GIS for Policy:

Workshop Guide

Tailored to QGIS, LTR version 2.14 (Essen)

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[1] In addition to the works cited throughout and listed in the "Resources" section, I am indebted to the wisdom and experience I have gleaned from my own GIS mentors at The Wilderness Society's Center for Landscape Analysis, my colleagues at Key-Log Economics, and my past and present students in this course. I learn something new every time I open my GIS software, and this guide will likely remain a work in progress for as long as I "learn as I go".

Why GIS for Policy?

Whether you want to boost a company's market share, win an election, reach people most in need with vital human services, fight for environmental justice, or protect wild places for people and for non-human creatures, being able to put information about key economic, political, social, and ecological relationships on the map is an increasingly critical skill. Geographic Information Systems (GIS) technology helps us better understand those relationships and design solutions for society's most pressing problems. This hands-on workshop (or short course) introduces underlying spatial reasoning from various fields (economics, politics, environmental justice, epidemiology, conservation biology) and prepares students to apply GIS tools and techniques to a real-life issue of their choosing.

Workshop sessions include examples, hands-on group instruction, and practice exercises to be completed on one's own or in class. Workshop participants also conduct a spatial analysis related to a topic of their choosing, with a final meeting reserved for presentations and discussion of these projects.

Using this Guide

The Remainder of this guide includes detailed step-by-step instruction for the in-workshop "GIS Tool Time" sessions, the practice exercises, and resources for further learning and practice. Workshop participants can also find these and other resources in the workshop Wiki pages. I recommend that participants repeat the in-workshop exercises on their own, then tackle the practice exercises to hone their skill in using the tools.

Data for the in-workshop and practice exercises will be posted in the appropriate course management system, or on shared space on the cloud.

Contents

Abbreviations and Terms

CRS: Coordinate Reference System, also "projection", is the set of rules that determine how the three-dimensional world is represented on a two-dimensional map. See https://docs.qgis.org/2.14/en/docs/gentle_gis_introduction/coordinate_reference_systems.html?highlight=coordinate%20reference%20system

GIS: Geographic Information System

QGIS: Quantum GIS, the open source GIS software used for this course

Layer: A set of spatial data to be displayed on the map, including instructions for how it will be displayed.

Print Composer: A representation of a particular view of your QGIS project where you do your *cartography*, or turn your view of the spatial data into a map w

Project: A QGIS file that provides a set of commands for how map data will be displayed. It is within the Project workspace (the canvas) that you will do your *GIS analysis*.

Spatial Data: The actual data that are displayed as a Layer in your map Project and your Print Composer. These data are not part of your Project, but they reside on your hard drive or on a server accessed via the internet or other network.

Raster Data: Spatial data in which an area is covered by a grid (like a checkerboard or matrix) with each square taking a numeric value representing something about the corresponding spot on the surface of the earth, like population density, land cover, elevantion, etc.

Vector Data: Spatial data for depicting and analyzing Points, Lines, and Polygons

Conventions

Navigating menus: Each step or selection is separated by a forward slash, so "Project/Project Properties/CRS" means click the "Project" menu, then click the "Project Properties" option, then click the "CRS" option, and so on. (Back slashes are used to show file structure, as in "Save your project to C:_GIS\GISWorkshop\ToolTime1\MYPROJECTNAME.qgs".

Open: Double click the thing to be opened (a project, a layer, etc.) so you can work with it.

Right click: This usually gives you a range of options for what to do with/about/to the thing right clicked (project, layer, etc.). The default option is usually to "open" it, but not always. If you are running QGIS on Mac OS, you "right click" by holding the Control key and clicking your one mouse button. (Note: it is HIGHLY preferable to have a two-button mouse with a scroll wheel for working in QGIS, even if you use a Mac.)

Select: means single-click the indicated item, tool, layer, map feature, etc. This usually results in the item being highlighted in some way, indicating that it has been selected, and you can now do something with it.

Tool Time 1: Loading data; navigating the Canvas; creating and calculating attributes; symbolizing your map; and using the Print Composer

Note: Instructions will be fairly complete for the first time we do something. When we do the same thing again, only the key points or the intended outcome are included in the instructions.

Tool / Skills	**Instructions**
Install QGIS	QGIS main download page: http://www.qgis.org/en/site/forusers/download.html You want the "Long Term Release" (version 2.14) For Windows, follow the link to the 32- or 64-bit version For Mac, click the “Download for Mac OsX” link, then KyngChaos and QGIS Dowload page. Then scroll down to the "Long Term Support" Before proceeding, watch the video that corresponds to your OS. Windows: https://www.youtube.com/watch?v=I-HZ__H3YyA Mac: https://www.youtube.com/watch?v=xcPJpYnLfWA For Windows users, after installation, search your hard drive for “QGIS.BAT” and put a shortcut to it on your desktop or another easily accessible place. You should ALWAYS start QGIS from that batch file, rather than double-clicking the .exe directly. This will ensure that QGIS will be able to access the full complement of plugins and other files we’ll need for some of these exercises and which you’ll use in your future GIS analyses.

Create Folders for storing your GIS data and QGIS projects	In whatever file management system you have: 1. Make a folder called "GISWorkshop" on your hard drive, such as “C:_GIS\GISWorkshop” 2. If you have been provided a data USB drive or via download, copy (or extract) the contents the GISWorkshop folder (or the GISWorkshopDATA.zip file) on that source to the folder you just created. 3. If not, create a subfolder in GISWorkshop called “ToolTime1”, then a folder within that called “VectorData1”
Download and Extract data for Class 1	1. Go to www.census.gov and navigate to Geography / Maps & Data / TIGER Produts. 2. From there, select TIGER/Line Shapefiles - New 2016 Shapefiles 3. Pick “Download” from the 2016 tab, then select "Web interface" 4. Pick “Counties (and equivalent)”, “Submit", and "Download national file" 5. Now pick “States (and equivalent)”... 6. Extract both .zip files to [c:\...\]GISWorkshop\ToolTime1\VectorData1 Note: Nice feature of QGIS is that you preview GIS data w/in a .zip file. However, you will not be able to edit data w/in a .zip. I don’t know if there are any other issues.
Open (or Start) QGIS	1. Windows: a. Locate the batch file qgis-ltr.bat (or shortcut to it), hopefully on your desktop. b. Double click the .bat file 2. Mac: a. Use search to find QGIS and click the icon for QGIS 3. Note the tips that pop up. I always read them, because there is always something new to learn. 4. Close the tips. 5. Start a new project by clicking the “New” (blank page) icon at the left hand side of the tool bar.

	You can also select "Project / New"[2] from the menu.
Install Plugins Plugins are key to using QGIS. We will install and use just a fraction of them in this course, but feel free to explore others.	1. Plugins Menu 2. Manage and Install Plugins 3. Search for "OpenLayers Plugin" a. Select it and click "Install Plugin" 4. We'll use this in a minute 5. Before you close the Plugins dialog box, go to its Settings and click on the option for "Show also experimental plugins." We'll use some of those too.
The Browser Panel	1. Explore your hard drive and any connected cloud storage here. If you don't see the Browser panel, see the next instruction.
Panels and Toolbars	1. Practice turning toolbars on and off. 2. If you do not see the browser panel, **right click**[3] in the blank part of the toolbar that the top and turn on the 3. Make sure the basics are turned on. a. Browser b. Layers c. File d. Help e. Labels f. Manage layers g. Map navigation h. Plugins i. Vector
Adding Data to the map 1. Using Layer Tool 2. Using Drag and Drop from Browser	1. Menu: Layer/Add layer/Add vector layer 1. GISforPolicy\GIS20\11\states 2. Drag and drop 1. GISforPolicy\GIS20\01\Counties

[2] Throughout this Guide, this notation means "click or select the named item from a menu or in a dialog box, then click or select the next named item, etc."

[3] I am not familiar with the Mac OS (and hardware) equivalents of right versus left clicking, and of rolling a scroll wheel, so forgive me for giving these instructions in such a Windows-centric way. Please translate in to Mac on the fly.

