Introduction to QGIS

Learning outcomes:	Tools & techniques:
Be able to set up QGIS and add data (p. 1)	QGIS (p. 1)
Understand how to add data with a latitude / longitude coordinate (p. 4)	Add Delimited Text Layer (p. 4)
Join tabular data to spatial data (p. 5)	Joining data (p. 5)
Understand how to undertake simple calculations (p. 7)	Adding a new field (p. 7)
Understanding how to classify data for representation on a map (p. 7)	Classifying and symbolising data (p. 7)

1. Introduction and Setup

Anyone can download QGIS from the Internet and it works on Windows, Ubuntu and Mac. QGIS is consistent with the principles of Windows software, so if you are familiar with programs such as Word or Excel you should find that similar concepts apply. Several conventions have been adopted in the following instructions:

- **Bold type** indicates software commands, options or window names (e.g. **Open**, **Delete** etc.)
- A courier font is used for folder, file or program names (e.g. `world_countries`)
- Accessing a command through a sequence of menus is shown as:

View > **Zoom Data** > **Full Extent**

Many commands require the OK button to be clicked or the Enter key to be pressed after a name has been typed in or an option selected. Download the necessary data files for this practical to a directory on the hard disc of your PC (we will use `Documents`).

- Open `Documents` and create a new folder named `GIS`.
- Open this folder and create a new folder called `prac1`. This is where we will be storing all of the data that we copy and create during this practical session.

As there are several files they have been compressed into a single zip file, and you will need to first *copy* this and then *extract* the data files. Follow the instructions on screen to download the zip file from:

- bit.ly/qgisprac1 or www.github.com/nickbearman/intro-qgis-spatial-data/ or Moodle

2. Starting up QGIS

- Start QGIS by clicking on **Start**, then type **QGIS** and select **QGIS Desktop 2.18**. If you get a **QGIS Tips** window (see below) you can tick the "I've had enough tips" tickbox to stop it opening every time you run QGIS.
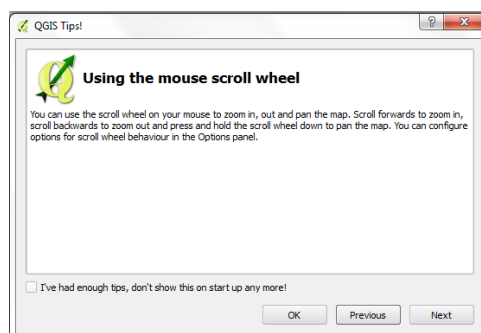
Let's start off by adding data to the map display.

- Start by clicking the **Add Vector Layer** button
- Then choose **Browse** and navigate to `Documents\GIS\prac1` folder
  Change the option in the drop down menu on the bottom right to `ESRI Shapefiles (*.shp *.SHP)`. Select the `world_countries.shp` file, click **Open** and click **Open** again.
- This will add a layer which shows the countries of the world.

QGIS has a number of different ways of navigating around spatial data. Click on the **Zoom In** tool and draw a box around Europe – the display will zoom in to show this area. To view all of the data, click the **Zoom Full** tool .

Use the **Pan Map** tool to move around the map by clicking on the tool and then click and drag around the map. You can also use the mouse wheel to zoom in and zoom out. Experiment with the zoom and pan tools, and when you are happy, move on to the next section of the practical.

This is where the on screen demonstration ends. Carry on with the practical instructions below.

The **Identify Features** tool allows you to select a country on the map and see the attribute information stored in the shapefile about that country.

- Select the **Identify Features** tool , and then click on a country.
- A window will appear, titled Identify Results, with information about the country you selected. You may need to expand the window to see more of the details.
- Try selecting different countries, to see how the tool works.

When we added the `world_countries` shapefile, QGIS randomly assigned a colour. We can change this to something more sensible – green, for instance.

- Right click on the `world_countries` entry in the layers window on the left hand side of the screen, and click on **Properties**:
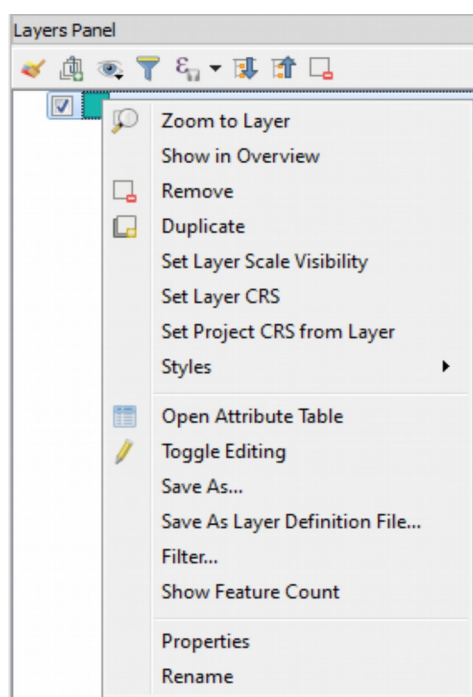

