**Graduate Urban Economics, Shanghai University of Finance and Economics**

Spatial Methods in QGIS, Spring 2024

1. Start up QGIS and add provinces and prefectures
   a. To add a layer, you can either navigate using the "browser window" or click Layer->Add Layer->Vector Layer and then choose a .SHP file. If you don't see the Browser window, enable it by clicking View->Panels->Browser.
   b. Practice zooming, selecting, and identifying features
   c. Practice changing the layer opacity to see how prefectures have changed over time
2. Look at prefecture changes over time
   a. First click Settings->Options->Processing and under "General" change to "ignore features with invalid geometries"
   b. Then play around with the graphical intersection tools under the Vector menu
      i. See here: https://docs.qgis.org/3.34/en/docs/user_manual/processing_algs/qgis/vectoroverlay.html
3. Add **inflow.csv** using delimited text layer
   a. Click Layer->Add Layer->Add Delimited Text Layer
   b. Select "inflow.csv" using file dialog (click box on right with three dots)
   c. Make sure "decimal separator is comma" is ***not clicked***
   d. Under "Geometry Definition" select "No geometry", then click "Add" button at bottom
4. Merge on the "inflow.csv" data (more detailed explanation here)
   a. Right click on 2000 provinces layer and select properties, then click Joins
   b. Click green plus (+) sign in bottom left-hand corner
   c. Join layer is "**inflow.csv**", join field is **prov5yr_code**, target field is **PROV2000**
5. Draw a choropleth map showing migration shares from each province, into one particular province (ex: share of migrants into Beijing coming from each province)
   a. Right click on 2000 provinces layer, click Properties, then select "Symbology"
   b. Change the symbol to "Graduated"
   c. In the "Value" box, select the variable you want to color provinces by (ex: in_Beijing00)
   d. Select a "color ramp" (ex: Blues)
   e. Select the number of classes (color increments) in lower right hand corner
   f. Click OK
6. Test yourself: add the **outflow.csv** and create a choropleth map showing outflows from a specific province
7. Georeference the SUFE map
   a. Open Raster->georeferencer (enable plug-in if not already enabled; "plugins" menu)
   b. Import the file "new_sufe_map.jpg" (File->Open Raster)
   c. Add four points using lat/lon below:
      i. Zhengli road and Guoding road: 31.30991, 121.49859
      ii. Zhengli and Wuchuan: 31.30998, 121.49179
      iii. Wudong and Wuchuan: 31.30503,121.49074
      iv. Wudong and Jipu: 31.30645, 121.48580
   d. Then in Georeferencer click Settings->Transformation Settings

        i.   Transformation type is "thin plate spline"

       ii.   Choose an output file name (or accept default)

     iii.   Click load in QGIS when done, then OK

   e.   Then File->Start Georeferencer

8.   Add SUFE OSM map tiles to check the accuracy: add layer "SUFE_map.osm"

   a.   Can also add the QuickMapServices plugin

        i.   Plugins->Manage and Install Plugins

       ii.   Search for QuickMapServices and click install

     iii.   This will add a new toolbar with several buttons. Click the button with a plus sign on a globe and then select OSM->OSM Standard. This will add a base layer map.

9.   Digitize SUFE roads:

   a.   Set Digitizing Options:

        i.   Settings->Options

       ii.   Find the "Digitizing" tab on the left and click it

     iii.   On the right under "Rubberband" change the line width to 5

     iv.   On the right under "Snapping" choose "Enable snapping by default"

      v.   Make sure that "Default snap mode" is set to "Vertex" and that the "Default snapping tolerance" and "Search radius for vertex edits" are both defined in terms of pixels (the values should be 12 and 10)

   b.   Create a new layer for campus roads and paths

        i.   Click Layer->Create Layer->New Shapefile Layer

       ii.   In the dialog box that pops up, click the "…" three dots button next to "File name" and choose "sufe_roads.shp" in the same location as the rest of your data

     iii.   For "Geometry type" choose "LineString"

     iv.   Under "New Field" create two new fields:

