



# INTRODUCTION TO GIS USING QGIS

Basics in QGIS

## ABSTRACT

This lesson covers many basic functions in QGIS that will enable you to conduct basic data organization and manipulation. It works with data from the Washington State Department of Education and the US Census Bureau TIGER/Line database.

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## TO USE THIS DOCUMENT

The document is arranged in sections, which can be overviewed in the Table of Contents. It is subsequently broken down as an outline.

Descriptions and purposes are listed in black

Instructions for execution are highlighted in purple

Questions are highlighted in burnt orange

## YOU WILL NEED

- QGIS 3.0 (2.8 and 2.1.8 are acceptable, but some menu options and names differ)
  - Workflow in QGIS 3.2 has not been tested. As with 2.8 and 2.1.8, some menu options may differ
- Notepad ++, KomodoEdit, or your preferred IDE
- Notepad

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# 3

## GETTINGS STARTED

### 1. Adding data

- a. Go to <tinyurl.com/uwayatut>
  - i. Navigate to QGIS Tutorial page and download the first tutorial file archive
    1. Extract the file to your U Drive (flash drive, or preferred location)
- b. In QGIS, click Layer → Add Layer → Add Vector Layer
  - i. In the **Source** box, click the [...] button
  - ii. Add “K12\_Schools.shp”, and press **OK**
  - iii. Click the **Add** button
  - iv. Repeat steps **bi-iii** with “School\_Districts\_\_Washington\_State.shp” and “Montessori\_Schools\_\_Washington\_State.shp”
  - v. When all three layers have been added, click **Close**
- c. If your school district layer opened above the two point layers, you may not be able to see any points on your map
  - i. Look to the bottom left, and you will see your layer controls
  - ii. Drag the School District layer to the bottom, and the Montessori School layer to the top
- d. You can change the colors and shapes of your layers
  - i. Double-click the colorful circle to the left of the Montessori School Layer, and change it to red
    1. Play around with the color slider until you find a shade that you like
  - ii. Double-click the colorful circle to the left of the K-12 School Layer, and change it to blue
  - iii. Double-click the colorful box next to the School District layer and change it to a shade of beige
  - iv. If you’ve clicked on a layer and it takes you to another Properties Menu item, click **Symbology**
- e. Save your progress so far
  - i. At the top left, click **Project → Save As...**
  - ii. Navigate to your preferred working folder, and call the file “WASchools”
- f. You can also turn rows on and off
  - i. For now, uncheck the box next to the Montessori school layer

### 2. Navigating the Analytical Interface

- a. Right-click the K12\_Schools layer, and click **Open Attributes Table**
  - i. The attributes table is where all of your data is stored
  - ii. Each point has a data entry for each attribute
  - iii. The column heads are clickable
    1. Click the column head for “District”: What does it do?
  - iv. Pan across the top row of buttons

1. The Editor pencil allows you to make permanent modifications to the table
  - a. You must toggle this setting on and off to make textual changes to the table
  - b. You can select features using an expression or formula
  - c. You can also activate the **Filter** function
  - d. Name one other function available in this screen: \_\_\_\_\_
- v. On the bottom-left, click blue funnel
  1. This pulls up several other “show” features, such as showing only selected features
  2. Using these features does not modify your dataset
- vi. Close the attributes table
- vii. In the top row of buttons, click the magnifying glass with a “+” in it
  1. Click near a clustering of points and drag a box around them to zoom in (I start with Spokane)
- viii. Double-click the School Districts layer
  1. This is the **Properties** window
    - a. You can also reach it by right-clicking the layer and selecting **Properties**
    - b. Here, you will be able to access many options, such as symbology for making choropleth maps, selecting labels, building diagrams, and conducting joins
  2. Click the **Labels** button
    - a. In the drop menu, select **Show labels for this layer**
    - b. **Label With “NAME”**
    - c. Feel free to choose any font from the drop menu, and click OK
    - d. Which school districts are in the viewing extent of your selection? \_\_\_\_\_
  3. Click the white hand tool to pan around the map
    - a. Click and drag 3 times in any direction. What do you see now? \_\_\_\_\_
  4. Roll the mouse wheel towards your palm to zoom out and pan to a new cluster
  5. Zoom in on that cluster (I went to Yakima)
- ix. In the top row of buttons, look for the white “I” in a blue circle – this is the “identify” tool
  1. Select the tool, and click any of the school districts that are in view
    - a. What is the Educational Service District (ESD) of the selection? \_\_\_\_\_
    - b. What is the region number? \_\_\_\_\_
- x. To the right of the **Identify** tool, click the white arrow with the yellow box for **Select Features**

1. Click any of the points representing schools
  - a. Note, QGIS does not carry out single selects on polygons
2. Right-click the K-12 schools layer, and **Open Attribute Table**
3. On the bottom-left, open the funnel drop menu that currently says **Show All Features**
4. Change it to **Show Selected Features**
5. Click back to the main window
  - a. Click and drag the selector tool just like you did the magnifying glass, and try to capture as many points as you can
  - b. Click back to your attribute table window, and look at the top bar
  - c. **How many points were you able to select?** \_\_\_\_\_
6. Two spaces to the right of the **Select Features** tool, click the yellow box with the red "X" to clear selected features
7. Close the attributes window