3. Open Layers 4. Using a Map Service	3. Open Layers Plugin 1. Web/OpenLayers Plugin/[whatever option you like] 4. Map Service 1. Make sure “Manage Layers” toolbar is active 2. Go to http://viewer.nationalmap.gov/services/ 3. Pick Base Maps (top option) 4. Pick “WMS”, then find and copy this string (not counting the quotes): “http://basemap.nationalmap.gov/arcgis/services/USGSTopo/MapServer/WmsServer?version=1.3.0%26service=WMS” 5. Or pick WMTS and copy "http://basemap.nationalmap.gov/arcgis/rest/services/USGSTopo/MapServer/WMTS?" 6. In QGIS, look for and click this icon in the Manage Layers toolbar:  You should see “Add WMS/WMTS layer” when you hover over the icon. 7. Click “new” 8. Paste the URL into the URL field 9. Type a name in the Name field, and click “OK” 10. Click Connect and select an available Layer (will look a bit different depending on which of WMS/WMTS you chose in steps 4/5. 11. Pick a layer and click “Add” 12. Zoom in using the magnifier tool or scroll wheel. Notice that you lose the layer when you zoom in too far. (Same as you see using satellite view in Google.)
Now that we have some layers, let’s explore the Table of Contents	1. Turn Layers on and off 2. Move Layers (drawing order) a. Move counties on top of states or vice-versa

Navigating the Map	1. Pan (hand tool)
	2. Zoom in/out
	    1. Incremental in/out
	    2. Bounding box in/out
	    3. Previous Extent
	    4. Global Extent
	3. Identify features
	    1. Identify from drop-down box
	    2. Clicking on Map
	    3. Clicking on the feature in the identify box

Saving the Project	Project/Save as "Class1.QGS" You can also click this icon: 

Exploring Attribute Tables
1. Emphasize the ID fields / nature of databases / foreshadowing for homework
2. Create Field
3. Field Calculator
	Using Counties layer:
	1. Explore the attribute table
	    1. Right click the layer name and select "open attribute table"
	2. Click the abacus and select “Create New Field”
	3. Make Output Field name “AreaL”
	4. Select Decimal Number from Output Field type
	5. Click the plus sign next to “Fields and Values”, since we are going to calculate the value based on the value of other field.
	6. Double click “ALAND” (which is the area that is land).
	7. Click OK
	8. Repeat steps 2-5 for AreaW and AWATER
	9. NOW create a new decimal field called PctWater
	    1. Double click AreaW from Fields and Values
	    2. Click divided by sign “/”
	    3. Click the open parentheses “(”
	    4. Double click AreaW
	    5. Click “+” (or type a plus sign)
	    6. Double click AreaL
	    7. Click “)”
	    8. Click OK.
	Note, this is not normally such a pain, but for some reasons the calculations would not work going directly from the ALAND and AWATER fields.

	Do not worry about the nulls, or blanks, in the PctWater field we created. I am fairly certain that it is problem with bad data. I don't know why that would have happened, but we don't need to worry about it. As long as you see the process of symbolizing a map layer, like the counties, by the value of a field, you will be in good shape. (We'll do this a bit later.)
Selecting Features and Creating New Layers	1. Select by attribute a. Open the attribute table for the County layer b. Click this button:  for "Select Features using Expression" c. Open Fields and values d. Double click STATEFP e. Type or click "=" f. Type "50" without the quotes g. Click select at the bottom right. 2. Save the selected features as a new layer a. Right-click the county layer b. Select Save as c. Browse to where you want to save the file (…\VectorData1\ would be good) d. Give your layer a file name, Like VermontCounties (NO Spaces) e. Select "Save only selected features" f. Click "OK" at the bottom.
Selecting Features 1. From the Attribute Table 2. By clicking on the map 3. Clearing selection 4. By attribute 5. By location	Using Counties in Vermont layer: 1. Select in the Table, see on the map 2. Review Selection / Interactive Selection method 1. Show bounding box option 2. Show fine tuning (if too many chosen) 1. <CTRL> click to add or remove one feature from the selected set. 3. Polygon option

	1. Left click vertices, then Right click to select 4. Freehand (just draw something) 5. Radius 3. Show clear selection  4. By location 1. Select state of Vermont by attribute or by clicking on the map 2. From the menu, select Vector/Research/Select by location 3. Select Counties from the 1st dropdown list 4. Select States from the second dropdown list 5. Make sure “only selected features” is checked. 6. Check the “Include input features that intersect the selection features” 7. Click OK then close 8. Note that we get too many counties 1. Correct by removing counties we don’t want 1. <ctrl>-click using the selection tool 2. Re-do with “Include input features completely within the selection features” Caution: this might not always be completely accurate if the polygons have convoluted shapes.
Create a new layer from selected features	1. Select New England States using bounding box or polygon selection tool 1. Right click the states layer and click “Save As” 2. Name it "NewEnglandStates.shp" (no spaces or other taboo characters) 3. Select New England counties using Vector/Research/Select by location (completely within NewEnglandStates.shp) 4. Save As "NewEnglandCounties" to …\VectorData1\

Changing How Layers are Displayed
1. Symbolizing and labeling
	1. For States layer, double click the layer, go to "Style" and pick a different color (not blue).
	2. Turn on Labels and label with name
	3. For New England Counties layer, right-click layer name and select properties
	    1. Click Style
	    2. Pick Graduated from the drop down at the top
	    3. In the Column dropdown, pick PctWater
	    4. Change to a blue color
	        1. Note the color ramp options
	    5. In Classes, select Mode/Natural Breaks
	    6. Click Classify
	    7. Click Apply
	    8. Note that you can change the values in the classification

Working with the Composer
 	
See also "The Print Composer" on the course site
	Get your layers ready:
	● Zoom to New England Counties
	● Click on US States
	● Click off other layers
	
	1. Click Project / New print composer. Give it a name
	2. Click Composer / Page Setup and change to Portrait
	3. In the Composition tab, change orientation to Portrait.
	4. Click the add a new map tool:
	 
	5. Drag a big box onto the composer page
	6. Click the Move Item Content tool
	 
	and center and zoom as needed (Zooming requires a scroll wheel. If you don't have one, pop over to the map view and zoom into the layer and possibly re-add your map to the composer.
	7. Add a Legend
	    1. In the legend item properties, deselect Auto Update
	    2. Click the entry, in turn, for the layers you don't want to display a legend entry for,

	and then click the red minus sign below the list to remove the layer from the legend. 8. Add a scale bar 1. Reduce left segments to zero 9. Select the map item 1. In the Item properties / Main, change "render" to "cache" 10. Now we add a locator map. 11. Go back to the map canvas, zoom to the US states layer and then re-zoom to the lower 48 1. Turn off New England Counties 2. Turn on New England states 12. Back to the Composer 13. Add a new map to the upper left-hand corner and position the map as needed. 14. Add an Arrow from the big New England map to the little New England States layer on the little map. 15. Add a text box with a title. 16. Add a text box with data sources.
Locator maps	The main trick is that you first create your detail map, then lock the display in the Composer window. Then you go back to your map interface, set up the locator (or overview) map you want, Finally go to the Composer and add a new map, which will be your overview/locator map. 1. Two videos with details: a. https://www.youtube.com/watch?v=0uRds8DOwQc https://www.youtube.com/watch?v=cBbcNf1ERgM
Export your map	From the Composer: 1. Click Export as .pdf, select a location and type a file name. 2. Or Click Export as image, select a location, pick an image type, and when the dialog opens in QGIS, select options for resolution, and cropping (often handy for images you want to bring into a Word .doc or PowerPoint

A word about coordinate reference systems

In order for QGIS (or any geographic information system software) to properly align and perform analysis with spatial data in different layers, it has to know HOW the each data layer is related to the real world. That "know how" is embodied in the Coordinate Reference System, or CRS. This is also known as the "map projection".

I have found that QGIS does a pretty good job of displaying layers with different CRSs, it is terrible about performing analyses (geoprocessing) layers that have different CRSs. Therefore, it is good practice to simply run through all of your layers and use "Save As" to make a copy of the layer in the CRS in which you want to work.

For example, if you are doing a project centered on Charlottesville, you might want to work in UTM zone 17N, for "Universe Transverse Mercator, zone 17 (east-west), Latitude Ban N (north-south)". You might get data from the city that is already in that CRS, but you then might want to combine with county data from the US Census that is in Albers Equal Area CONUS (for "CONtinental United States"). Before combining the data for any analysis, you'll want to save your county layer as a new layer in UTM Zone 17N.

For more on map projections, See the hand out titled "CoordinateReferenceSystesms_Overview.pdf" in the workshop resources (in Collab).

Tool Time 2: More querying/selecting data; geoprocessing; joining tabular and spatial data

Tool / Skills	Instructions
Create a new Project	1. Open QGIS and select Project / New from the menu 2. Select File / Project Properties from the main menu 3. Click on "General" and a. Give your project a TITLE in the second box (e.g. "Tool Time in Vermont") b. Select "relative" from the "Save paths" dropdown. 4. Click on "CRS" and a. Check the box next to "Enable 'on the fly' CRS transformation b. In the Filter box type "NAD83 / UTM zone 18N" c. Click that CRS (EPSG: 26918) when it shows up 5. Click "Apply" then "OK"
Load data (Shapefiles) from ToolTime2\VectorData2: ● AppalachianTrail_UTM18 ● GMNF_MAs_2014_UTM18 ● GMNF_Porclamation_North_UTM18 ● GMNF_Porclamation_South_UTM18 ● NEK_DeerWinteringAreas_UTM18 ● NEK_Wetlands_UTM18 ● Roads_Major_UTM18 ● VermontCounties_UTM18 ● VermontTowns_UTM18GMNF_Proclamation_South	1. Load your data. a. Click on the Browser Panel b. Navigate to ToolTime2\VectorData c. Drag and drop all of the layers to your map canvas 2. Turn off all layers other than the counties, and the two GMNF Proclamation layers a. Arrange your drawing order so that the proclamation boundaries show on top of the counties

