API-231 / GIS-PubPol
Meeting 11 (Lab Exercise + Problem Set 6)

Yuri M. Zhukov
Visiting Associate Professor of Public Policy
Harvard Kennedy School

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Goal: geocode historical lynching locations in U.S.

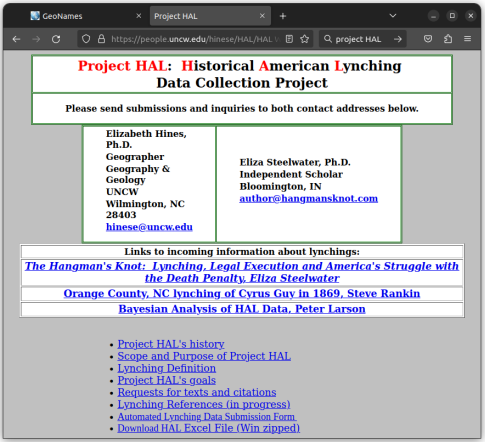
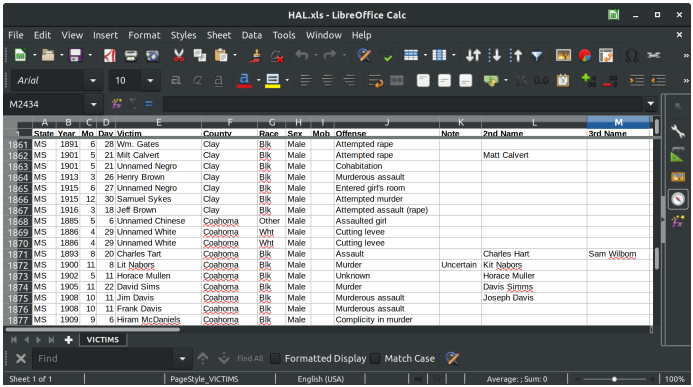


Figure 1: We will geocode these data

Overview of lab exercise and problem set

1. Lab exercise
   a) Geocode lynching data sample
   b) Point-in-polygon analysis (lynchings per county)
2. Problem set
   a) Create a map and boxplot, showing relationship between 100 lynching locations and 1920 U.S. Presidential election results

We will use 2 methods to geocode these lynching locations:



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	State	Year	Mo	Day	Victim	County	Race	Sex	Mob	Offense	Note	2nd Name	3rd Name
1861	MS	1891	6	28	Wm. Gates	Clay	Blk	Male		Attempted rape			
1862	MS	1901	5	21	Milt Calvert	Clay	Blk	Male		Attempted rape		Matt Calvert	
1863	MS	1901	5	21	Unnamed Negro	Clay	Blk	Male		Cohabitation			
1864	MS	1913	3	26	Henry Brown	Clay	Blk	Male		Murderous assault			
1865	MS	1915	6	27	Unnamed Negro	Clay	Blk	Male		Entered girl's room			
1866	MS	1915	12	30	Samuel Sykes	Clay	Blk	Male		Attempted murder			
1867	MS	1916	3	18	Jeff Brown	Clay	Blk	Male		Attempted assault (rape)			
1868	MS	1885	5	6	Unnamed Chinese	Coahoma	Other	Male		Assaulted girl			
1869	MS	1886	4	29	Unnamed White	Coahoma	Wht	Male		Cutting levee			
1870	MS	1886	4	29	Unnamed White	Coahoma	Wht	Male		Cutting levee			
1871	MS	1893	8	20	Charles Tart	Coahoma	Blk	Male		Assault		Charles Hart	Sam Wilborn
1872	MS	1900	11	8	Lit Nabors	Coahoma	Blk	Male		Murder	Uncertain	Kit Nabors	
1873	MS	1902	5	11	Horace Mullen	Coahoma	Blk	Male		Unknown		Horace Muller	
1874	MS	1905	11	22	David Sims	Coahoma	Blk	Male		Murder		Davis Simms	
1875	MS	1908	10	11	Jim Davis	Coahoma	Blk	Male		Murderous assault		Joseph Davis	
1876	MS	1908	10	11	Frank Davis	Coahoma	Blk	Male		Murderous assault			
1877	MS	1909	9	6	Hiram McDaniels	Coahoma	Blk	Male		Complicity in murder			

Figure 2: Project HAL raw data

Method 1: Geocode using web service/API (OpenStreetMap)

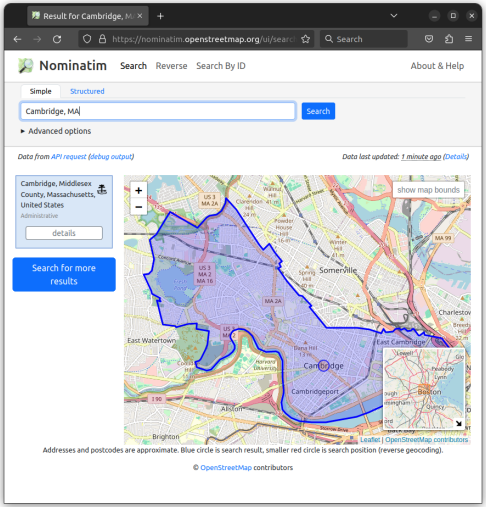


Figure 3: OSM Nominatum

Method 2: Geocode offline, with gazetteer data (GeoNames)

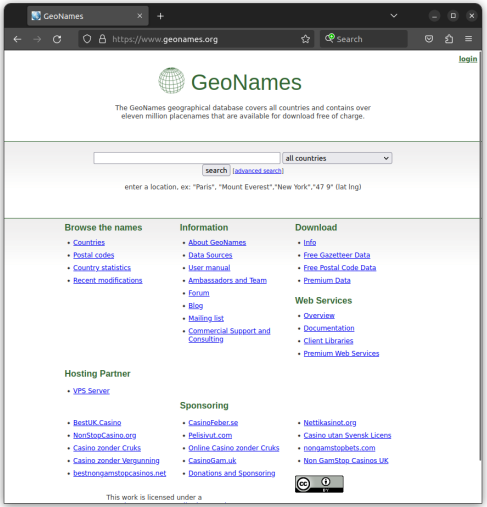


Figure 4: GeoNames

You will then do some *point-in-polygon analysis* to see how lynchings (as part of broader voter suppression efforts) may have impacted vote share in 1920

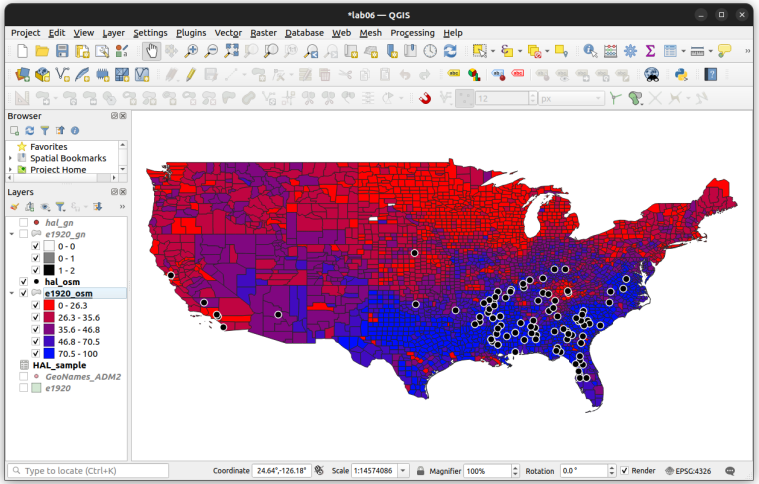


Figure 5: 1920 Presidential elections results

Your assignment: create (1) boxplot of vote share against lynchings, (2) map of geocoded lynching locations vs. election results

