable pour le cas des services en flux.

18.1.3 responseComplete

Cette fonction est appelée lorsque les services principaux (si lancés) terminent leur processus et que la requête est prête à être envoyée au client. Comme indiqué ci-dessus, elle est normalement appelée avant `sendResponse()` sauf pour les services en flux (ou les filtres d'extension) qui peuvent avoir lancé `sendResponse()` plus tôt.

`responseComplete()` est le moment adéquat pour fournir de nouvelles implémentations de service (WPS ou services personnalisés) et pour effectuer des manipulations directes de la sortie des services principaux (comme par exemple pour ajouter un filigrane sur une image WMS).

18.2 Déclencher une exception depuis une extension

Il reste encore du travail sur ce sujet: l'implémentation actuelle gère les exceptions gérées ou non en paramétrant la propriété `QgsRequestHandler` avec une instance de `QgsMapServiceException`. De cette manière, le code C++ peut capturer les exceptions Python gérées et ignorer les exceptions non gérées (ou mieux, les journaliser).

Cette approche fonctionne globalement mais elle n'est pas très « pythonesque »: une meilleure approche consisterait à déclencher des exceptions depuis le code Python et les faire remonter dans la boucle principale C++ pour y être traitées.

18.3 Écriture d'une extension serveur

A server plugin is a standard QGIS Python plugin as described in *Développer des extensions Python*, that just provides an additional (or alternative) interface: a typical QGIS desktop plugin has access to QGIS application through the `QgisInterface` instance, a server plugin has also access to a `QgsServerInterface`.

Pour indiquer à QGIS Server qu'une extension dispose d'une interface serveur, une métadonnée spécifique est requise (dans *metadata.txt*)

```
server=True
```

The example plugin discussed here (with many more example filters) is available on github: QGIS HelloServer Example Plugin. You could also find more examples at https://github.com/elpaso/qgis3-server-vagrant/tree/master/resources/web/plugins or browsing the QGIS plugins repository.

18.3.1 Fichiers de l'extension

Vous pouvez voir ici la structure du répertoire de notre exemple d'extension pour serveur

```
PYTHON_PLUGINS_PATH/
  HelloServer/
    __init__.py     --> *required*
    HelloServer.py  --> *required*
    metadata.txt    --> *required*
```

18.3.2 __init__.py

This file is required by Python's import system. Also, QGIS Server requires that this file contains a `serverClassFactory()` function, which is called when the plugin gets loaded into QGIS Server when the server starts. It receives reference to instance of `QgsServerInterface` and must return instance of your plugin's class. This is how the example plugin `__init__.py` looks like:

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

def serverClassFactory(serverIface):
    from HelloServer import HelloServerServer
    return HelloServerServer(serverIface)
```

18.3.3 HelloServer.py

C'est l'endroit où tout se passe et voici à quoi il devrait ressembler : (ex. `HelloServer.py`)

Une extension côté serveur consiste typiquement en une ou plusieurs fonctions de rappel empaquetées sous forme d'objets appelés QgsServerFilter.

Chaque `QgsServerFilter` implémente une ou plusieurs des fonctions de rappel suivantes:

- `requestReady()`
- `responseComplete()`
- `sendResponse()`

L'exemple qui suit implémente un filtre minimaliste qui affiche *HelloServer!* pour le cas où le paramètre **SERVICE** vaut "HELLO":

```
from qgis.server import *
from qgis.core import *

class HelloFilter(QgsServerFilter):

    def __init__(self, serverIface):
        super(HelloFilter, self).__init__(serverIface)

    def responseComplete(self):
        request = self.serverInterface().requestHandler()
        params = request.parameterMap()
        if params.get('SERVICE', '').upper() == 'HELLO':
```

```
            request.clearHeaders()
            request.setHeader('Content-type', 'text/plain')
            request.clearBody()
            request.appendBody('HelloServer!')
```

Les filtres doivent être référencés dans la variable **serverIface** comme indiqué dans l'exemple suivant:

