

# GIS Level 2: QGIS Workshop Exercises

## Exercise 1: Map projections

Map projections, also called Coordinate Reference Systems (CRS) can be viewed or changed using GIS software.

1. Examine the data in GIS\_Level2\_Data\workshop\_exercise. Is there a projection file for each dataset?

Note that cambridge\_dem is a raster dataset and uses a .tfw file (known as a “world” file), which contains the information needed to transform image coordinates to real-world coordinates. Shapefiles use a .prj file, which includes the coordinate system information.

2. Open QGIS. Click Project > Save As and save the new project to your working folder.
3. Add the following two data layers from GIS\_Level2\_Data\workshop\_exercise
  - a. MBTAbusroutes
  - b. CambridgePlaygrounds
4. Click Ok when you are asked to select a transformation. Close the Data Source Manager window.

The transformation box changes the coordinate reference system of your map project (not the data layers). This changes how the data look on the screen and can help minimize distortion.

5. To add a basemap click Web > QuickMapServices > OSM > OSM Standard.
6. Right click on CambridgePlaygrounds and select Zoom to Layer.

Do the playgrounds and bus routes seem to be in the correct locations?  
They should be since both layers had a defined projection (.prj) file.

7. Right click on CambridgePlaygrounds and select Properties.
8. Select the Information tab.

What is the coordinate reference system?

Depending on your version of QGIS, you will either see the name NAD83 / Massachusetts Mainland (ftUS) or a generic name, such as SOURCECRS. QGIS sometimes has trouble identifying the names of projections even though the .prj file is being read correctly by the software. Regardless of the name we can tell it is projected because the Units are in feet.

9. Do the same for the MBTAbusroutes data layer. What is the coordinate reference system? Is it the same or different from the playgrounds?
10. Close the Properties box and select Vector > Data Management Tools > Reproject Layer.

We will use this tool to change the projection of the playgrounds so that it is the same as that of the bus routes. Note that when right clicking on a layer there is the option to Set Layer CRS. This should only be used to assign a projection to a data layer that does not already have one or to

change one that is incorrect. Our map projections appear to be correct so we do not need to use this tool.

Although not always required, your analysis results may be quicker and more accurate if your data layers are in the same projection. If you want to calculate the proximity of playgrounds to bus routes, you would first want to make sure the projections of both data layers are the same.

11. Choose playgrounds as the Input layer.
  - a. In Target CRS, from the dropdown menu select EPSG 26986 -NAD83 / Massachusetts Mainland\_FIPS, the coordinate system of the MBTA bus routes. EPSG numbers are unique ID numbers assigned to every CRS.
  - b. Click the ... icon next to the [create temporary layer] box and select Save to File. Save your output dataset in your working folder.
  - c. Click Run.

## Exercise 2: Access basic analysis tools

Tools can be accessed via the menus at the top of the screen in QGIS.

- A number of “core” tools come with QGIS and most can be found under the Vector or Raster menus. You will also find tools by opening the Processing Toolbox (Processing > Toolbox).
- Since QGIS is an open source GIS software, additional tools have been developed by individuals. These can be added by clicking Plugins > Manage and Install Plugins and searching for the tool you want.
- Googling is a good way to find tools that have been created for QGIS. Note that when there is a major upgrade, some tools may not work immediately.

1. Add MBTA\_NODE to the map from GIS\_Level2\_Data\workshop\_exercise.



2. Click Ok if you see a coordinate system message.
3. Click Vector > Geoprocessing Tools > Buffer.

How do you know what inputs and parameters to use? A short description of the tool appears on the right side of the tool window. Click the help button to learn more about this tool and its parameters.

4. Select the MBTA\_NODE as your Input layer from the dropdown menu.
5. Enter a distance of 1000 meters.
6. Most QGIS tools will create a temporary layer unless you specify otherwise. Do this by clicking the ... button next to the box at the bottom of the window that says [Create temporary layer]. Select the Save to File option and choose an output location. Choose .shp as the file type.
7. Run the tool. Turn off your buffers after you have looked at the layer.

The interface for all tools looks similar in QGIS, with most requiring input data, required parameters, and optional parameters.

## Exercise 3: Use raster tools

Different tools can be used with raster data versus vector data, although the output could be a vector, raster, or table, depending on the tools. There are also tools that allow you to convert from one data type to another.

1. Add the `cambridge_dem.tif` to your map. Click Ok if you see a coordinate system window. Close the Data Source Manager window.
2. Click Raster > Extraction > Contour.
3. Select the dem as your Input layer and scroll down to choose an output location in the Contours box. It's useful to choose an output name that indicates the contour interval so you can use this for future reference.
4. In the Interval between contour lines box, type 5. What are the units of this interval? While some tools default to the unit of the coordinate reference system, QGIS also uses the measurement unit specified in the project properties. You can find this under Project > Properties > General. It's a good idea to set the unit the same as the CRS of your data layers.
5. Click Run. Close the Contour window when the tools is finished running.

You will notice that the output is a vector line layer, which could then be exported to other programs or used as input for vector analysis tools.

## Exercise 4: Use Geoda to access spatial statistics tools

While QGIS includes a wide variety of tools, there are some tools that are not currently included in QGIS, including those for spatial statistics. We will use another open-source software called Geoda, which was specifically developed for exploratory analysis and spatial statistics.

1. Open Geoda.
2. Next to the Input file box, click the folder icon and select ESRI shapefile. Select `median_income_suffolk_ma` from the workshop data folder.
3. Click the W icon in the toolbar (Weights Manager) and Create. Specify the following:
  - a) Weights File ID Variable: `spatial_id` (this is any ID that uniquely identifies each polygon)
  - b) Rook contiguity (rook shares borders, queen shares borders and vertices/corners)

These parameters tell Geoda how to define a neighborhood for analysis. Feel free to experiment with other parameters in the future.

4. Click Create and save your weights file.
5. Close the Weights File Creation window and Weights Manager window.
6. Select Space > Univariate Local Moran's I.
7. Choose VALUE0 as the variable, which is the median household income in each tract, and verify that your weights file is listed in the Weights box. See the text file in the workshop exercise data folder for the attribute field information. Click OK.

8. Check off the cluster map and Moran Scatter Plot and click OK.
9. Where are there clusters of high and low income? The tool has also output a scatterplot that you can examine. Close Geoda when you are finished.

The Moran scatter plot provides a classification of spatial association into four categories, corresponding to the location of the points in the four quadrants of the plot. These categories are referred to as High-High, Low-Low, Low-High and High-Low, relative to the mean, which is the center of the graph. It is important to keep in mind that there is a difference between a location being in a given quadrant of the plot, and that location being a significant local cluster or spatial outlier.

In the take-home exercise you will learn how to output these results so they can be added to QGIS. You can learn more about the statistics used in Geoda here:

<https://geodacenter.github.io/documentation.html>

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