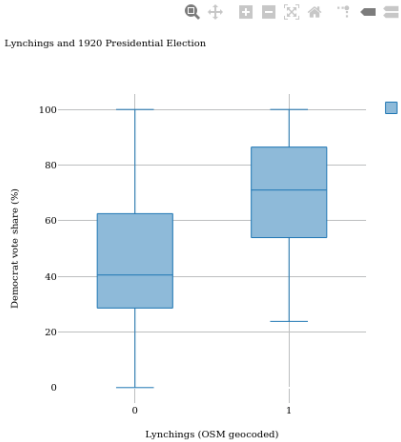


Figure 6: Boxplot

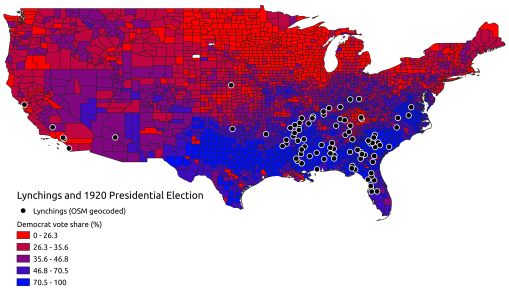


Figure 7: Map

You can make these plots in QGIS or in R. Instructions for both are below.

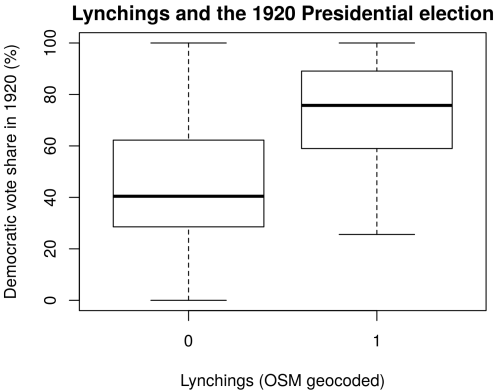


Figure 8: Boxplot in R

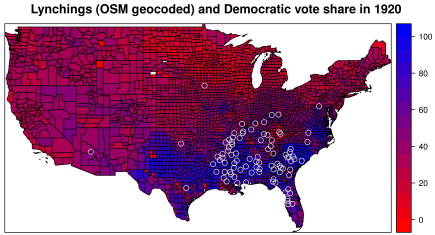


Figure 9: Map in R

We have three (and a half) sources of data:

Category	Type	Format	Data source
Lynchings (sample)	Table (non-geo)	`.csv`	`Project HAL`
County gazetteer	Table	`.csv`	`GeoNames`
1920 county borders	Vector (polygons)	`.geojson`	`Newberry Library`
+ 1920 election results			`CQ Voting/Elections`

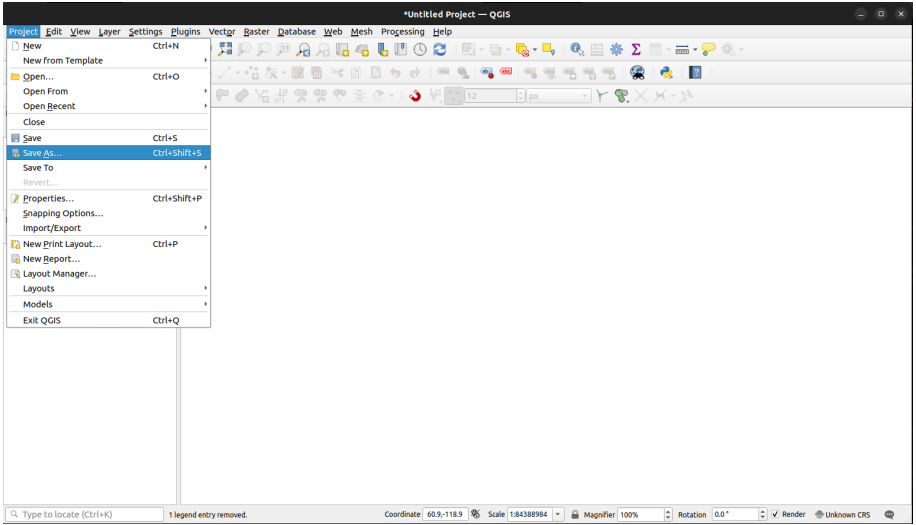
These are all in the `PS06.zip` file posted on Canvas.

Let's open QGIS...

QGIS

Always save your progress!

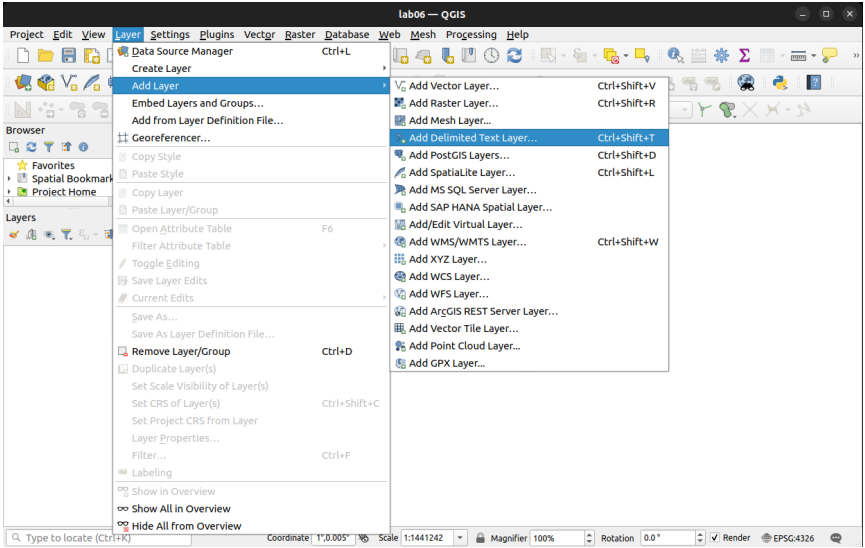
Go to `Project` → `Save As...`



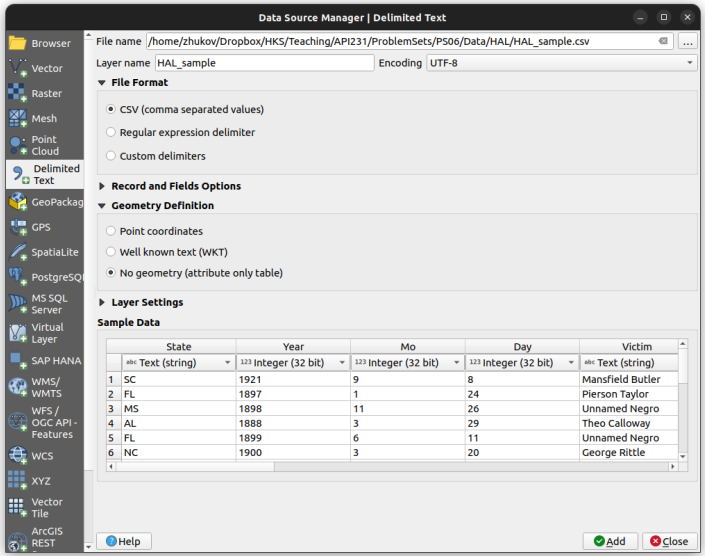
Geocoding

Load the Project HAL data:

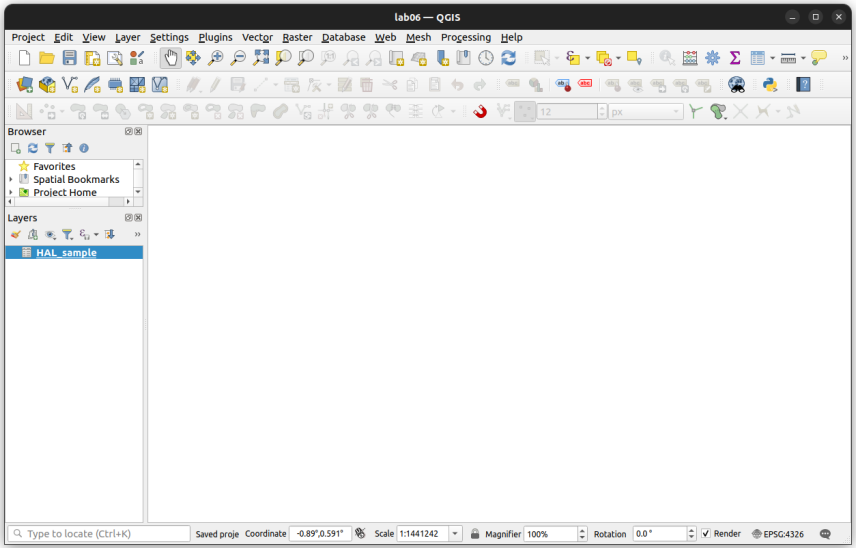
`Layer` → `Add Layer` → `Add Delimited Text Layer...`



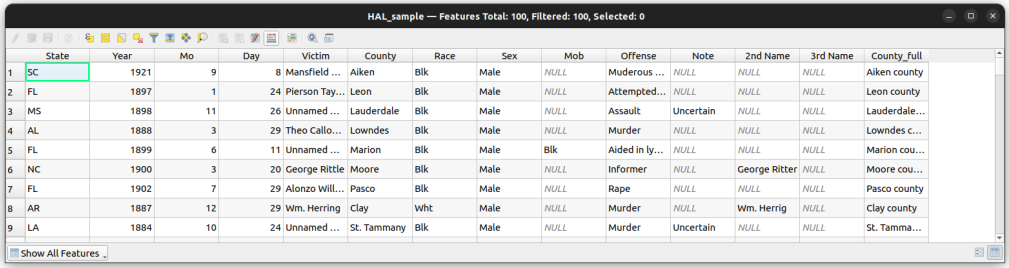
Open the file `HAL_sample.csv` in the `HAL` folder.
Geometry definition should be set to `No geometry`. Click `Add` ‘



You should now see `HAL_sample` in your layer menu. But there are no points on map, because the data are not geocoded.

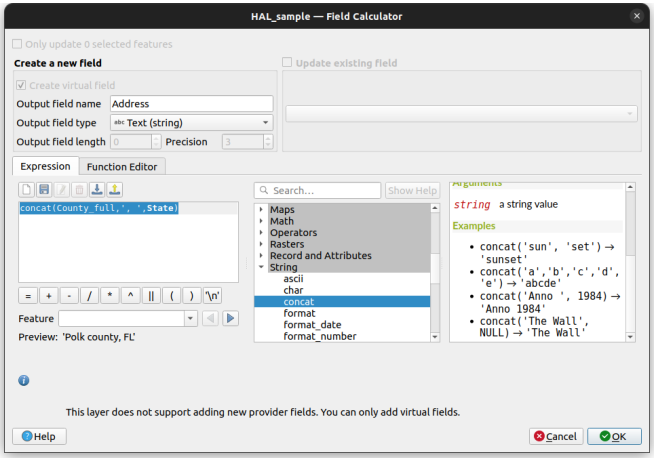


Open the Attribute Table for `HAL_sample`, navigate to the `Field Calculator`

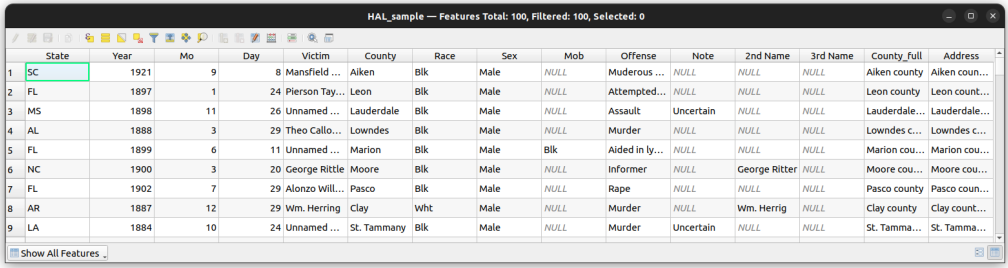


	State	Year	Mo	Day	Victim	County	Race	Sex	Mob	Offense	Note	2nd Name	3rd Name	County_full
1	SC	1921	9	8	Mansfield …	Aiken	Blk	Male	NULL	Muderous …	NULL	NULL	NULL	Aiken county
2	FL	1897	1	24	Pierson Tay…	Leon	Blk	Male	NULL	Attempted…	NULL	NULL	NULL	Leon county
3	MS	1898	11	26	Unnamed …	Lauderdale	Blk	Male	NULL	Assault	Uncertain	NULL	NULL	Lauderdale…
4	AL	1888	3	29	Theo Callo…	Lowndes	Blk	Male	NULL	Murder	NULL	NULL	NULL	Lowndes c…
5	FL	1899	6	11	Unnamed …	Marion	Blk	Male	Blk	Aided in ly…	NULL	NULL	NULL	Marion cou…
6	NC	1900	3	20	George Rittle	Moore	Blk	Male	NULL	Informer	NULL	George Ritter	NULL	Moore cou…
7	FL	1902	7	29	Alonzo Will…	Pasco	Blk	Male	NULL	Rape	NULL	NULL	NULL	Pasco county
8	AR	1887	12	29	Wm. Herring	Clay	Wht	Male	NULL	Murder	NULL	Wm. Herrig	NULL	Clay county
9	LA	1884	10	24	Unnamed …	St. Tammany	Blk	Male	NULL	Murder	Uncertain	NULL	NULL	St. Tamma…

Create new field, `Address`, of type `Text (string)`.
For the `Expression`, write `concat(County_full,', ',State)`.
The `Preview` should show a county-state ID. Click `OK`