- This will open the Layer Properties window, where we can change many different options for how the layer is displayed, as well as other options about the layer.
- Click on the **Style** option on the left hand side.
- To change the colour, click on the drop down menu next to the color option:
- You can then either select one of the preset colours, or click on **Choose color...** and select a colour from the color picker. Use either option, and change the colour to something you like.
- Click **Ok** (and **Ok** again if necessary) and this will close the Layer Properties window and update the colour on the map.

The options you have in this layer will depend on what type of spatial data you are dealing with. The countries layer is a polygon layer, so we can change the colour of the polygons. Point layers or line layers will have different options. Experiment with different colours and the other options in the Style section of the Layer Properties window.

You may have noticed that when QGIS started, there were lots of toolbars and windows on display. It's helpful to tidy this up a bit so we only have the buttons on display that we need.

- Right-click on the toolbar (grey area at the top) and you should see something similar to the menu below:
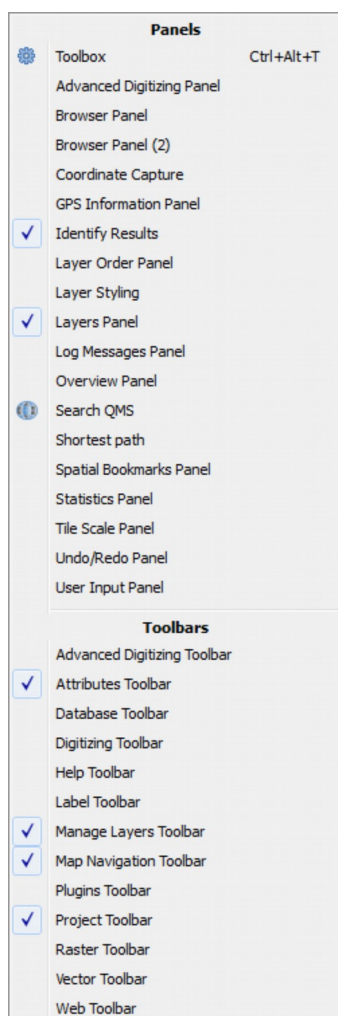
- You can click different toolbars on/off by checking their checkbox ✖. Spend some time turning the toolbars on/off to see what the different options do. Once you are finished, leave the following toolbars with their checkboxes checked ✖: **Identify Results; Layers Panel; Attributes Toolbar; File; Label; Manage Layers** and **Map Navigation**

This is a basic set of tools to get you started; we will turn on others as we require them.

- You can also use the handle on each tool bar to drag the toolbars around and arrange them as you wish:

You should now have a big empty space with a few toolbars.

- Using the same process as previously (or select **Layer > Add Layer > Add Vector Layer… > Browse > …**) add three more shapefiles to the map.
- The files to add are: `world_deg30.shp,` `world_lakes.shp` and `world_rivers.shp` shapefiles.
- To select multiple files, select the one at the top of the list, hold down Shift on the keyboard and click on the bottom file.

QGIS will add the layers, and again assign a random colour. However, you may not be able to see all the data. This is because the order of the different layers in the Layers window is important.

- Re-order the layers (by dragging them up or down) so they are in this order (from top to bottom): `world_lakes,` `world_rivers,` `world_countries` and `world_deg30.`
- Now you should be able to see the three different data sets. We can rename the layers as well – right click on `world_deg30` and select **rename**. Rename this layer to `oceans` and press **enter**.
- Also use the **Identify Features** tool to investigate some of the new data layers.
- Now is a good time to save the QGIS project file. Select **Project > Save** and save the file somewhere sensible.

The colours of the different layers will also need to be changed, so update the colours to reflect what the layers represent. Remember also to save the project file!

3. Adding point data from a delimited CSV file

We have already added polygon data and line data, and now we are going to look at adding some point data. Open up the `world-cities.csv` file included in the zip file – it should open in Excel. You can see the file contains four columns: Name, Latitude, Longitude and Country. As this data has some coordinates, QGIS can plot the data on our map. Close the file (without saving, if Excel asks), and return to QGIS.