Bookmarks Turn on Counties and the two Proclamation Boundaries	1. Right click on the Southern proclamation portion and select "Zoom to layer" 2. From the main menu, Select View / New Bookmark a. Give your o Enter a descriptive name for the bookmark (up to 255 characters). Press Enter to add the bookmark or click elsewhere. 3. Select Bookmarks/Create Bookmark from the top menu 4. Enter a descriptive name, like "GMNF South" 5. Zoom to full extent  6. In the Bookmarks Panel, double click "GMNF South"
Review: Querying/selecting data by attribute Major Roads (rdsmaj2)	1. Zoom to the full Extent 2. Turn off the GMNF Proclamation boundary layers 3. Turn on rdsmaj2 4. Right click rdsmaj2 and "Open attribute table" 5. Sort the table by AOTCLASS (AOT stands for Agency of Transportation). Do this by clicking on the column heading that says "AOTCLASS" 6. Scroll down and notice that US highways are class 40 and above, and interstate highways are 50 and above 7. Use the Select by expression tool  and build an expression that ends up looking like this: "AOTCLASS" >=40 [include the quotes...use the Fields and Values list to make it easier. 8. Click Select 9. Close the attribute table and notice that some roads are selected 10. Right click rdsmaj2, then select Save as. a. Pick ESRI Shapefile[4]

[4] Note, it IS possible to save into our existing ESRI File Geodatabse (GDB). However the QGIS gnomes have not yet incorporated that functionality into the GUI, and you would have to do it from the command prompt. That would be beyond the scope of what we are doing in this class.

	b. Click browse and navigate to your VectorData folder c. Type “USandInterstateHWYS_VT” in the File name box and click “Save” d. Check the “Save only selected features” option e. Check to see that your data will be saved in the same CRS (NAD83 / UTM zone 18N) f. Click “OK” 11. Turn off the two roads layers
Review: Selecting data from the Attribute table Wilderness (GMNF_MAs_2014)	1. Show "GMNF_MAs_2014_UTM18", right click the layer name, open the attribute table and sort by the "MA" field in reverse order (click the column heading a second time. 2. Highlight the rows with "Wilderness" in the MA field 3. Go to the map canvas. 4. Right click "GMNF_MAs_2014_UTM18" then select Save as. Then follow the steps we followed for the highways and create a shapefile called "GMNF_Wilderness"
Review: Select by Location VermontTowns_UTM18 GMNF_Proclamation_North_UTM18	1. Turn off all layers besides VermontTowns_UTM18 and GMNF_Proclamation_North_UTM18 2. Main menu / Vector / Research / Select by Location from the main menu a. Select features in: [pick the VermontTowns__UTM18] b. That intersect features in: [pick the GMNF_Proclamation_North_UTM18 layer] c. Select “Include input features that intersect the selection features d. Click OK, then Close 3. Clear the selected features 
Joining Data from a table: For when you need to connect additional data to places on the map.	1. Turn off all layers besides VermontTowns_UTM18 2. Drag and drop GeoCode.xls and Skitowns.xls to the map 3. Open the Attribute table for VermontTowns_UTM18 and for the two spreadsheet tables just added

4. Note that SkiTowns has a code called "FIPS10" as does Geocode, but that VermontTowns_UTM18 does not. We need to make a connection from VermontTowns_UTM18 through Geocode to SkiTowns in order to identify the towns with alpine ski areas.
5. The common code between VermontTowns_UTM18 and Geocode is called FIPS6.
    a. Right click VermontTowns_UTM18 layer and select properties (or double click the layer) We'll call this "Open the properties for [the layer]" from here on out.
    b. Click the "Joins" tab/option
    c. Click the green + sign at the bottom
    d. Select GeoCode as the join layer
    e. Select Fips6 as the Join field
    f. Select Fips6 as the Target field (this is the one in your polygon layer)
    g. Click OK
6. Click the green + again.
    a. Join layer = SkiTowns
    b. Join field = FIPS10
    c. Target field = GeoCode_FIPS10 (This is a field in GeoCode that, by virtue of the first join is now also a part of Towns)
    d. Click OK
    e. Click Apply
    f. Use the identify tool  to see that you now have data from both tables connected to the VermontTowns_UTM18.
7. Now symbolize your map of Vermont Towns to show those with an Alpine Ski Area.
8. We'll first have to create a new field.
   Call it "SkiTown2"
    a. Here is the expression you need
       CASE WHEN "SkiTowns_ALP_SKI" is null THEN 0
       WHEN "SkiTowns_ALP_SKI" = 1 THEN 1
       END
    b. Click OK

	9. Right clck the Towns_Vemont layer and save your edits then toggl editing off 10. Open the properties for Towns_Vermont 11. Click Style then **Categorized** a. Column = SkiTown2 b. Click Classify c. Change the colors if you like d. Click Apply, then OK
Joining data from a layer (Spatial Join) (After creating points from polygons) [Use when there is not common field in the attributes. In this example, we want to know the county within which each town lies.] We'll will to start by creating a different representation of our towns.	1. Turn on VermontCounties_UTM18 2. Using the Identify tool, verify that the town layer does not include the county identifiers. 3. From the Main Menu, select Vector / Geometry Tools / Polygon Centroids a. Select VermontTowns_UTM18 as the input' b. Browse to your data folder and type "Towns_Centroids" as you output point shapefile c. Click OK d. [Why did we do that? Because if we used the Town polygons we could get weird results for some towns in the next step.] e. Close the tool 4. From the Main Menu, select Vector / Data Management / Join attributes by location a. Target = "Towns_Centroids" b. Join vector = VermontCounties_UTM18 c. Browse and give a name to your output file, "TownCentroidWithCounty" d. OK, then "Yes," add the layer to the map. 5. Symbolize the map of town Points according to their county (The field name for County is "NAME"). 6. Zoom to the County layer 7. Can you spot a town or two that might have gotten mis-joined if we had not made the centroids first?
Geoprocessing tools:	**See also "QGIS_VectorDataProcessing.PDF", posted in the workshop resources.**

Clip: use one layer as a cookie cutter to cut out a portion of another layer. Appalachian Trail and Counties	1. Turn on Appalachian Trail and Vermont Counties layers 2. Select Vector/ Geoprocessing tools / Clip 3. Input layer = AppalachianTrail_UTM18 4. Clip layer = VermontCounties_UTM18 5. Output shapefile [you know the drill, browse and name it ATinVermont_Clip 6. Select “Add result to canvas” 7. Click "OK" 8. Turn off Appalachian Trail layer
Buffer: create a layer that is one layer (or a selection) plus a little bit more; can also be used to identify other features within a certain distance of the buffered features Clipped Appalachian Trail	1. Select Vector/ Geoprocessing tools / Buffer(s) 2. Input vector layer = ATinVermont_Clip 3. Output Feature Class = ATinVermont_Buffer 4. Distance = 500 5. Select “Dissolve buffer results” 6. Click OK, wait a bit, then close 7. Zoom into your buffered layer and use the measure tool  to verify that you have a buffer 1km wide.
Union: putting TWO layers of the same geometry type together into a single, third layer NEK Deer Wintering Areas and Wetlands	1. Select Vector / Geoprocessing Tools / Union 2. Input vector layer = NEK_DeerWinteringAreas_UTM18 3. Union Layer = NEK_Wetlands_UTM18 4. Output Feature Class = "NEK_DeerWinteringAndWetlands” 5. Click OK...wait...close. 6. Check out the attributes of the new layer. It will have all the fields of the input and the union layers, but not all field will have values
Merge: combining <u>TWO OR MORE</u> layers of the same geometry type (polygon, point, line) into a single layer DATA: North & South Proclamation Boundaries	1. In QGIS Select Vector / Data Management Tools / Merge Shapefiles into One 2. Check the box next to “Select by layers in the folder” 3. For Input files, browse to …\VectorData, hold down the control key and select GMNF_Proclamation_North_UTM18 and GMNF_Proclamation_South_UTM18

	4. Output Dataset = GMNF_Proclamation_Both 5. Click OK
The difference between Merge and Union is that IF the input data layers have the same attributes (fields), Merge will put each layer's attribute data into ONE set of field names. By contrast, a Union of layers will retain all the fields from all of the input layers. (See also "Should I Merge or should I Union" in the Resources section	
Dissolve: lumping similar features of one layer together to form a layer of larger features Since I don't have a State layer, I can make one out of Counties (or Towns)	1. Select Vector / Geoprocessing Tools / Dissolve 2. Input Features = VermontCounties_UTM18 3. Dissolve field = StateFP 4. Output shapefile = State_VT 5. (Not necessary here, but would be helpful helpful if you want to dissolve into a feature class with more than one feature.) 6. OK...Close
Intersect: creating a new layer with just the portions of two (or more) layers that overlap, and retaining the attributes from each overlapping layers VermontTowns_UTM18 and GMNF_Wilderness	1. Select Vector / Geoprocessing tools / Intersect 2. Input vector layer = GMNF_Wilderness and VermontTowns_UTM18 3. Output Feature Class = TownXWilderness 4. Click OK 5. Zoom in on Bristol Cliffs (the wilderness area farthest to the northwest in the group, and use the identify tool to explore the features. We could now use the resulting "Shape Area" to compute the percentage of each town that is in Wilderness.

<table>
<tr><th colspan="2">Calculating Distances:</th></tr>
<tr><td colspan="2">When you want to show a uniform distance from a feature or set of features, use buffering, as in the AT example above.