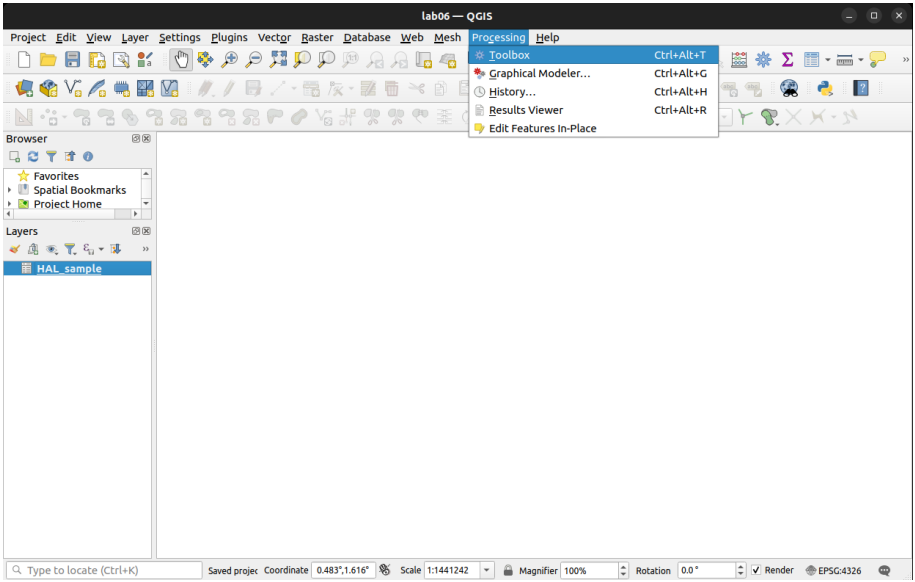


The new field should appear in the Attribute Table

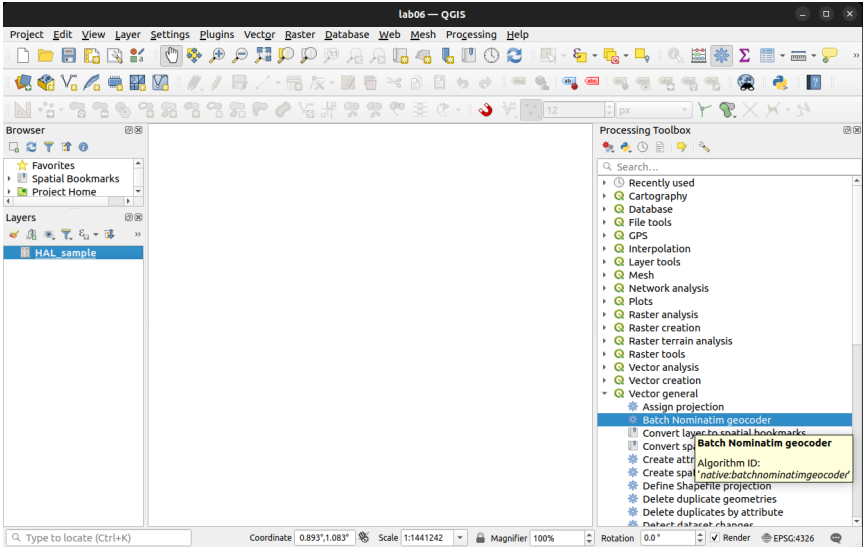


	State	Year	Mo	Day	Victim	County	Race	Sex	Mob	Offense	Note	2nd Name	3rd Name	County_full	Address
1	SC	1921	9	8	Mansfield …	Aiken	Blk	Male	NULL	Muderous …	NULL	NULL	NULL	Aiken county	Aiken coun…
2	FL	1897	1	24	Pierson Tay…	Leon	Blk	Male	NULL	Attempted…	NULL	NULL	NULL	Leon county	Leon count…
3	MS	1898	11	26	Unnamed …	Lauderdale	Blk	Male	NULL	Assault	Uncertain	NULL	NULL	Lauderdale…	Lauderdale…
4	AL	1888	3	29	Theo Callo…	Lowndes	Blk	Male	NULL	Murder	NULL	NULL	NULL	Lowndes c…	Lowndes c…
5	FL	1899	6	11	Unnamed …	Marion	Blk	Male	Blk	Aided in ly…	NULL	NULL	NULL	Marion cou…	Marion cou…
6	NC	1900	3	20	George Rittle	Moore	Blk	Male	NULL	Informer	NULL	George Ritter	NULL	Moore cou…	Moore cou…
7	FL	1902	7	29	Alonzo Will…	Pasco	Blk	Male	NULL	Rape	NULL	NULL	NULL	Pasco county	Pasco coun…
8	AR	1887	12	29	Wm. Herring	Clay	Wht	Male	NULL	Murder	NULL	Wm. Herrig	NULL	Clay county	Clay count…
9	LA	1884	10	24	Unnamed …	St. Tammany	Blk	Male	NULL	Murder	Uncertain	NULL	NULL	St. Tamma…	St. Tamma…

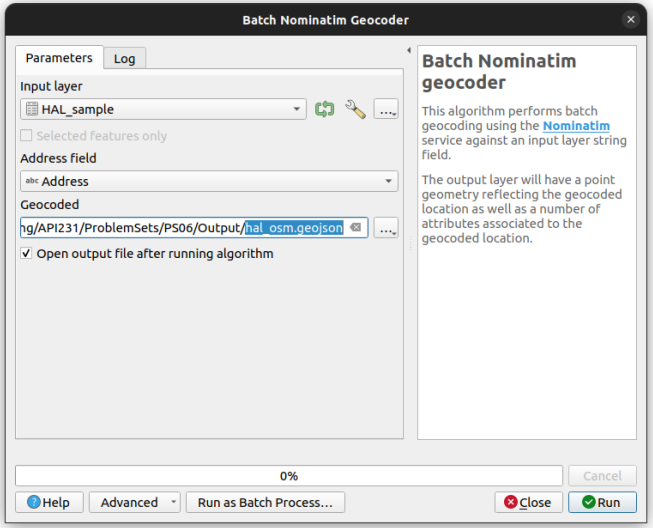
To access the OSM/Nominatum geocoder, go to `Processing` → `Toolbox`



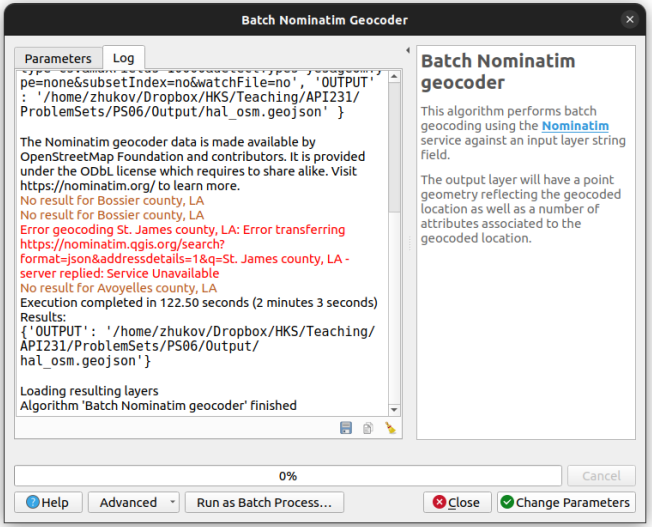
In the `Processing Toolbox` panel, go to `Vector general` menu → `Batch Nominatum geocoder`