- Click **Layer > Add Layer > Add Delimited Text Layer…** and click **Browse** and select the `world-cities.csv` file.
- You should see the different columns appear at the bottom of the window.
- Make sure that File format is set to **CSV** and Geometry definition is set to **Point coordinates.**
- Check that X field is set to **Longitude** and Y field is set to **Latitude**.
- Click **OK**.
- Depending on the settings, QGIS may ask what coordinate system the coordinates are in. Make sure Coordinate Reference System **WGS 84** – Authority ID **EPSG:4326** is selected (type the ID number **4326** in the filter box if needed), and click **OK**.

You should now see the 15 cities added to the map. Update the symbols to a colour that fits in with your existing map. *Optional Exercise - See if you can work out how to add a name to each of the cities. Look in the Layer Properties window under Labels.*

4. Joining tabular data

We only need the `world_countries` layer for the next exercise, so turn all of the other layers off by clicking on the check box next to each layer entry in the Layers panel.

> *Not every dataset you want to use comes as a Shapefile or in a spatial format (in fact, the majority do not!). Often data will be in the format of a report, spreadsheet or table that you need to link to your existing spatial data for use in some analysis. For example, you may be working with population data for a country where the data is in a table, csv, Excel file (.xls, .xlsx), or any other non-spatial format. To map this data, you have to merge this with a Shapefile containing country boundaries. This operation is known as a Join and this section will cover how to carry out table joins in QGIS. To demonstrate this we will join a table of updated population data to our world_countries layer.*

In order to join tabular data it is necessary that both of your datasets have a *common attribute* (e.g. a name, unique reference or code). This attribute must be *unique* (i.e. a country must not be listed twice in your Attribute table) and *identical* (i.e. the country names must be the same and spelt identically, e.g. "Gambia, The" and "The Gambia" will not join successfully).

- **Open** the Attribute table of the `world_countries` layer and you'll see that the **NAME** field is unique (different) for each country.
- **Close** the Attribute table.
- In the data files that you copied today you'll notice that there is also an Excel file named `pop.xls`. Double-click this file and it should open in Excel. The dataset contains two fields, a unique identifier called **NAME** and the other named **pop_2011**. Close the Excel file once you have finished viewing the data.

Now that we've identified the two fields in our datasets that we will use to make the join we can move on.