You can then "select by location" those members of another feature class that intersect the buffer.</td></tr>
<tr><td>When you want to know the distance from each member of one feature class to the nearest point in another feature class, use the "Near" tool.</td><td>1. Install the “NNJoin” plugin
2. Turn off all layers but Towns_Vermont_Points and GMNF_Wilderness
3. Open the NNJOIN plugin Source points layer = Towns_Centroids
4. Input vector layer = Towns_Centroids
5. Join vector layer = GMNF_Wilderness
6. Output layer = TownsToWilderness
7. Click OK then Close.
8. Zoom in on the area between Bristol Cliffs and Breadloaf and explore your results.</td></tr>
</table>

Tool Time 3: Creating spatial data; creating features from coordinates; georeferencing earth imagery; creating features from nothing

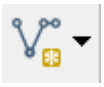
NOTE: The last skill is described in a bare bones fashion. Details will be added later

Tool / Skills	**Instructions**
Digitizing Addresses	Further help from the Web http://blog.mangomap.com/post/74368997570/how-to-make-a-web-map-from-a-list-of-addresses-in
Install Plugins	1. Georeferencer GDAL 2. MMQGIS for various functions, including digitizing addresses 3. Autotrace to allow digitizing by tracing existing features 4. Digitizing Tools
Digitizing 1: Creating Features from coordinates (lon/lat; easting/northing)	1. Start a new project and set the PROJECT CRS to "WGS 84" 2. Load the States layer from Class 1 (it is called "tl_2016_us_state.shp). 3. Click Layer / Add Layer / Add Delimited Text Layer 4. Browse to and select WoodPelletMills.csv and select it. 5. Select the following options in the dialog: a. File format: CSV b. First record has field names c. Geometry definition: i. Point Coordinates ii. X field = Lon iii. Y field = Lat d. Click OK 6. Select "WGS 84" (EPSG:4326) as your CRS. 7. Just for kicks, buffer these points by 75 miles (120,700.8 m), which is the sourcing radius for these mills. This will give you a picture of how much of the region's forests could be used to feed

	biomass generation in Europe. NOTE: you will first have to use Save As to convert your pellet mills points into a projection that uses meters as the distance units. USA_Contigous_Albers_Equal_Area_Conic will do for this layer.
Digitizing 2: Creating Features from Addresses	1. Turn off all layers besides the states, and pan/zoom to Texas. 2. From the main menu, select MMQGIS / Geocode / Geocode CSV with Google / OpenStreetMap a. Browse to and select Agencies_Sample.csv b. Don't worry if the Address Field, City Field, etc. seem odd...it doesn't seem to matter c. Web Service = Google Maps If you have a Google API code and want to geocode > 2,500 addresses per day, paste in your API code[5] d. Click OK and watch the progress at the lower left of your QGIS window. Note that progress will seem to cease after 8 addresses. have been found. [This is a good time to take a break.] 3. Zoom to the new layer and notice that some of the addresses have been found in NY. Zoom to the ones in Texas instead. a. You could deal w/ the mismatches by deleting them, or by looking up the addressess manually, creating a lat/lon table and then importing those lat/lon coordinates and unioning the two sets of features.
Digitizing 2a: another way to go from addresses to point features	1. Go to http://www.gpsvisualizer.com/geocoder/

[5] "API" means application program interface. Getting a key to use The Google's is free and fairly painless to do. Follow the instructions here: http://www.gpsvisualizer.com/api_key.html#google, or Go to https://developers.google.com/maps/documentation/javascript/ and select "get a key". There is a Google Maps Java Script API and a Google Maps Geocoding API. Either might work.

	2. Open the .csv file, select all, and paste into the Input box. Delete the first row with the headers. 3. Type of data = Raw list 4. Source: Google 5. Paste your Google API key into the box. 6. Click Start Geocoding 7. Select KML (Google Earth) as the output format 8. Click Draw Map 9. Click the "….kmz" file to download it. 10. Drag that .kmz file into QGIS
Georeferencing (an interlude): Putting pictures on your map	1. Start a new project. 2. Set the project CRS to "WGS 84 / Pseudo Mercator" If you see two of these, select "EPSG: 3857". Then check the box for "Enable 'on the fly' CRS transformation. 3. From the Web\Open Layers Plugin menu, load the OpenStreetMap web service. a. Zoom into Charlottesville 4. Start the Georeferencr Plugin by clicking this Icon on your toolbar:  A new window will open 5. Maximize the Georeferencer window 6. Click the open raster icon (or click File\Open Raster), navigate to ToolTime3\RasterData3 and select "OHill_Topo_Map_24000.pdf" (Windows) or "OHill_Topo….jpg" (Mac).  7. Zoom in to the area that contains UVa. We will now add several points on the topo map (which as far as QGIS knows at this point is not even a map) that correspond to known points on the OpenStreetMap layer (which QGIS does know is a map). 8. Click the "Add Point" tool,  9. Then click on a point on the topo map that you think you'll be able to recognize on the OpenStreetMap layer. Road intersections, sharp turns, and the corners of buildings are often good options.

	10. A dialog for "Enter map coordinates" will pop up. Click the button for "From map canvas," and you'll be back on the map canvas. a. Click the spot on the canvas that corresponds to your point in the topo map. The coordinates will be filled in for you. b. Click "OK" 11. Repeat steps 9 and 10 at least two more times. 12. From the Georeferencer menu, select Settings\Transformation Settings and fill in as follows:  a. Target SRS = WGS 84 / Pseudo Mercator b. Output raster: click the ellipses, browse to your ToolTime3 folder and type a file name (no spaces) like "OHillTopo". c. Leave the type as Geo TIFF. d. Check the box next to "Load in QGIS when done". e. Click OK 13. Start Georeferencing by clicking the button or selecting File\Start Georeferencing.  Your topo map will now appear in the Map Canvas 14. Open the properties for the new layer and make it 50% transparent. 15. Drag the OpenStreetMap layer so that it is beneath the OHillTopo layer.
Digitizing 4: Creating new features from nothing	1. Layer / Create layer / New shapefile layer, or if the "Manage Layers" toolbar is open, use the dropdown arrow on the icon at the right, and pick "New shapefile layer".  a. Pick Polygon b. set the CRS to WGS 84 / Pseudo Mercator (again, choose EPSG: 3857, if you have multiple options), and type "BuildName" in the Name box. c. Click "Add to fields list" d. Click OK.

	e. Give your new layer a file name, like "NewBuildings". 2. Make sure your "Digitizing Toolbar" and "Digitizing Tools" toolbars are showing. (Right click the toolbar area or use "View \ Toolbars" from the menu. 3. Select the "NewBuildings" in the Layers Panel and toggle editing on by right clicking and selecting "Toggle editing" or clicking the pencil icon in the Digitizing Toolbar. 4. Zoom into the area around JPJ 5. Click the Add Feature tool. 6. Add JPJ a. Click the corners (vertices) visible in the OpenStreetMap layer. b. Right click, give an ID (an integer) and a building name, Click OK 7. Add another building that is visible on OpenStreetMap, but is not in the Topo. 8. Save your edits by clicking the disk/pencil icon. 9. Save your project. (similar icon on the main toolbar, or File \ Save
Snapping, Tracing, and Cutting: Drawing and modifying features using the features of other layers.	More help on AutoTrace Plugin: http://www.lutraconsulting.co.uk/products/autotrace/AutotracePlugin 1. Make sure your AutoTrace tool is showing in the Digitizing Toolbar. 2. Open Settings / Snapping options from the main menu. a. Choose Advanced. b. Check the box next to "road_centerline…" and set the tolerance to 20 pixels. c. Click Apply, then OK. 3. Turn on the "road_centerline" layer 4. Pan and zoom to the area just north of the Rotunda and bounded by Rugby Road, Chancellor Street and Elliewood Ave. 5. Use the AutoTrace tool (icon next to step one) to create a new "building" that includes all of the area from the corner of Ruby and Main, north to

	Chancellor, and all the way down Chancellor back to Main. Notice that as your cursor (a red circle w/ crosshairs) gets near a road centerline, a grey "crosshairs" shows up on the road centerline. Those are vertices of the (or a) layer to which you can snap. Click to the red circle and crosshairs. a. When you have traced the area, right click, assign an ID and a name, and click OK. 6. Suppose you want to turn that polygon feature into two: one east of Madison Lane and one to the West. Here's how: a. Select/activate the road_centerline layer and select Madison Lane b. Switch to your NewBuildings layer and select the polygon just created (the one that covers Mad Bowl to Chancellor Street (Your Madison Lane selection will appear to have been undone, but that is just because both selections are indicated by the same color.) c. From the Digitizing Tools toolbar (not to be confused with the Digitizing Toolbar!), click the icon for "Split selected features with selected line from another layer"  d. Pick "road_centerline…" as your splitter layer and click "OK." 7. Open the attribute table and edit the id and BuildName fields for one of the two polygons. [Hint: Click one of the rows to see which row is for which feature on the map and rename accordingly.] 8. Save your edits and save your project.
Repeat for a line feature. Complete the bike lane for Jefferson Park Avenue Extended in Fry's Spring.	