```
class HelloServerServer:
    def __init__(self, serverIface):
        # Save reference to the QGIS server interface
        self.serverIface = serverIface
        serverIface.registerFilter( HelloFilter, 100 )
```

Le second paramètre de `registerFilter()` permet de définir une priorité indiquant l'ordre des fonctions de rappel ayant le même nom (une priorité faible est invoquée en premier).

En utilisant les trois fonctions de rappel, les extensions peuvent manipuler l'entrée et/ou la sortie du serveur de plusieurs manières. A chaque instant, l'instance de l'extension a accès à la classe `QgsRequestHandler` au travers de la classe `QgsServerInterface`, `QgsRequestHandler` dispose de nombreuses méthodes qui peuvent être utilisée pour modifier les paramètres d'entrée avant qu'ils intègrent le processus principal du serveur (à l'aide de `requestReady()`) ou après que la requête ait été traitée par les services principaux (en utilisant `sendResponse()`).

Les exemples suivants montrent quelques cas d'utilisation courants :

18.3.4 Modifier la couche en entrée

L'extension d'exemple contient un test qui modifie les paramètres d'entrée provenant de la requête; dans cet exemple, un nouveau paramètre est injecté dans *parameterMap* (qui est déjà analysé), ce paramètre est alors visible dans les services principaux (WMS, etc.), à la fin du processus des services principaux, nous vérifions que le paramètre est toujours présent:

```
from qgis.server import *
from qgis.core import *

class ParamsFilter(QgsServerFilter):

    def __init__(self, serverIface):
        super(ParamsFilter, self).__init__(serverIface)

    def requestReady(self):
        request = self.serverInterface().requestHandler()
        params = request.parameterMap( )
        request.setParameter('TEST_NEW_PARAM', 'ParamsFilter')

    def responseComplete(self):
        request = self.serverInterface().requestHandler()
        params = request.parameterMap( )
        if params.get('TEST_NEW_PARAM') == 'ParamsFilter':
            QgsMessageLog.logMessage("SUCCESS - ParamsFilter.responseComplete",
↪'plugin', QgsMessageLog.INFO)
        else:
            QgsMessageLog.logMessage("FAIL    - ParamsFilter.responseComplete",
↪'plugin', QgsMessageLog.CRITICAL)
```

Ceci est un extrait de ce que vous pouvez voir dans le fichier log:

```
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 plugin[0]␣
↪HelloServerServer - loading filter ParamsFilter
 src/core/qgsmessagelog.cpp: 45: (logMessage) [1ms] 2014-12-12T12:39:29 Server[0]␣
↪Server plugin HelloServer loaded!
```