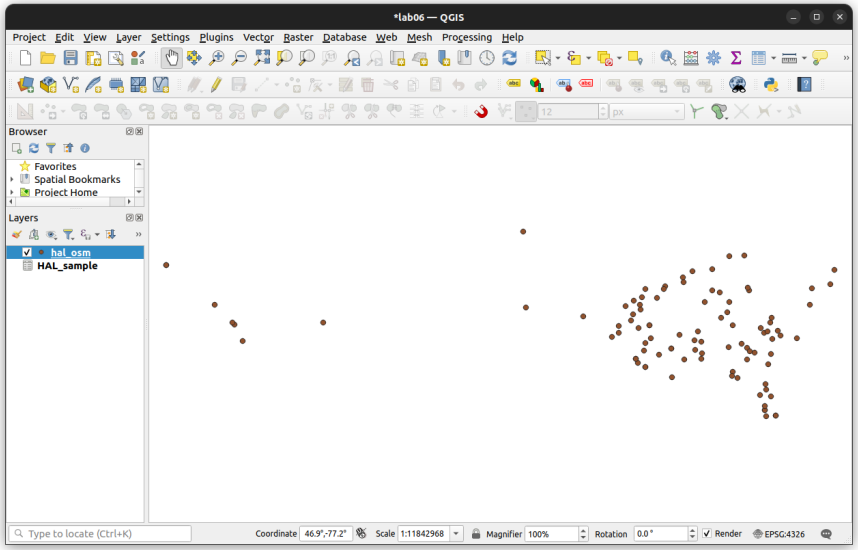
Set `Input layer` = `HAL_sample` and `Address field` = `Address`. Save the output to a file called `hal_osm.geojson`. Click `Run`



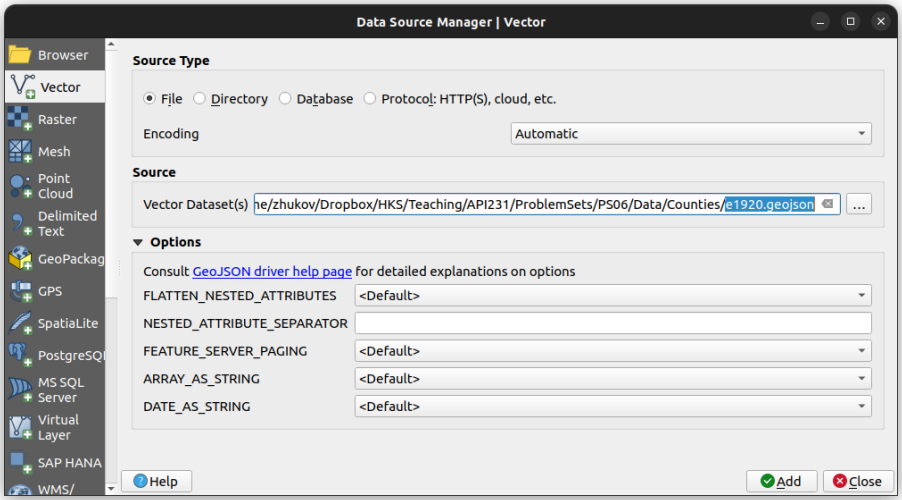
After running, the log may tell you that some addresses could not be geocoded. Click `Close`



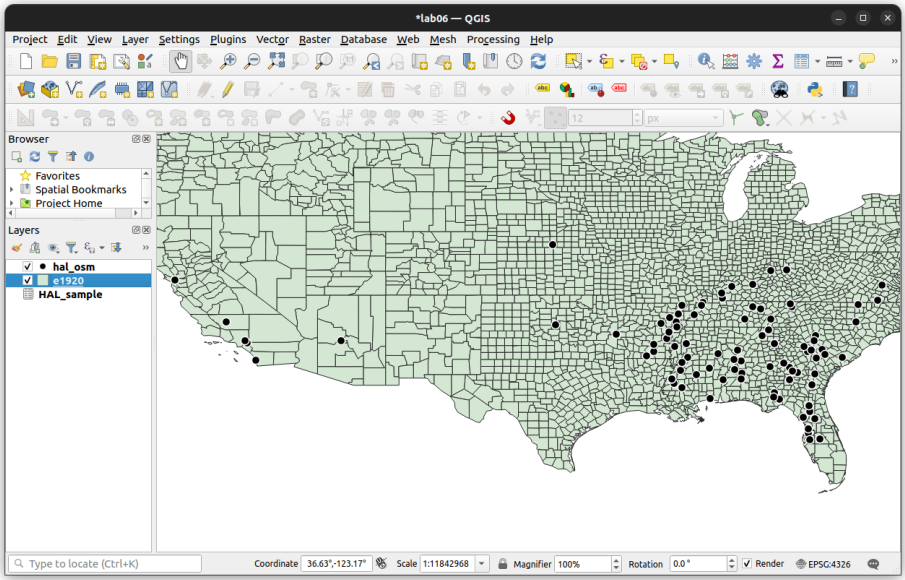
You should see the geocoded points in the main project window, and a new layer, `hal\_osm`. Let's plot it against an historical county boundary shapefile.



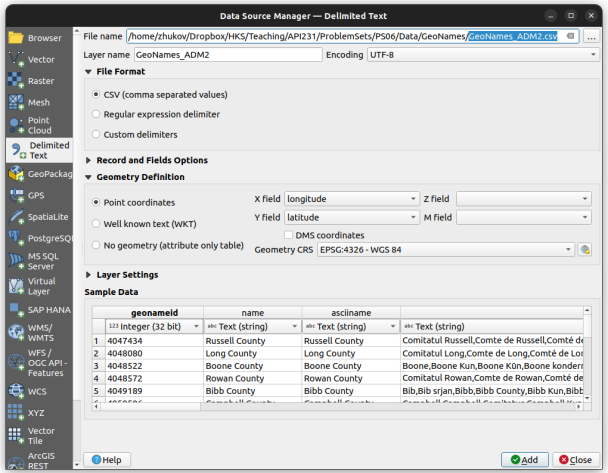
Go to `Layer` → `Add Layer` → `Add Vector Layer...`.
Navigate to `e1920.geojson` file in `Data/Counties` folder. Add it to the map.