- To add our table to the map we need to use the **Add Vector Layer** button. Click on this now and **Browse** to the `prac1` data files. Select `pop.xls` (if it doesn't show, change the box next to File Name from `ESRI Shapefiles` to `All files`) and click **Open**, and click **Open** again to add the table of updated population data to the map project
- The table will now appear as a layer in the Layers window:
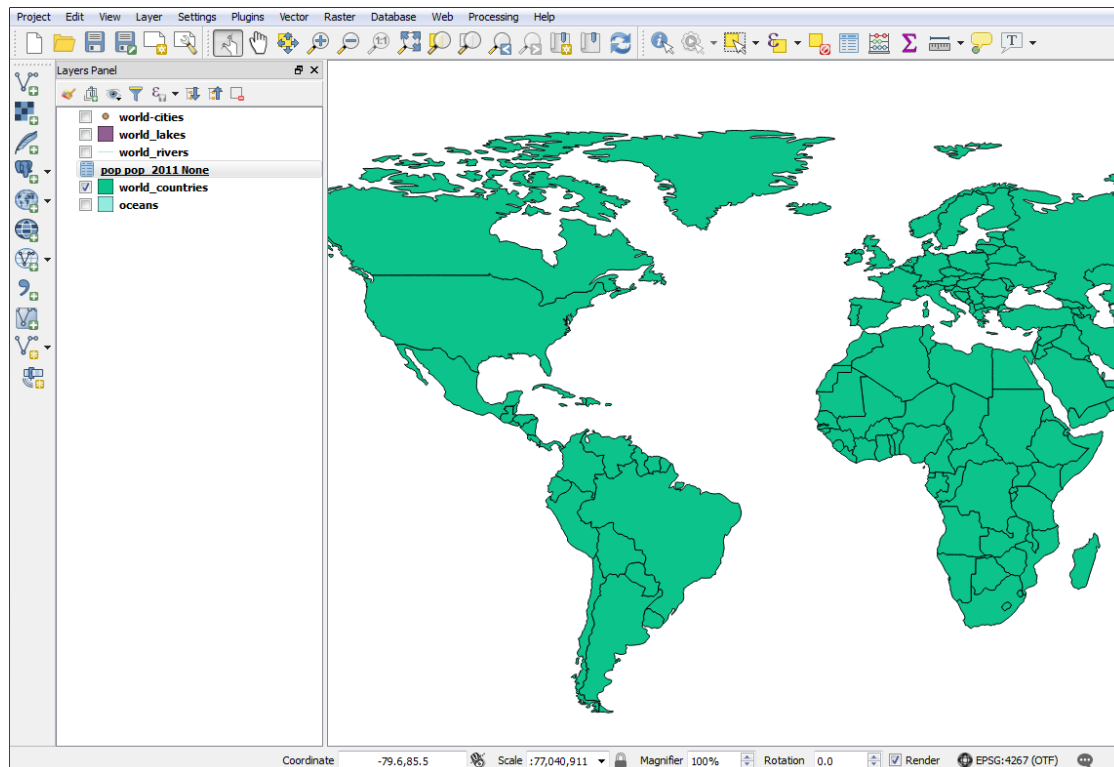
- Rig
ht-
click on the table we have just added (pop_pop_2011_None) and **Open Attribute Table** to check
that the data appears correctly (if you have all <null> values there has been a problem importing
your data, adding it again). You should see both fields with data populated, the first row containing
Afghanistan with a population of 25500 ('000s people). **Close** the attribute table when you finished
viewing the data
- Now we will join this table layer with your spatial data. Right-click on the world_countires
layer, select **Properties** and click on the **Joins** option
- Click on the plus ⊕ button to create a new join. The **Add Vector Join** dialogue box will now open
- Make sure that pop_pop_2011_None is selected in the **Join layer** dropdown box
- NAME should be selected in the **Join field** dropdown box
- NAME should also be selected in the **Target field** dropdown box
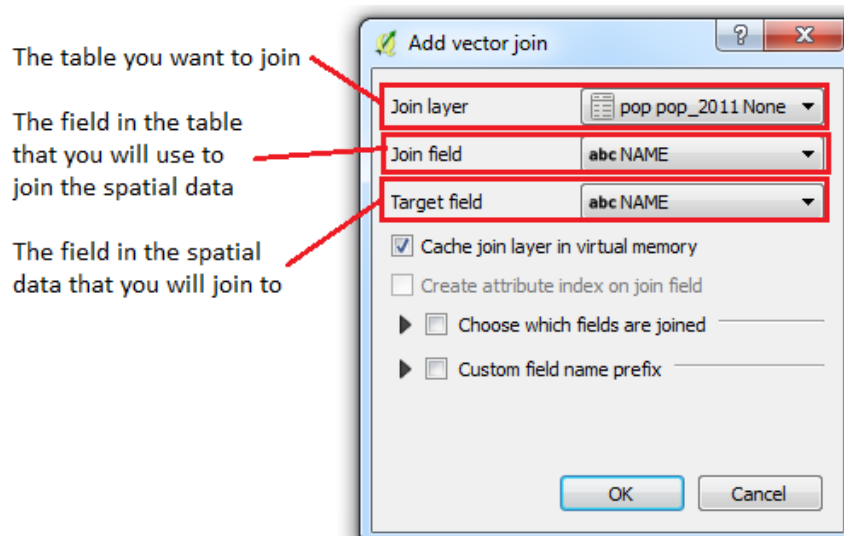
- Hit **OK** on the Add vector join window and also in the Layer Properties window

- **Open Attribute Table** of `world_countries` and you will see that a new field (named `pop pop_2011 None_pop_2011`) has been added to the Attribute table! Please ask for help if this is not the case.

The join that we have made is not permanent; it is a temporary link between the two datasets. To make the Join permanent we need to save a new copy of the `world_countries` layer.

- Right-click `world_countries` and click on **Save as**
- In the Save vector layer as window make sure that the following variables are selected:
  - Format is `ESRI Shapefile`
  - Save the new layer as `world_countries_updated` in the `prac1` folder (click **Browse** to select the folder and enter the filename)
  - Leave all other fields as they are
  - Check the checkbox next to ☒ **Add saved file to map**
- Hit **OK** and the new layer will be added to the map. Open the attribute table to check that the new field (potentially shortened to `pop pop_20`) is present.
- Right-click `world_countries` and select **Remove**
- If you like, **Save** 💾 your project

5. Adding a new field and calculating values

We will now add a new field to the attribute table and calculate some values (the change in population between 2004 and 2011) using a simple mathematical operation. This can be useful when you want to create new data or undertake some analyses.