Symbolizing a Map with dot density	1. Start a new Project 2. Load Counties_Pa from Tooltime3\VectorData3 3. Save as a new file but in the GeoJSON format (pick from the dropdown menu)[6]. 4. Create new field called "PopIn000s" (whole number (integer) is fine), defined as POP_2010 divided by 1,000. 5. To create a new layer that is a dot-densisty map: a. Vector/research tools/random b. Select your GeoJSON layer with the new field c. Pick "Use value from input field" and select POPIn000s from the dropdown list. d. Browse to ToolTime3 and type the name of your new layer in the File name box. e. Click Save, then OK. f. Wait…wait…wait… g. "X" out of the Random Points box when done.
Turn dot density into a heat map, using the Heatmap plugin.	1. Load the Heatmap plugin, which installs itself in the Raster menu, and puts the button at right in your toolbar. 2. Click that button (or select Raster/Heatmap/Heatmap… from the menu) 3. Browse (elipses button) to ToolTime3 and type a name for your raster, like PA_Population_Heatmap. 4. Leave the Radious as 20000 layer units. (This is the radius within which the influence of each point in your input layer will be felt. 5. Select "Add generated file to map 6. Click OK. 7. Use the Style properties of the resulting raster layer to change the appearance of your heat map. For more information on the Plugin, including using data to give different weights to different points, see http://docs.qgis.org/2.0/en/docs/user_manual/plugins/plugins_heatmap.html.

[6] I am not sure why this is necessary, but I have found that one cannot use the field we'll create in the next step to do the dot density map if the layer is an ESRI shapefile.

Tool Time 4: Animating a map; introduction to raster data

Tool / Skills	Instructions
Animating Features that happen at one location Load the following layers from ToolTime4\VectorData4: • Outline • Bldgs • Schools • Streets • CADCalls (If you didn't load them in that order, rearrange the layers so that Outline is at the bottom. The order of the other layers is less important.) Click off all but Outline and CADCALLS.	1. Install TimeManager Plugin 2. Right click "CADCalls" and select "Duplicate" a. Rename the copy to "CADCallsContext" 3. Open attributes for CADCallsContext and add a new field called "ENDDATE" a. ="to_date("CALLDATE" + '14 days')"[7] 4. Symbolize CADCalls as black, and CADCallsContext as red 5. Open TimeManager 6. Click settings a. Add Layer i. Layer = CADCalls ii. Start time = CALLDATE iii. End time = "No end time…" iv. Click OK b. Add Layer i. Layer = CADCallsContext ii. Start time = CALLDATE iii. End time = ENDDATE iv. Click OK c. Leave other settings as their defaults or adjust as you like. d. Click OK 7. Set the time frame size to 1, and days. 8. Click the play button in the Time Manager window a. Use the pause button and slider as you would in YouTube. More on Time Manager:

[7] Note that this adds the new data to the CADCalls layer as well, because you are really adding the new field and doing the calculations on the underlying data set, which both CADCalls and CADCallsContext are using.

	https://www.youtube.com/watch?v=nHrFOPf1UGw (skip ahead to ~4:00 where he brings in his data on earthquakes. See the earthquakes as the "CADCALLS" from the in-class example.) https://www.youtube.com/watch?v=0aYrNUUKM-4
Export an Animated Map as a Video	1. To export as video: a. Drag the slider to the beginning b. Click "Export Video" c. Select an ouput folder (e.g. "...\Class4\CallFrames") d. Change "Animation frame delay" to 500 milisec (½ second) e. If doing this a second time, select "Clear previous frames in directory" f. Click OK and wait. 2. Use Photoshop, Gimp or another program to turn your frames into an animated .GIF that you can then drop into a PowerPoint, Gslide or other presentation. If you use GIMP, here are good instructions: http://www.elearnhub.org/how-to-make-an-animated-gif-in-gimp/ [The instructions err at the file saving step. Don't "Save As" .gif, but "Export to" the .gif.] Or http://www.digitalcitizen.life/how-create-animated-gif-using-your-own-pictures-gimp
Animating features that change locations (Not covered in class, but see me if you want help.)	Use the "PointsToPaths" Plugin (first enable the "Show also experimental plugins" under Plugins/Manage and Install Plugins). See also: http://michaelminn.com/linux/mmqgis/

Raster Data	Make sure the "Processing" Plugin is installed. Open the Processing Toolbox by clicking Processing/Toolbox from the main menu or selecting "Toolbox" from the Panels menu when you right-click an empty spot in the toolbars area.
Key Considerations	Rasters have a Resolution (how big each cell will be) and an Extent (how many cells will there be). The extent is given as the coordinates of the corners of a rectangular portion of your map. Each cell in a raster are characterized by a single number. Think of it as rasters having one attribute. To figure out what map extent to use for a new raster layer, look at the properties of a layer that is as large as you want your new vector layer to be. For our purposes, we'll use the "Outline" layer to get our extent. 1. Open the properties for the "Outline" layer and Go to Properties/Metadata (expand) and scroll down through the "Properties" area until you get to "Extents". 2. Copy to your clipboard the part that says, "xMin, yMin [followed by four numbers separated by commas]" 3. Click Cancel to close the properties

Converting Vectors to Rasters
 	
Do not use Raster/Conversion/Rasterize
	1. In the Processing Toolbox, expand "GDAL/OGR" and then "[GDAL] Conversion".
	2. Double click "Rasterize (vector to raster)
	3. Select Schools as the input layer.
	4. Select SUBCAT as the attribute field
	5. Change both the Horizontal and the Vertical fields to 30
	6. Expand "Advanced Parameters" and scroll down until you can see "Additional Creation Parameters"
	   a. In the box, type "-te " (no quotes) and then paste your output extent from the clipboard
	   b. Now DELETE everthing but the numbers, but leaving and one space between the

	numbers (no commas, no xMax, etc.) You should end up with something like this: -te 203325.57 4371729.26 204852.35 4372888.32 7. Click the ellipsis next to the "Rasterize" box a. Click "save to file", and navigate to where you want to store your new raster layer. b. Type a file name, like "SchoolsRaster". The file extension will be .tif. c. Click "Save" 8. Click "Run" 9. Behold, a useless black rectangle and a new layer called "Rasterized." (See next step.) More info on the rasterize tool: http://www.gdal.org/gdal_rasterize.html
Make your raster layer more sensible.	1. Double click "Rasterized" 2. Under General, give the layer a sensible name in the "Layer name" box, like "Schools Raster". a. Double check to see that it is stored where you want it to be stored. You can't change that here, but it's good to know that you did the rasterizing process right. 3. Click "Style" 4. Simple symbolization: a. Leave "Render type" as "Singleband Gray" b. Change "Color gradient" to "White to black" c. Leave "Min" as 0, but change "Max" to 5, which is the highest number for the SUBCAT field. 5. Click "Apply" and "OK" 6. More interesting symbolization a. Change "Render type" to "Singleband pseudocolor". b. Pick a color ramp you like c. Set "Max" equal to 5 d. Click Classify

	e. Double click the color bar for the 0.000000 value and change its opacity to zero. This will make invisible all parts of your raster that are not schools 7. Click “Apply” and “OK”.
Create a new raster with distance to another feature. This is like a heat map	1. Search the toolbox for Proximity “(raster distance)” 2. Input Layer = Schools Raster 3. Output File (click select, navigate and give a name like “DistanceToSchool”, then click “Save”. 4. Click “OK” 5. If you wish, go to the properties for the distance layer and symbolize (change the style). 6. Put your either your Schools Raster or Schools (vector) layer on top of the DistanceToSchool layer to see the results.
Clip a Raster using a Vector	1. In the GDAL/OGR part of the Processing Toolbox, find the [GDAL] Extraction / Clip raster by mask layer 2. Input Layer = DistanceToSchools 3. Mask Layer = Outline 4. No data value = 0 5. Click “Run” Practice this again by clipping the Pennsylvania density heat map by the PA Counties layer
Make another raster of CADCALLS for Drugs	1. Turn on the CADCalls Layer 2. Open the attribute tables for CADCalls a. Create a new field called “Value” and set that value = 0 for all records b. Sort by “NATURE_COD” c. Scroll to find that there are a bunch of calls coded as “DRUGS” d. Click the select by expression button  e. Construct the expression: "NATURE_COD" ='DRUGS' (note single quotes around DRUGS) f. Click Select and Close

	3. In the CADCalls attriute table, choose "Show Selected Features" from the dropdown box at the lower left corner of the window.  4. Open the Field Calculator again, but this time choose "Update Existing Field". 5. Pick DrugCalls from the dropdown list 6. Click "OK" 7. Back in the attribute table, change "Show Selected Features" back to "Show All Features" and note that the calculation you still have zeros as the value for "DrugCalls" for the calls that are not drug calls. 8. Now make a new layer with just the Drug Calls: File/Save As "DrugCalls" shapefile, being sure to check "Save only selected features" 9. Use the processing toolbox (GDAL/OGR…[GDAL] Rasterize…) as before to create a raster of drug calls. a. Call it DrugRaster b. Don't forget to change the cell sizes (Horizontal and Vertical) to 30 and the extent to –te 3325.57 4371729.26 204852.35 4372888.32 c. Click Run 10. In properties for DrugRaster, change the name and style so that drug arrests show up as black cells.
Raster Reclassification Use the DistanceClass.txt file	1. In the Processing Toolbox, find Grass GIS 7 / Raster / r.reclass 2. Input raster layer = DistanceToSchool 3. File containing… is DistanceClasses.txt [other formats might be OK.] 4. Reclassified is the name of your output raster, "DistanceToSchoolReclass" 5. Click Run
Raster Calculation: numerically combining the value of different raster layers at each location.	Suppose we want to classify the severity of drug offenses, if "severity" is a function of distance from a school. 1. In the Processing Toolbox, search for "Raster calculator". Double click it when you find it.