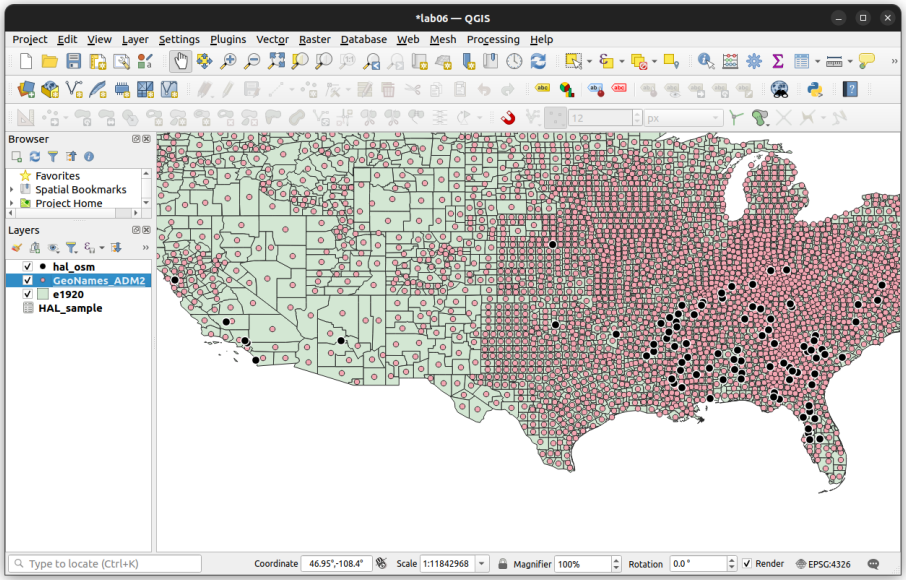
Looks about right. Now let's try geocoding with gazetteer data.



Add the GeoNames gazetteer to the project, using `Add Delimited Text Layer...`. Load `GeoNames_ADM2.csv` from the `Data/GeoNames` folder. Set `X field` = `longitude` and `Y field` = `latitude`



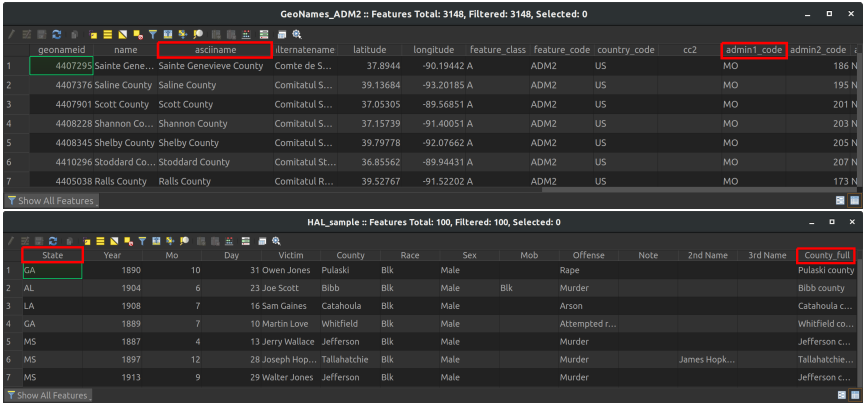
The centroids for (contemporary) counties should appear in the project window.



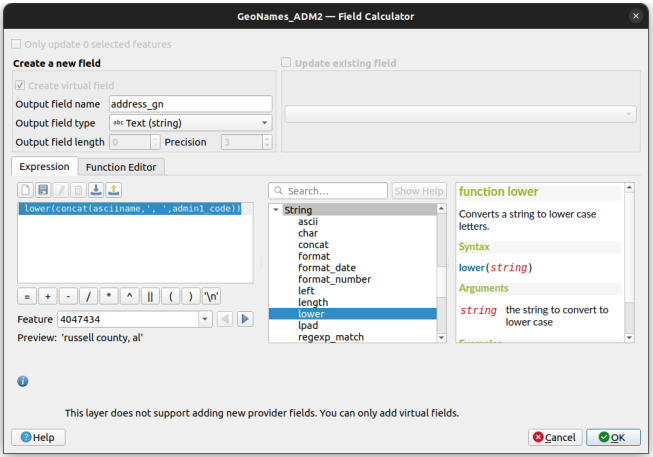
In the `Attribute Table`, we see that

- `asciiname` field in `GeoNames_ADM2` corresponds to `County_full` in `HAL_sample`
- `admin1_code` corresponds to `State`

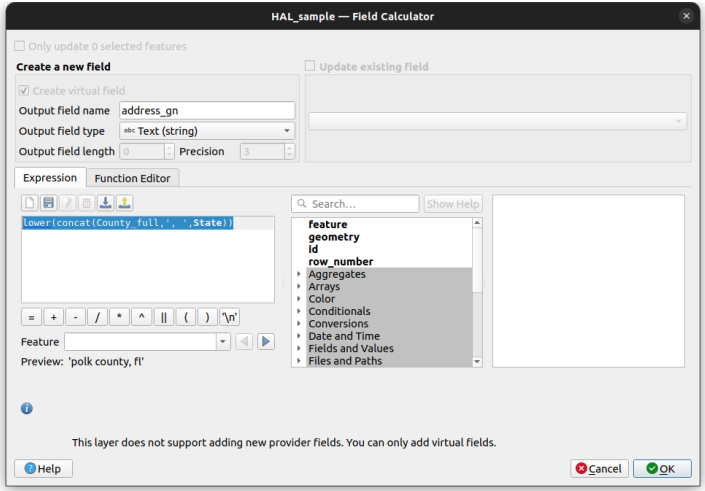
We can use these to create a unique key to match on



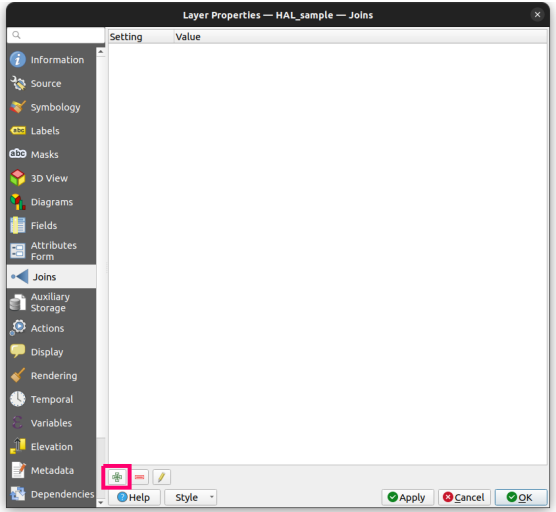
Open the `Field Calculator` for `GeoNames_ADM2`.
Create a new variable called `address_gn` of type `Text (string)`.
Set `Expression` to `lower(concat(asciiname,', ',admin1_code))`.
The `Preview` should show a *lower case* county-state ID. Click `OK`



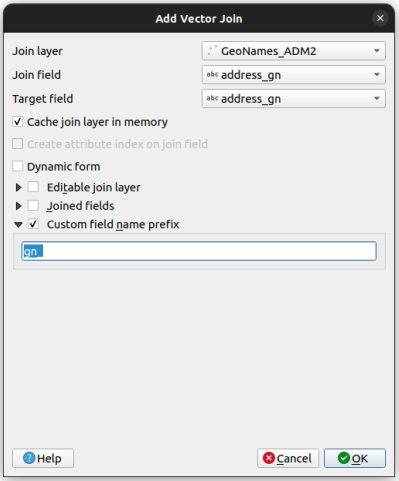
Now open `Field Calculator` for `HAL_sample`.
Create the same new field, `address_gn`, of type `Text (string)`.
Set `Expression` to `lower(concat(County_full,', ',State))`. Click `OK`