```
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 Server[0]␣
↪Server python plugins loaded
 src/mapserver/qgsgetrequesthandler.cpp: 35: (parseInput) [0ms] query string is:␣
↪SERVICE=HELLO&request=GetOutput
 src/mapserver/qgshttprequesthandler.cpp: 547: (requestStringToParameterMap) [1ms]␣
↪inserting pair SERVICE // HELLO into the parameter map
 src/mapserver/qgshttprequesthandler.cpp: 547: (requestStringToParameterMap) [0ms]␣
↪inserting pair REQUEST // GetOutput into the parameter map
 src/mapserver/qgsserverfilter.cpp: 42: (requestReady) [0ms] QgsServerFilter␣
↪plugin default requestReady called
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 plugin[0]␣
↪HelloFilter.requestReady
 src/mapserver/qgis_map_serv.cpp: 235: (configPath) [0ms] Using default␣
↪configuration file path: /home/xxx/apps/bin/admin.sld
 src/mapserver/qgshttprequesthandler.cpp: 49: (setHttpResponse) [0ms] Checking␣
↪byte array is ok to set...
 src/mapserver/qgshttprequesthandler.cpp: 59: (setHttpResponse) [0ms] Byte array␣
↪looks good, setting response...
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 plugin[0]␣
↪HelloFilter.responseComplete
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 plugin[0]␣
↪SUCCESS - ParamsFilter.responseComplete
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 plugin[0]␣
↪RemoteConsoleFilter.responseComplete
 src/mapserver/qgshttprequesthandler.cpp: 158: (sendResponse) [0ms] Sending HTTP␣
↪response
 src/core/qgsmessagelog.cpp: 45: (logMessage) [0ms] 2014-12-12T12:39:29 plugin[0]␣
↪HelloFilter.sendResponse
```

Sur la ligne en surbrillance, la chaîne « SUCCESS » indique que le plugin a réussi le test.

La même technique peut être employée pour utiliser un service personnalisé à la place d'un service principal: vous pouviez par exemple sauter une requête **WFS SERVICE** ou n'importe quelle requête principale en modifiant le paramètre **SERVICE** par quelque-chose de différent et le service principal ne serait alors pas lancé; vous pourriez ensuite injecter vos resultats personnalisés dans la sortie et les renvoyer au client (ceci est expliqué ci-dessous).

18.3.5 Modifier ou remplacer la couche en sortie

L'exemple du filtre de filigrane montre comment remplacer la sortie WMS avec une nouvelle image obtenue par l'ajout d'un filigrane plaqué sur l'image WMS générée par le service principal WMS:

```
import os

from qgis.server import *
from qgis.core import *
from qgis.PyQt.QtCore import *
from qgis.PyQt.QtGui import *


class WatermarkFilter(QgsServerFilter):

    def __init__(self, serverIface):
        super(WatermarkFilter, self).__init__(serverIface)

    def responseComplete(self):
        request = self.serverInterface().requestHandler()
        params = request.parameterMap( )
        # Do some checks
        if (request.parameter('SERVICE').upper() == 'WMS' \
                and request.parameter('REQUEST').upper() == 'GETMAP' \
                and not request.exceptionRaised() ):
```

```
            QgsMessageLog.logMessage("WatermarkFilter.responseComplete: image␣
↪ready {}".format(request.infoFormat()), 'plugin', QgsMessageLog.INFO)
            # Get the image
            img = QImage()
            img.loadFromData(request.body())
            # Adds the watermark
            watermark = QImage(os.path.join(os.path.dirname(__file__), 'media/
↪watermark.png'))
            p = QPainter(img)
            p.drawImage(QRect( 20, 20, 40, 40), watermark)
            p.end()
            ba = QByteArray()
            buffer = QBuffer(ba)
            buffer.open(QIODevice.WriteOnly)
            img.save(buffer, "PNG")
            # Set the body
            request.clearBody()
            request.appendBody(ba)
```

Dans cet exemple, la valeur du paramètre **SERVICE** est vérifiée. Si la requête entrante est de type **WMS GETMAP** et qu'aucune exception n'a été déclarée par une extension déjà déclarée ou par un service principal (WMS dans notre cas), l'image WMS générée est récupérée depuis le tampon de sortie et l'image du filigrane est ajoutée. L'étape finale consiste à vider le tampon de sortie et à le remplacer par l'image nouvellement générée. Merci de prendre note que dans une situation réelle, nous devrions également vérifier le type d'image requêtée au lieu de retourner du PNG quoiqu'il arrive.

18.4 Extension de contrôle d'accès

18.4.1 Fichiers de l'extension

Voici l'arborescence de notre exemple d'extension serveur:

```
PYTHON_PLUGINS_PATH/
  MyAccessControl/
    __init__.py     --> *required*
    AccessControl.py  --> *required*
    metadata.txt    --> *required*
```

18.4.2 __init__.py

This file is required by Python's import system. As for all QGIS server plugins, this file contains a `serverClassFactory()` function, which is called when the plugin gets loaded into QGIS Server when the server starts. It receives reference to instance of `QgsServerInterface` and must return instance of your plugin's class. This is how the example plugin `__init__.py` looks like:

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

def serverClassFactory(serverIface):
    from MyAccessControl.AccessControl import AccessControl
    return AccessControl(serverIface)
```