	2. Input Layer A is DrugRaster 3. Input Layer B is DistanceToSchoolReclass 4. Calculation in gdalnumeric syntax…. Is A*B 5. Calculated is a file, DrugsXSchoolDist 6. Click "Run" 7. In Properties for the new layer: a. Singleband pseudo color b. Mode=Equal Interval c. Classes=2 d. Max=2 e. Classify f. Change symbols to Yellow and Red 8. Apply and OK http://www.gdal.org/gdal_calc.html
Vectorize the Raster (because QGIS does not yet have full attribute tables for rasters)	Assume we want to know the exact address of the drug arrests closest to schools. 1. In the Processing Toolbox, search for "Polygonize (raster to vector). 2. Input Layer = DrugsXSchoolDist 3. Output field name = DrugSchool 4. Vectorized (file name) = DrugSchool 5. Click Run 6. Properties of "Vectorized" a. Layer Name = DrugSchool b. Style / Categorized c. Classify d. De-select the class with no value and no legend e. Change Legend labels to ">= 1000 m" (for 1) and "<1000 m (for 2) 7. Apply and OK 8. Do a spatial join to connect the DrugSchool Layer to the Drug Calls Layer. Who remembers how?

	9. Vector / Data management / Join attributes by location a. Target vector layer = DrugSchool b. Join vector layer = Drug calls c. Give Output Shapefile a name and location d. Keep all records. e. OK
Other Raster Processing, if Time Permits	

Additional Exercises

(For the Virginia Workshop, these are assignments.)

Exercise 1: Getting data, basic mapping, and using spreadsheets for data development

1. Open QGIS and start a new map.
2. Load in the County and State layers that we used in Class 1
3. Get Census Data for Places for your chosen state.
   You can find the state for the number you chose at random here:
   http://www.columbia.edu/~sue/state-fips.html
   a. Go to www.census.gov and click the link to Geography.
   b. Click “Tiger Products” from the right-hand column
   c. Click "TIGER/Line Shapefiles" in the first column, make sure the 2015 tab is highlighted, then click the Download link in the bottom portion of the page.
   d. Pick Web Interface
   e. Pick 2015 again and select “Places” for the layer type
   f. Pick your state from the dropdown list and click download.
   g. Extract the files from the .zip to your GISforPolicy folder (or a subfolder named with your state’s name)
4. Load the places to your map and zoom to the layer with the places.
5. Save your map.
6. Symbolize your map as you like, but please use some combination of the following:
   a. Labels for your counties
   b. Places in a different / contrasting color than your counties
   c. Surrounding states in a different color.
7. Save your map
8. Use the snipping tool or do a screen grab to copy an image of your map to the clipboard.
9. Create a new Word or or Google word processing document and paste your screen grab into the document.
10. Above your map, add a heading / title along the lines of “Places and Counties, [my state]. On the next line, put “[My name], GIS for Public Policy, Skill Practice 1”

    Make sure your map and title fit on one page and then save/download as .PDF with a file name as follows. MYNAME_GIS4Policy_Assignment1.pdf

    That’s it for the mapping part of the assignment. You can close QGIS for now.

11. Go back to census.gov. We’re going to need some more demographic data.
    a. This time, go to Data / Data tools and Apps / American Factfinder / American Factfinder
    b. Click Advanced Search

c. Select Geographies, Counties, [Your State], All Counties within [Your State]
d. Click “Add to your selections”
e. Click “close” at the top right.
f. You now have to search for your data.
g. Type “DP-1: Profile of General Population and Housing Characteristics: 2010” in the Topic or table name search box, then click “Go”
h. Check the box by the first option (2010 SF1 100% Data)
i. Then click “Download” which will create a zip file.
j. Click download agin to download said zip file.
k. Do the usual w/ the zip file. (unzip it to your GISforPolicy folder.

12. Import the data into excel.

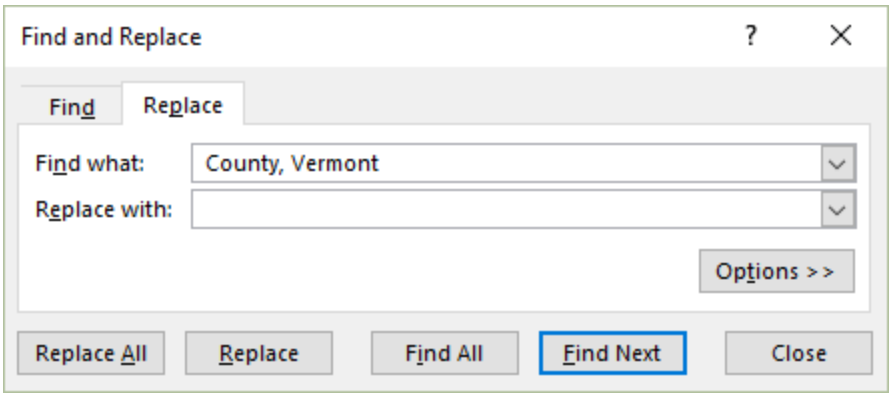
It is VERY important that you do this in the following way (do not just double click the file and let Excel open it).

a. Start Excel with a blank workbook
b. Use Data/Get Data/From Text
c. Navigate to your data and select the file called something like “DEC_10_SF1_SF1DP1_with_ann.csv”
d. Select “Delimited” and “My Data has headers” then click next
e. Uncheck tab and check comma, click next.
f. For the second column, with GEO.id2 at the top, click Text, then click finish.

13. Clean up the spreadsheet as follows:

a. Delete all columns from E (HD002_S001 / Percent: Sex and Age…) through AY (HD02_S024 / Percent; Sex and Age - Total population - 62 years and over) Column E will now be HD01_S025 / Number; SEX AND AGE - Total population - 65 years and over
b. Delete ROW 2
c. Delete Column A
d. Delete Columns F through LO
e. Rename the column headings as follows
    i. FIPS5
    ii. CountyName (NO SPACES)
    iii. Population
    iv. Seniors
    v. PctSeniors
f. Delete the State name from each cell in the CountyName Column, using the search and replace feature.

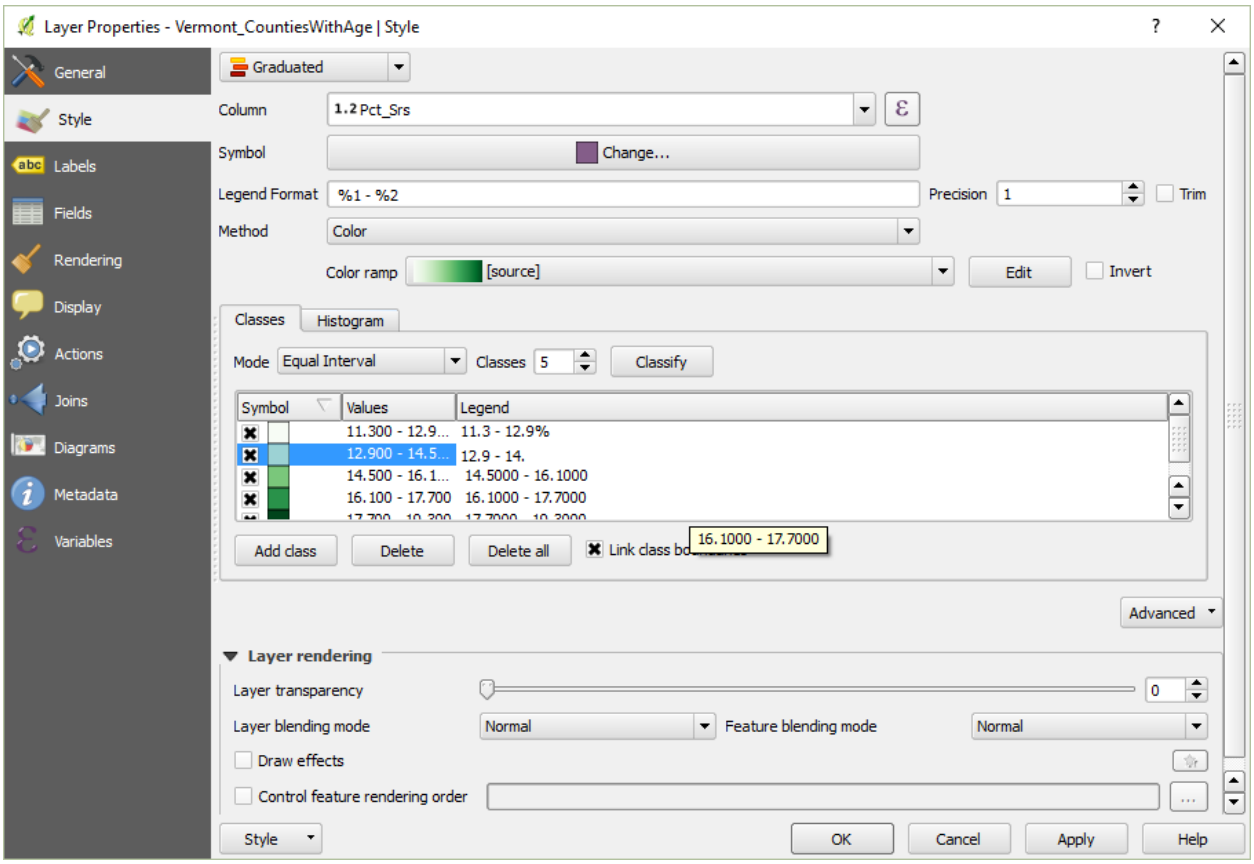
    For example, if your state is Vermont, change all instances of “ County, Vermont” to “”, where “” means, don’t put anything in the Replace with box.



g. Change the name of your worksheet tab to “AGE”
h. Save your worksheet as an Excel version 97-2003 file named MYNAME_AGE_Assignment1.xls.