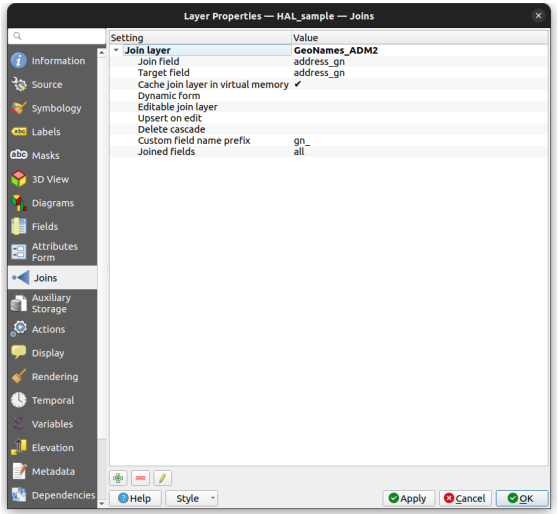
Now we are ready to join these layers. Double-click `HAL_sample` layer to bring up the `Properties` window. Open the `Joins` tab, and click the + button.



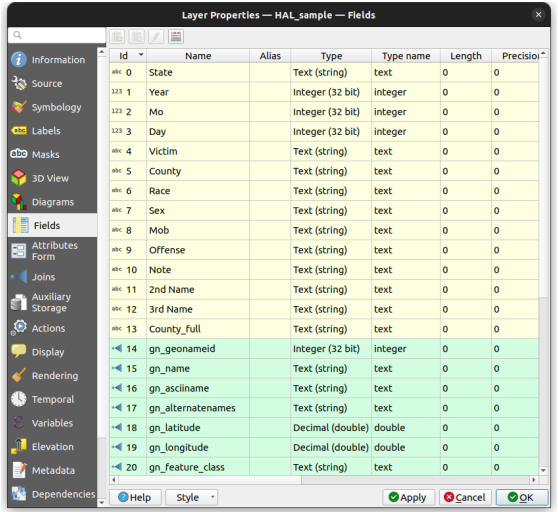
Set `Join layer` = `GeoNames_ADM2`, with `address_gn` as the join and target field. Check the box next to `Custom Field Name Prefix` and enter `gn_` in the box. Click `OK`.



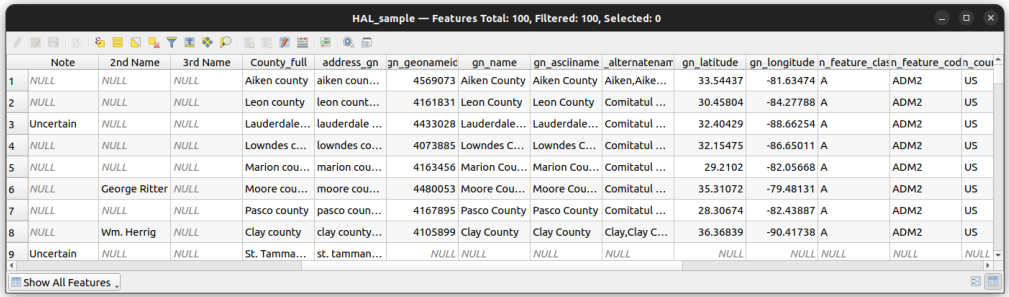
The new join should appear in the `Joins` tab



If you click on the `Fields` tab, you should see the new fields appended to `HAL_sample`

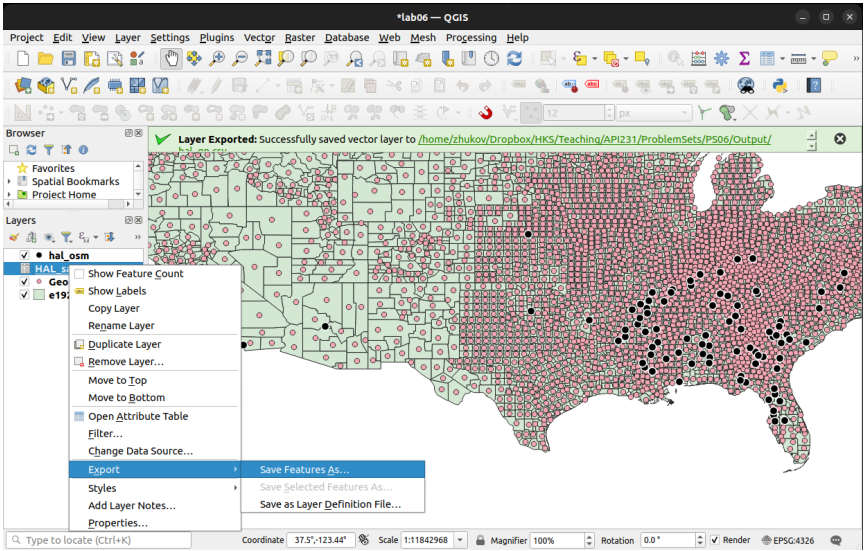


You can also open the `Attribute Table` for `HAL_sample`. Do you see the coordinates?

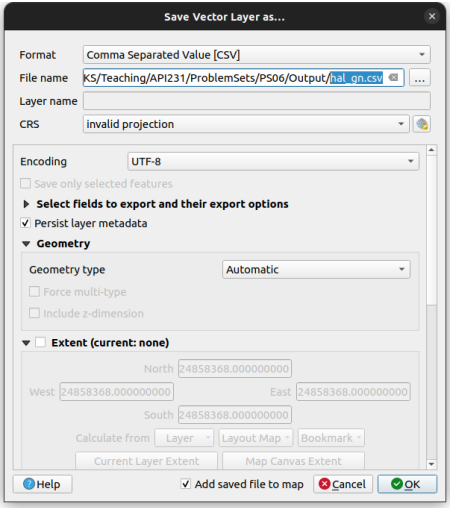


	Note	2nd Name	3rd Name	County_full	address_gn	gn_geonameic	gn_name	gn_asciiname	_alternatenam	gn_latitude	gn_longitude	n_feature_cla	n_feature_cod	n_cou
1	NULL	NULL	NULL	Aiken county	aiken coun…	4569073	Aiken County	Aiken County	Aiken,Aike…	33.54437	-81.63474	A	ADM2	US
2	NULL	NULL	NULL	Leon county	leon count…	4161831	Leon County	Leon County	Comitatul …	30.45804	-84.27788	A	ADM2	US
3	Uncertain	NULL	NULL	Lauderdale…	lauderdale …	4433028	Lauderdale…	Lauderdale…	Comitatul …	32.40429	-88.66254	A	ADM2	US
4	NULL	NULL	NULL	Lowndes c…	lowndes co…	4073885	Lowndes C…	Lowndes C…	Comitatul …	32.15475	-86.65011	A	ADM2	US
5	NULL	NULL	NULL	Marion cou…	marion cou…	4163456	Marion Cou…	Marion Cou…	Comitatul …	29.2102	-82.05668	A	ADM2	US
6	NULL	George Ritter	NULL	Moore cou…	moore cou…	4480053	Moore Cou…	Moore Cou…	Comitatul …	35.31072	-79.48131	A	ADM2	US
7	NULL	NULL	NULL	Pasco county	pasco coun…	4167895	Pasco County	Pasco County	Comitatul …	28.30674	-82.43887	A	ADM2	US
8	NULL	Wm. Herrig	NULL	Clay county	clay county…	4105899	Clay County	Clay County	Clay,Clay C…	36.36839	-90.41738	A	ADM2	US
9	Uncertain	NULL	NULL	St. Tamma…	st. tamman…	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