           1.   Type "roadname" in the "Name" box, leave the "Type" as "Text Data", and hit "Add to Field List"

           2.   Then type "speed" in the "Name" box, choose "Decimal Number" for "Type", and hit "Add to Field List"

      v.   Click OK

   c.   Digitize one of the campus paths

        i.   Make sure the "sufe_roads" layer is selected from the Layers list in the lower left hand corner of the screen
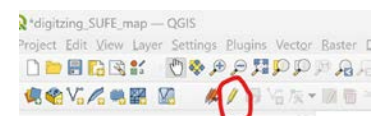
       ii.   Click the "toggle editing" button to edit this layer

     iii.   Make sure the "Digitization Toolbar" is showing: click View->Toolbars and select "Digitization Toolbar"

     iv.   Click the "Add Line Feature" button

     v.   Create a series of connected line segments representing a walking path through Guoding campus from the entrance gate at Guoding Road, past the teaching buildings (一教), down along the main path (past the faculty canteen), through to the exit gate at Wu Chuan road. To do this, left-click at the entrance gate and then add additional vertices by left-click every time you wish to end a line segment. When you are done, right-click to finish the connected path. This will bring up dialog box that asks you to input values for the fields. Choose ID as 1, name as "main path", and speed as "5", which will be in km/h.

    d.   Create a new path from the same starting point but that takes the alternative way passing by the Muslim Canteen. Make sure to start by clicking on the start of the "main path" segment: if you put the target cursor over the start you should see a purple box (click it). End the path by connecting the Muslim Canteen path to another vertex from the "main path" (again, use the purple box). Choose a speed of 5 for the Muslim Canteen path.

    e.   Click the "save" button (it has a floppy disk icon) next to the "toggle editing" button, and then click the "toggle editing" button again to end "Edit" mode

10. Digitize a SUFE building:

    a.   Create a new layer but this time choose "Polygon" for geometry type

    b.   Click the "toggle editing" button and then click the "Add Polygon Feature" button:

     i.   This function works in a similar way to adding lines: left-click several times on the vertices of a building and then right-click to end the process. You should see red shading cover the area you have captured, and after right-clicking this will turn into a solid polygon.

    c.   Create new polygons for the School of Economics building, 四教, and any other buildings you feel like

    d.   When you are done creating new buildings, click save and toggle edits to end the editing session.

11. Right click on any of the new features you've created and you can see their properties. For example, you can use this to measure area and length—is the Muslim Canteen path longer than the main path? You can also directly use the measure area or measure line tools and apply them to any feature on the map.

12. Network Analysis: which route is faster?

    a.   Click Processing->Toolbox->Network Analysis, and select "Shortest path (point to point)"

    b.   Leave the "path type to calculate" as "Shortest"

     i.   For "Vector layer representing network" choose "sufe_roads"

     ii.   Click the three dots button next to "start point" and choose a point on the paths near the Guoding road entrance

     iii.   For "end point" choose the WuChuan gate, or simply where the two paths converge in your road network. Then click OK. This will output a new temporary layer showing the shortest route. You can click on this to see the estimated distance.

    c.   Repeat the exercise but select "Fastest" under "path type to calculate"

        i. Under "Advanced Parameters" in the "Speed field [optional]" dropbox choose the "speed" field

        ii. Click run. Try changing the speed of different pathways (toggle editing, then open the attribute table, and change the field manually). What speed makes the other pathway the fastest?

    d. Note: in some versions of QGIS the outputted "cost" is incorrect if the underlying coordinate reference system is in decimal degrees (see this bug report). It should be distance in meters for shortest path and hours for fastest path. It can be corrected by simply multiplying by 111,319.9, which is the number of meters in a decimal degree.

13. Add some of the data from Baum-Snow, Brandt, Henderson, Turner, Zhang ReStat 2017
    a. Plan5_7
    b. Rivers
    c. 2010bshp (highways, railroads)
        i. You can use the 2010_highgrade_highway file to calculate shortest distances and travel times between Chinese cities

14. Explore the Manhattan tracts and restaurants data
    a. Discard the current project
    b. Click Project->New
    c. Click Project->Properties and set coordinate system to "NAD83 / New York Long Island" (put "2236" into search box)
        i. Note that default is WGS 84 (EPSG:4326)
    d. Add Manhattan tracts
    e. Add menu data:
        i. Layer->Add Layer->Delimited Text Layer
        ii. Select menupages_Wb126.csv from "File name" dialog box (click three dots)
        iii. Under "Geometry Definition" choose "Point coordinates"
        iv. For X field select "x_feet"; for Y field select "y_feet"
        v. Make sure Geometry CRS readds "EPSG:2263 – NAD83/New York Long Island (ftUS)"
    f. Play around with different colors for different cuisines
    g. Try filtering by cuisine