### SELECTING SPATIALLY and SPATIAL JOINS

3. **Selecting by Location – and Saving**
  - a. Open the attributes table for School Districts
  - b. Click the column header for "Name" one time, and select the row indicator "11" for "Bellingham"
  - c. At the top of the attributes table window, click the yellow box with four blue arrows facing in the cardinal directions – **Pan map to the selected rows**
    - i. Alternatively you can use **CTRL+P**
  - d. Along the top row of drop menus, select **Processing → Toolbox**
  - e. In the newly opened side pane, select **Vector Selection → Select by Location** – make sure that the School Districts layer is selected in your layers list
    - i. Select Features: the K12 schools layer
    - ii. Fill the checkbox for **Are Within**
    - iii. By comparing features from: the School districts layer
    - iv. Fill the checkbox for **Selected features only**
    - v. Make sure that **creating new selection** is active in the drop menu
    - vi. Click the **Run** button
    - vii. **Look to the bottom-left: how many features were selected in the K12 schools layer?** \_\_\_\_\_
  - f. Use the selector arrow to click on the neighboring Mount Baker school district – Make sure that you have the K12 schools layer selected in your layer list
    - i. Select By Location
    - ii. Again, select features from the K12 schools layer, and use the school districts layer as your selector
    - iii. Make sure that **Selected features only** is checked

1. This time, change the **Modify current selection by** drop menu says **adding to current selection**
2. **Run**
3. How many features are now selected in the K-12 layer? \_\_\_\_\_

#### 4. Extracting by Location

Sometimes it is helpful and necessary to trim your data to a limited scope, especially if your dataset is very large. Extracting by Location and Selecting by Location in order to extract are two methods for trimming your data.

- a. Remove all selections
- b. Pan to the Seattle School District
- c. We'd like to select all school districts that touch the waters of Lake Washington
  - i. Click "Shoreline"
  - ii. Hold the CTRL button, and then click the following districts
    1. Northshore
    2. Lake Washington
    3. Bellevue
    4. Renton
    5. Seattle
    6. Shoreline
  - iii. In the Toolbox select **Extract by Location**
    1. In the **Extracted(location)** dialogue, it currently says [Create temporary layer]
      - a. Click the [...] radio button
      - b. Select **Save to File**
      - c. Navigate to the file folder containing your data
      - d. Click on the drop menu that currently says "**GPKG Files (\*.gpkg)**"
      - e. Select "**SHP (\*.shp)**"
      - f. Name the file "LK\_WA\_Schls.shp"
      - g. Save the file
      - h. Select **Run in Background**
    2. QGIS adds a layer called "Extracted(location)" to your layers list. Modifications you make to this layer will edit the LK\_WA\_Schls.shp file
      - a. Right-click the "Extracted(location)" layer
      - b. At the bottom of the drop menu, select "Rename"
        - i. Rename the Layer "LK\_WA\_Schls"

5. “Extracting” by Location (Alternative)
  - a. Deactivate the K12 layer
  - b. Activate the Montessori Schools layer
  - c. Repeat steps from Part 3 to **select** Montessori Schools **by location**
    - i. If your polygons from the School Districts layer are no longer selected, make sure to repeat the selection steps from “Section 4cii”
    - ii. Select Features From “**Montessori\_Schools\_Washington\_State**”
    - iii. Select **Are Within**
    - iv. Select **School Districts**
    - v. Select **Selected Features Only**
    - vi. Select **Creating new selection**
    - vii. Select **Run**
    - viii. Close the window
    - ix. Right-click the Montessori Schools layer, and select “Open Attribute table”
      1. How many schools were selected? \_\_\_\_\_
    - x. Close the attribute table window
    - xi. Right-click the Montessori Schools layer, and select **Save Layers**
      1. Select **ESRI Shapefile** as the format
      2. Click the [...] Button
      3. Navigate to your project folder
      4. Name the file “LK\_WA\_Mont.shp”
    - xii. In the **Encoding** section, select **Save only selected features**
    - xiii. Make sure that **Add saved file to map** is selected
    - xiv. **Save** the file
    - xv. The new file will now be added to the layers list

## 6. Combining like vector files (point to point)

In order to run spatial analyses, it is often necessary to have all relevant data housed in the same shapefile. Spatial quantitative analysis will be addressed in future tutorials. For now, we will practice the steps for combining similar datasets.