- **Open Attribute Table** of `world_countries_updated`
- Click on the **Toggle editing mode** ✏ button
- Click on **New column** 🔳 button
- Set **Name** to `POP_DIFF`
- Leave **Comment** blank
- Set **Type** to `Whole number (integer)`, change **Length** to 10.
- Hit **OK**

> *In this instance we are dealing with whole numbers, so we can use the integer setting. If we were calculating something else (for example, % population change) which involved decimal numbers, we would need to select Decimal number (real), and set **Length** as 10 and **Precision** as 2.*

You will see that the new field contains values, by default, as `NULL`. We now need to populate this new field (column) with some data.

- Click on the **Open field calculator** 🧮 button and the Field calculator window will open. It is here that we can undertake many types of mathematical calculations
- Check the checkbox next to ✖ **Update existing field** and select the field named `POP_DIFF` from the dropdown box
- Under the list in the center, click on the expand sign next to **Fields and Values**
- Double-click the field named `pop pop_20` to add it to the Expression (the full name of the field has been cut off)
- Now click on the minus (-) sign and double-click on `POP2004`. Your expression should look like this: `"pop_2011_p" - "POP2004"` (notice how the expression builder puts in the double quote marks for you)
- Hit **OK** to run the calculation and the `POP_DIFF` field will populate with the calculated values (the first few values should be 75 (Luxembourg), 632 (Switzerland) and 5644 (France), ask if this is not the case)
- Finally, click on the **Toggle editing mode** ✏ button and choose **Save** when prompted. Close the attribute table
- **Save** 💾 your project.

By the time you get to this section, we should have completed the 'Classification Exercise' worksheet. If we haven't yet, please let me know that you have reached this point.

6. Classifying Population Change

Now we have calculated the change in population between 2004 and 2011, we need to display it on the map.

- Open the **Style** tab of the **Layer Properties** window for the `world_countries_updated` layer.
- Where the option says **Single symbol** at the top, change this to **Graduated**.
- Select the `POP_DIFF` field from the **Column** drop-down list.
- The click **Classify**, you will see the 5 classes for this data set appear in the window.
- Click **OK**, and QGIS will update the map.

Now we have a map of population change. However, there are various things wrong with it. What are they? Have a think, and then chat to your neighbour to see what they think might be wrong.

There are a number of things you can change to alter the classification:

1. Try changing the classification method, the default is **Equal Interval**. How do the different methods change the classification of the data. Which is "right"?
2. Try changing the number of classes.
3. Try changing the colours used – how does this impact the message of the map? *(ColorBrewer can be accessed through Color Ramp > New color ramp… > ColorBrewer).*
4. Try changing the class boundaries – use the Histogram tool in QGIS.

Once you have finished, remember to save your QGIS Project.

> If you wish to open this up on another computer, you will need to copy the QGIS Project File (*.qgs) and the data files (everything you downloaded from the zip file).
>
> Many of the principles of using QGIS are the same in other GIS software, such as ArcGIS and MapInfo. You can apply the principles you learnt here into any other GIS software, but the location and the names of some of the features might be slightly different.
>
> You may notice that some countries are missing from the map – for instance, Burma and Taiwan. This is because their data is missing from the files – you will see *NULL* written in place of the number, which means the number is missing. You do need to be aware of how missing values are represented, because each data set is likely to use a different setting. Some population data uses a value of '-99' to represent a missing value, which will play havoc with the population change calculation. Some will also use a value of 0, which is more subtly misleading, and can often be missed, because a value of 0 population (meaning a missing value) is very different to a value of 0 (meaning a population count of 0).

7. Classifying % Population Change (optional exercise)

What else might be wrong with the data we have calculated?

Currently we are comparing the increase in numbers of people between 2004 and 2011 in each country. It might make more sense to compare the % increase. Calculate this and then show this on a map. Why is this a more logical way of representing this data?

8. Adding a Basemap (optional exercise)

We have the option of adding a base map to the data we have in QGIS. We can do this through a plugin called **QuickMapServices**. To install it, click **Plugins > Manage and Install Plugins…** Then select the plugin and click install. Once installed, it is accessed through the web menu at the top of the window (try **OSM > OSM Mapnik** as a starting point).

9. Downloading and Presenting Data (optional exercise)

Try downloading and mapping some Energy Estimate data from http://data.cdrc.ac.uk for a Local Authority of your choice. You will need to register to download the data, and then search for the Local Authority (e.g. Liverpool) and download the data. Choose an appropriate way of symbolising the data and think about the questions these data could answer.