18.4.3 AccessControl.py

```
class AccessControl(QgsAccessControlFilter):

```

```
    def __init__(self, server_iface):
        super(QgsAccessControlFilter, self).__init__(server_iface)

    def layerFilterExpression(self, layer):
        """ Return an additional expression filter """
        return super(QgsAccessControlFilter, self).layerFilterExpression(layer)

    def layerFilterSubsetString(self, layer):
        """ Return an additional subset string (typically SQL) filter """
        return super(QgsAccessControlFilter, self).layerFilterSubsetString(layer)

    def layerPermissions(self, layer):
        """ Return the layer rights """
        return super(QgsAccessControlFilter, self).layerPermissions(layer)

    def authorizedLayerAttributes(self, layer, attributes):
        """ Return the authorised layer attributes """
        return super(QgsAccessControlFilter, self).authorizedLayerAttributes(layer,
↪ attributes)

    def allowToEdit(self, layer, feature):
        """ Are we authorise to modify the following geometry """
        return super(QgsAccessControlFilter, self).allowToEdit(layer, feature)

    def cacheKey(self):
        return super(QgsAccessControlFilter, self).cacheKey()
```

Cet exemple donne un accès total à tout le monde.

C'est le rôle de l'extension de connaître qui est connecté dessus.

Pour toutes ces méthodes nous avons la couche passée en argument afin de personnaliser la restriction par couche.

18.4.4 layerFilterExpression

Utilisé pour ajouter une expression pour limiter les résultats, ex:

```
def layerFilterExpression(self, layer):
    return "$role = 'user'"
```

Pour limiter aux entités où l'attribut role vaut « user ».

18.4.5 layerFilterSubsetString

Comme le point précédent mais utilise `SubsetString` (exécuté au niveau de la base de données).

```
def layerFilterSubsetString(self, layer):
    return "role = 'user'"
```

Pour limiter aux entités où l'attribut role vaut « user ».

18.4.6 layerPermissions

Limiter l'accès à la couche.

Renvoie un objet de type `QgsAccessControlFilter.LayerPermissions` qui dispose des propriétés suivantes:

- `canRead` pour autoriser l'affichage dans les requêtes `GetCapabilities` et pour permettre l'accès en lecture.

- `canInsert` pour autoriser l'insertion de nouvelles entités.
- `canUpdate` pour autoriser les mises à jour d'entités.
- `candelete` pour autoriser les suppressions d'entités.

Exemple :

```
def layerPermissions(self, layer):
    rights = QgsAccessControlFilter.LayerPermissions()
    rights.canRead = True
    rights.canRead = rights.canInsert = rights.canUpdate = rights.canDelete = False
    return rights
```

Pour tout limiter à un accès en lecture seule.

18.4.7 authorizedLayerAttributes

Utilisé pour limiter la visibilité d'un sous-groupe d'attribut spécifique.

L'argument attributes renvoie la liste des attributs réellement visibles.

Exemple :

```
def authorizedLayerAttributes(self, layer, attributes):
    return [a for a in attributes if a != "role"]
```

Cache l'attribut "role".

18.4.8 allowToEdit

Il permet de limiter l'édition à un sous-ensemble d'entités.

Il est utilisé dans le protocole `WFS-Transaction`.

Exemple :

```
def allowToEdit(self, layer, feature):
    return feature.attribute('role') == 'user'
```

Pour limiter l'édition aux entités dont l'attribut role contient la valeur user.

18.4.9 cacheKey

QGIS Server conserve un cache du capabilties donc pour avoir un cache par rôle vous pouvez retourner le rôle dans cette méthode. Ou retourner `None` pour complètement désactiver le cache.