- a. Open the attribute tables for the LK\_WA\_Schls and LK\_WA\_Mont shapefiles
  - i. Note similarities and differences between how data is classified and listed in each dataset
- b. Clear all selections
- c. Deactivate the original Montessori schools layer
- d. In the toolbox select **Vector General** → **Merge Vector Layers**
  - i. Select the [...] button in the **Input Layers** option
  - ii. Fill the check boxes for LK\_WA\_Mont and LK\_WA\_Schls layer
  - iii. Remove all other check boxes if any others are selected
  - iv. Click **OK**
  - v. The **Input Layers** listing should say “2 elements selected”



- vi. For **Destination CRS**, select “Project CRS”
- vii. Click the [...] button in the **Merged** section
- viii. Navigate to your project folder and name the file “LK\_WA\_Comb.shp”
- ix. Click the checkbox for **Open output file after running algorithm**
- x. Select **Run in Background**

We’ve encountered an Error! Even though on the surface, the data structure seems to be the same, QGIS tells us that the “FID field layer in LK\_WA\_Schls has a different data type than in other layers (Integer instead of Integer65)”. Fortunately, these data types are similar, and there are ways to edit data types using the “Refactor Fields” function.

- e. Make sure that the LK\_WA\_Schls layer is selected
- f. In the Toolbox, select **Vector Table → Refactor Field**
  - i. In the drop menu in the **FID** row, select the **Integer** button in the Type field and change it to **Integer64**
  - ii. Select **Run in Background**
  - iii. A new layer called “Refactored” will be added to your layers list
  - iv. Repeat the steps from “Section 6d” to merge files, but instead of using “LK\_WA\_Schls”, use “Refactored”
  - v. Run the algorithm – a new layer called “Merged” will be created
- g. Open the attribute table for the new “Merged” layer

It looks like we’ve gained a lot of columns! Observe the outcome. A few of the fields successfully merged, such as “County” and “Phone”. But many others have not. Open the attribute tables for LK\_WA\_Mont and LK\_WA\_Schls. The Zip Code columns are named differently. What are some other columns that are named differently? QGIS is adept in identifying which columns are similar based on having fields with identical names as well as data types. When you move on to your own projects, be sure to observe these differences in datasets. This final section

## SELECTING with ATTRIBUTES and FILTERS

You can also select features using data, known as “Filtering”, “Select by Attribute”, or “Select Using Expression”. This is another way of trimming your dataset to limit which samples you can analyze in your dataset, as well as limiting symbology.

### 7. Filters

- a. Activate the original K12\_Schools layers, and deactivate all other layers
- b. Right-click the K12 Layer, and select **Zoom to Layer**
- c. Right-click the K12 Layer, and select **Filter**
  - i. This will open a window called “Query Builder”
  - ii. Double-click “Type” – note how the value is added to the **Provide specific filter expression** box
  - iii. In the **Values** box, click **All**
  - iv. Double-click “High School”

- v. Click the **Test** button
  - 1. A pop-up window should arise: How many points were selected? \_\_\_\_\_
- vi. Click **OK**
- vii. Right-click the K12\_Schools layer, and save the layer as a new shapefile called “HighSchools.shp” – make sure that you are adding the new layer to the map
- viii. Right-click the K12\_Schools layer, and select **Filter**
- ix. Click the **Clear** button, and then close the window
- x. Make sure that the HighSchools layer is above the K12\_Schools Layer
- xi. You have now extracted a sampling of high schools
  - 1. Zoom to a clustering of high schools
  - 2. Activate and deactivate the high school layers to see how they overlap with the old dataset

## ANALYZING DISSIMILAR VECTOR FILES

Sometimes you would like to transfer data between files of different types, such as points and polygons. This can be useful to gathering information about locational commonalities of points, as well as tabulations of data within a polygonal boundary.

8. Tabulating Data Using Polygons
  - a. Activate the Zipcodes layer and the LK\_Wa\_Schls layer
  - b. Select **Vector** → **Analysis Tools** → **Count Points in Polygon**
  - c. Select the “Zipcodes” layer in Polygons
  - d. Select the “LK\_WA\_Schls” layer for Points
  - e. In the **Weight Field** select “Enroll2014”
  - f. Rename the **Count Field Name** “ENR\_2014”
  - g. Make sure that the checkbox for **Open output file after running algorithm** is selected
  - h. Select **Run in Background**
  - i. A new polygon field named “Count” will appear in your layers list
  - j. Open the attribute table for the “Count” Layer
    - i. Sort the “ENR\_2014” field descending
      1. Which zipcode has the highest enrollment rate? \_\_\_\_\_
      2. How many zipcodes have any students at all? \_\_\_\_\_
      3. There are many zipcodes with a count of “0”. Why is this the case?  
\_\_\_\_\_
9. Assigning Polygon Attributes to Points Using Location
  - a. Select **Vector** → **Data Management Tools** → **Join Attributes by Location**
  - b. **Input Layer:** Since we are trying to apply information from the Zipcode layer to the LK\_WA\_Schls layers, make sure that the LK\_WA\_Schls layer is selected here
  - c. **Join Layer:** Select the Zipcodes layer
  - d. **Geometric Predicate:** select **Intersect**
  - e. **Join Type:** Create Separate Feature for Each Located Feature

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Repeat the process: “I want my INPUT to adopt the attributs of my Join”. “I want my **points** to adopt the attributes of **my polygons**”

- f. Create a new file using the [...] button, and name it “Schl\_Zip”
- g. Open the attribute table for the new joined layer
- h. Scroll so that the “Zip” and “Zipcode\_2” are visible, and observe that they match