Exercise 2: Joining tabular and spatial data; and using the print composer

1. Open QGIS and open your map from the first assignment.
2. Load your spreadsheet from the first assignment. It should have these fields:
    a. FIPS5
    b. CountyName (NO SPACES)
    c. Population
    d. Seniors
    e. PctSeniors
3. Join your county polygon layer to your spreadsheet.
    a. See GISToolTime_Week2 and pages 54ff in *Learning QGIS.*
4. Use "Save As" to create a new shapefile called [my state]_CountiesWithAge[my state]age.shp
5. Symbolize the layer according to the percent of the population who are seniors.
    a. Edit the legend so that the legend labels are percentages. In the image below, this is in process. [You can double click into the "Legend" area to edit the legend labels.]



6. Review the Class 1 tool time notes (see the last section) and the excerpt from *QGIS by Example* about the print composer, then compose a map with the following elements:
    a. A main map zoomed into your state
    b. A locator map showing your state's location in the U.S.
    c. A title (add a text box) that includes "Assignment 1," your name, and a short description of the map. For example: "Assignment 1, Spencer Phillips: Population aged 65 and older, by County, Vermont, 2015"
    d. A legend with with the counties symbolized for PctSeniors field. Choose colors, number of classes, etc. as you see fit.
    e. A distance scale
    f. A text box at the bottom with sources. [Type "Source: U.S. Bureau of the Census…." and include URL for American Fact Finder and Tiger line files.
7. Export your map as a .PDF with a filename like MYNAME_GIS4Policy_Assignment2a.pdf
8. Add a field to your "CountiesWithAge" attribute table for Pct_Srs2
    a. Use the Expression builder to create the field as a decimal type, with a precision of 3.
    b. Calculate the field based on the total population and the population of seniors, NOT the existing percentage field.
9. Create a new Composer and add the attribute table for your CountiesWithAge layer.
    a. Change the settings under Item / Attribute table so that you are showing just the following fields (with these or similar HEADINGS) in your report:
        i. FIPS
        ii. County Name
        iii. Total Population
        iv. Senior Population
        v. Pct_Srs (will be from your excel file)
        vi. Pct_Srs2 (generated w/in QGIS)
    b. Add a Title that includes "Assignment 2," your name, and a descriptive title.
10. Export your tabular report to .pdf. Please call it MYNAME_GIS4Policy_Assignment2b.pdf

Exercise 3: Editing and creating spatial data.

Please read through all of this before you begin. You will need to form a strategy for getting / retaining all of the information you'll need, so be careful and methodical.

This assignment will test your mastery of and creativity in using the tools / skills covered so far. I recommend that you review the Tool Time notes 2 and 3, especially, then tackle the following scenario.

It is 2021, and Delaware, Maryland, Virginia and West Virginia, having finally gotten over MOST of their ages-old disagreements, have decided to re-configure their borders along the lines of the scenario that follows. Your job is to create the new map of the MidAtlantic region.

1. Determined to leave a lasting legacy for the nation, President Joe Biden (remember, this is hypothetical) urges the creation of "Greater Delmarnia" which is to include all of the current state of Delaware, plus the Eastern Shore of the Chesapeake Bay, stretching from Cecil County, Maryland down through Northampton County, Virginia.

2. Governor Hogan, meanwhile, is experiencing regret over his decision to ban fracking in Maryland, and has made a successful play to annex the eastern panhandle of West Virginia. (In exchange, West Virginia will continue to operate the casino and racetrack at Charlestown for a period of 25 years.) [Do NOT use existing county boundaries to draw this new boundary. Instead, you'll have to use the splitter tool from the Digitizing Tools. [Hint: you'll first have to create a line layer with which to do the splitting.]

3. Finally bowing to the obvious demographic and political divisions within its remaining borders, Virginia will be split in two states: Democroatia and Bratland. While these names may seem odd for STATES, stakeholders in both areas, for different reasons, hold out hope for eventual secession from the union and they figure they may as well just do the whole "pick a name thing" once.

Seeing as the idea of using natural features to guide the location of political boundaries is now thoroughly passe', it was decided to define Democroatia as that area of the state formerly known as "Virginia" lying north of I-64 and EAST of I-81. [For this change, please DO use existing county boundaries. This will mean a less than perfect use of the interstates as the boundaries, but Virginians being Virginians can only take so much change, and could not bear, for example, to have Montecello and UVA in different nations, er, I mean STATES.]

4. Finally, as you may be wondering what is to become of the District of Columbia, here's the answer. The former Washington, DC is now fully devoted to monuments, parades and conferences extolling the wonder that is America -- "Pyongyang on the Potomac," as many now call it. The seat of government, meanwhile, is now a man-made island floating off the coast of New Jersey, making it even harder to get to than via Dulles, but putting it within easy helicopter or yachting distance of the Hamptons. This greatly reduces the time lawmakers' must spend fundraising while increasing the time they can devote to debates

over how to not really repeal and replace the Affordable Care Act and hearings on Benghazi (it never ends) and the Hoax That is Climate Change. [You may make the island any shape you wish.]

Once you have your new state boundaries created, please select a city to be each state's capital. [Hint: Add an attribute field to the MidAtlantic_Cities layer called "Capital" and set it to 1 for the new Capitals, then select based on or create a new point layer and add the capital cities.]

BUT BEFORE YOU BEGIN, I want to be sure you are comfortable with re-projecting data, so do the following:

1. Download and unzip the Execise 3 data from the course site.
   Your four shapefiles should be in a folder called something like
   C:\...\GISWorkshop\Excercise3\

2. Create a **new** folder called "Assignment3_NAD83" or
   C:\...\GISWorkshop\Exercise3_NAD83

3. OPEN QGIS and load in the four original layers (Cities, Counties, Interstates, States). These are the versions in C:\...\GISWorkshop\Excercise3\ in the original projection (CRS)

4. Use "Save As" for each of those four layers in turn. For each layer, set the CRS = NAD83 / UTM zone 18N, and save the new layer to
   C:\...\GISWorkshopy\Exercise3_NAD83

5. NOW open a blank map file, add the new (NAD83 / UTM) layers and do the editing, etc. required above.

Please create, export to .PDF and upload TWO maps, as follows:

1) MYNAME_GIS4Policy_Assignment3a.pdf will show your editing skills: I am primarily interested in seeing that you were able to create new features out of whole cloth (DC) and from existing features.

   For this map, please be sure to include the following elements:
   a) A locator map showing the location of the re-configured Southern MidAtlantic relative to the US as a whole (or North America if you want to go crazy).
   b) Distance Scale in units of your choice
   c) A legend showing the new states, capital cities, and any other layers you would like to add for visual interest.
   d) The usual text box with the course, assignment number and your name.
   e) A title.

f) A North Arrow if you really want it.

2) MYNAME_GIS4Policy_Assignment3b.pdf will show off some of your analytical skills: I want to see that you are able to create and calculate new attributes and display those on your map.

   Accordingy, your map layout should show:

   a) A thematic map showing the percentage of people in each county that is non-white.
   b) Distance scale
   c) Legend
   d) the text box with your name, etc.
   e) A Title
   f) A North Arrow if you like.

All of the data you need is contained in the "Exercise3" folder

Enjoy!

Resources

GIS Data Sources

See Wiki in the course management site.

Using QGIS

Loading Data from an ESRI File Geodatabase (Windows only)

1. From the main menu, select Layer / Add Layer / Add Vector Layer
2. Select Directory as the Source type.
3. Pick ESRI FileGDB from the "Type" dropdown
4. Click Browse and navigate to the folder with your data.
5. SINGLE Click the **folder** containing your Geodatabase. It will appear to be a file with the extension ".gdb".
6. Click the "Select Folder" button at the bottom.
7. Click "Open"
8. Hold down the Ctrl key or Command key and click the layers you need from your geodatabase.

Locator maps:

https://www.youtube.com/watch?v=0uRds8DOwQc

https://www.youtube.com/watch?v=cBbcNf1ERgM

Adding a map service from the U.S. National Map (USGS):

See this site: http://www.northrivergeographic.com/qgiswms

Symbolize a point layer by the size of the point:

Suppose you want to symbolize a point layer with the points being different SIZES according to the level of some numeric field in the layer's attribute table. Here's how you do that in Windows and on a Mac:

Windows instructions (see also screen shot below):

1. Open properties for your point layer.
2. Click the Style tab.
3. Pick "Graduated" from the dropdown menu at the top.
4. As "Column" pick whatever attribute (field) has the data you want to use
5. Change the "Method" to "Size" (from color)
6. Click "Classify" The default is 5 classes. You can change that, change the range of sizes, the color of the dots, etc.

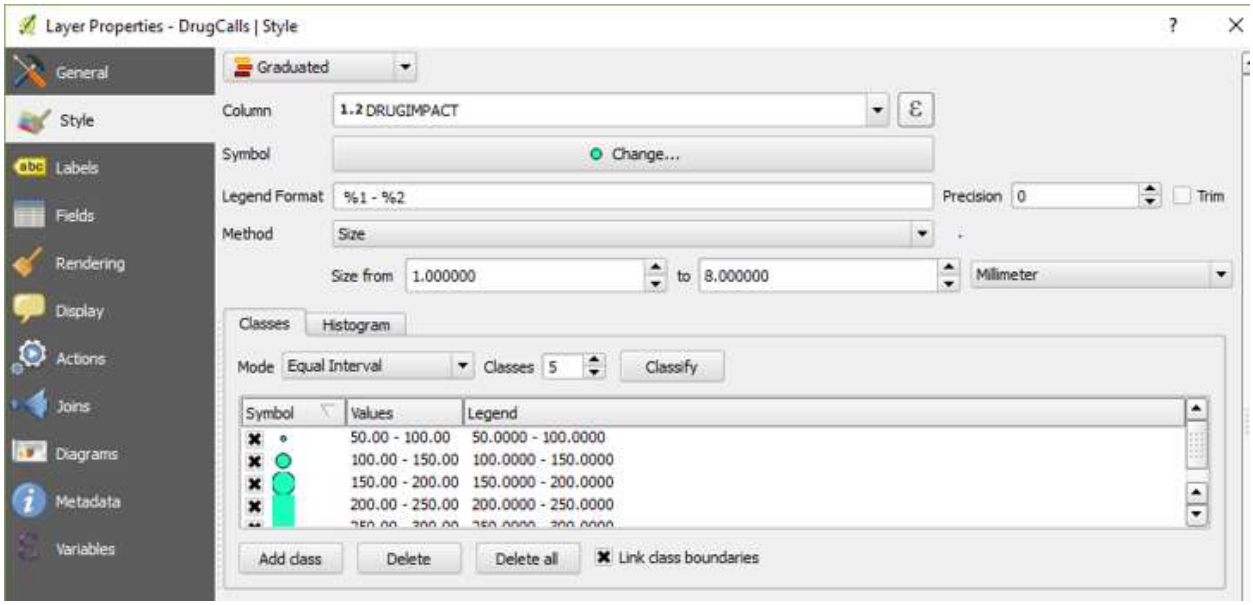
7. Click Apply and OK

For MAC, it is similar, but they have hidden the key settings behind an "advanced" button:

[Note: I'm reporting this second hand, and it seems to me that one of the steps highlighted in yellow might be incorrect. If you test this and can clarify, please reply to this this conversation with the information.]

1. Open properties for your point layer.
2. Click the Style tab.
3. Pick “Graduated” from the dropdown menu at the top.
4. As “Column” pick whatever attribute (field) has the data you want to use [This is the one I think is not part of the Mac process.]
5. Click "advanced" next to the "Classify" buttons
6. Select "Size Scale Field" Select the field that has data you want to use
7. Select "Scale area"
8. Click “Classify”
9. Change the “Method” to “Size” (from color)
10. Click “Classify”
11. make other changes, then click Apply and OK
12. Click Apply and OK

Happy Symbolizing!



Should I merge or should I union?

In the workshop exercise (Tool Time 2), we used Union to combine the two halves of the Green Mountain National Forest proclamation boundary. But we can also Merge them using the steps

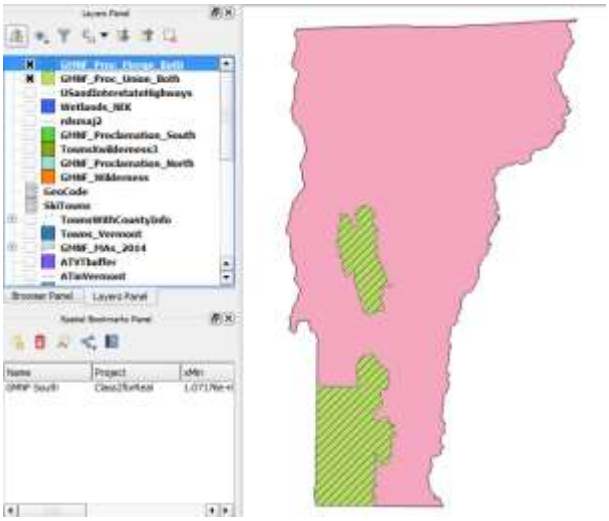
described in for the example of wetlands and deer wintering areas in the Northeast Kingdom. However, the Merge and Union tools do give you slightly different results in their attribute tables.

So long as the two input data sets have the same fields in their attribute table, **MERGE** takes the data from both input data sets and records them in the same fields in the attribute table of the output data set.

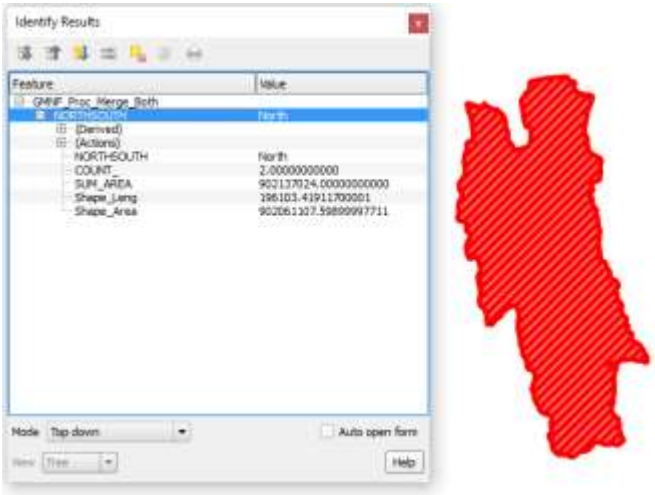
UNION, by contrast, treats each data set as having its own unique set of attributes and it retains puts a copy of all of the input layers' fields in the output data set. So, even if the data themselves mean the same thing and the field names are the same in both input data sets, UNION will give you two sets of fields in the output data set.

Test this out by running both Union and Merge on the proclamation boundaries (North and South) and then compare what you see in the resulting attribute tables.

Both Union and Merge produce a layer that looks the same. The MERGED layer is cross-hatched, the UNIONed layer is solid green.



The difference is in the Attribute tables. Using the info tool, the lower image below shows you get when you click on the northern feature of the MERGEd layer. Note that there is but one set of attributes. If we ID'd the southern portion, the NORTHSOUTH field would be "South".



A couple other features of these two tools:

- With MERGE, you can combine two OR MORE layers of the same type (points, lines or polygons). So, for example, we could combine the buffered Appalachian Trail layer we created (a polygon) with the two separate proclamation boundary layers, the deer wintering area or any other polygon layer.
- UNION, by contrast, operates on just two layers at a time. You can, however, union a third layer to the result of the union of your first and second layer. You do end up with a lot of extra attributes.

- For MERGE, you select layers to merge from folders on your hard drive, not from the layers already in the map. You can also select a whole folder full of compatible layers to merge.
- UNION, by contrast, operates only on layers already in your map canvas/project.

Favorite Plugins

Time Manager, for making animated maps: https://plugins.qgis.org/plugins/timemanager/

NNJoin for finding the distance to the "nearest neighbor" of features in a dataset: https://plugins.qgis.org/plugins/NNJoin/

Cartography Examples

[See the Wiki for this too, for now.]

The CIA has released its declassified maps collection. It is well worth a look. This article has an overview and some samples, including a nice illustration of how various projections can distort our perception of the size of countries/land masses. The article has the links to the CIA Flickr page w/ the maps themselves. http://geoawesomeness.com/cia-declassified-map-collection-flickr-totally-awesome/.

Counterexamples: "Cartastrophe: mistakes were made": https://cartastrophe.wordpress.com/page/2/

A note on Raster processing for Mac Users [DRAFT]

Our Mac-using colleagues (i.e. most of you) may be unable to find the raster reclassification and raster calculation tools in QGIS. The reason is that while they are part of the GRASS (for Geographic Resources Analysis Support System that has been around for more than 30 years) is automatically installed with QGIS on the Windows machines to which we lesser humans still cling, it is NOT installed automatically for the Mac. You can download it from this page: https://grass.osgeo.org/download/software/mac-osx/

Once downloaded and installed, I assume you will be able to access the GRASS-based tools via the Processing plug-in from QGIS. I do NOT recommend trying to run GRASS directly. That is possible, but it uses different file formats, has its own separate interface, etc. and is not necessary for our work here.

There is also SAGA (for "System for Automated Geoscientific Analyses"), which is another GIS software package, like QGIS and GRASS that you can download from here: https://sourceforge.net/projects/saga-gis/files/ There are not separate Windows and Mac versions, as the code is designed to run on any system. (The SAGA people do note that things are not fully tested out on the MAC OS.) You don't want to run SAGA separately either.

Here's what you need to know, however: QGIS while a GIS package in its own right is designed to access and use algorithms (procedures, tools, etc.) written in/for GRASS and SAGA (and some other packages, including R). Your Processing Plug-in and the Processing Toolbox give you easy access to those tools from the QGIS interface. You can activate GRASS and SAGA algorithm access by clicking the "enable additional providers" link at the bottom of the Processing Toolbox. Expand the "providers" list, and you'll see the various providers. Make sure that GDAL, GRASS GIS 7 (and/or GRASS commands) and SAGA are activated. (See the attached file for a screen shot.)

I think that should give us what you need for the Tool Time exercises.