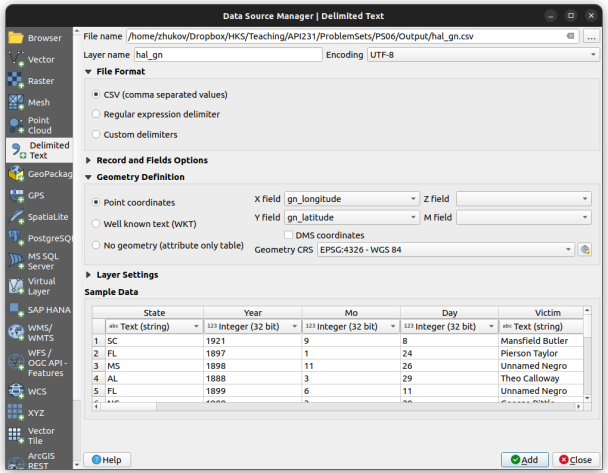
To display the geocoded locations, we need to export the joined file and re-import it. Right-click on `HAL_sample` and go to `Export` → `Save Features As...`.



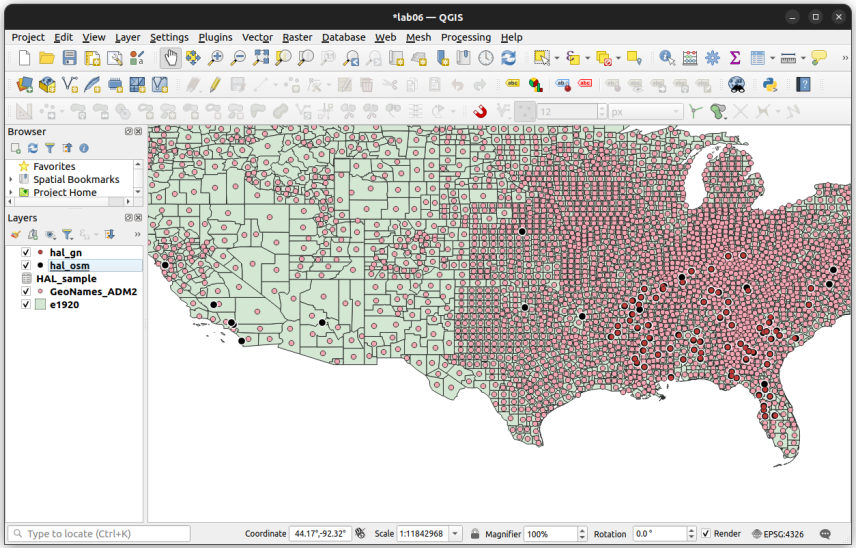
Save the file as `hal_gn.csv` (comma separated values)



(Re-)import `hal_gn.csv`, using `Add Delimited Text Layer...`.
Set `X field` = `gn_longitude` and `Y field` = `gn_latitude`.
Set `CRS` = `EPSG:4326`

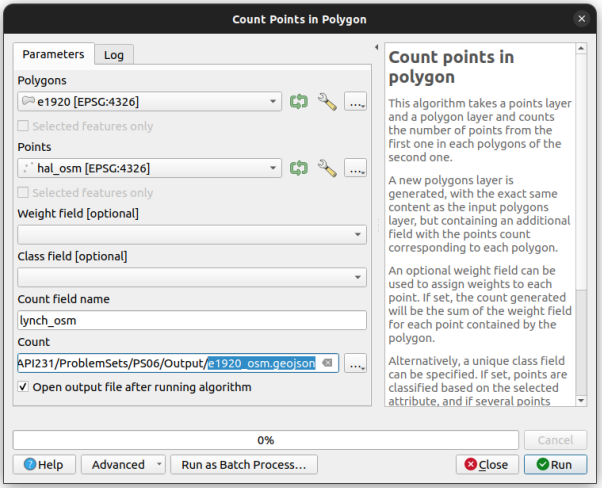


The new geocoded locations should appear on the project window.
Now let's do some point-in-polygon analysis!

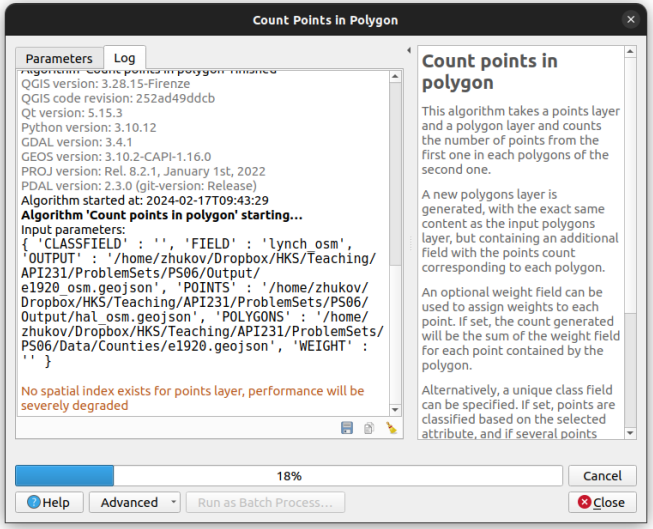


Boxplot

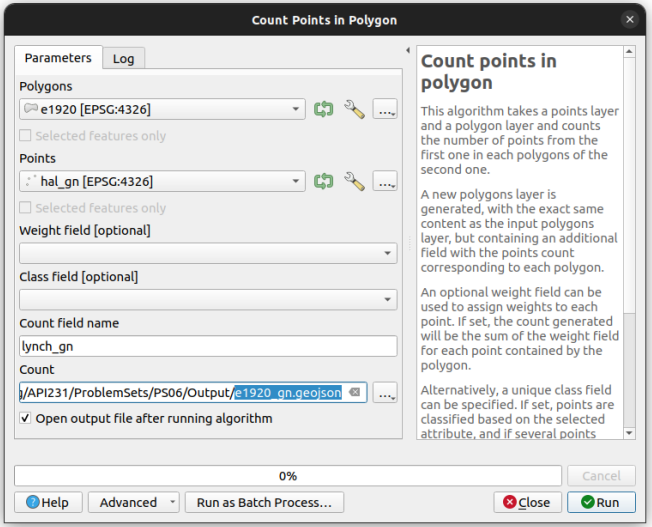
Navigate to `Vector` menu → `Analysis Tools` → `Count Points in Polygon`. Select `Polygons` = `e1920`, `Points` = `hal_osm`. Name the count field `lynch_osm`, and save the output to `e1920_osm.geojson`. Click `Run`



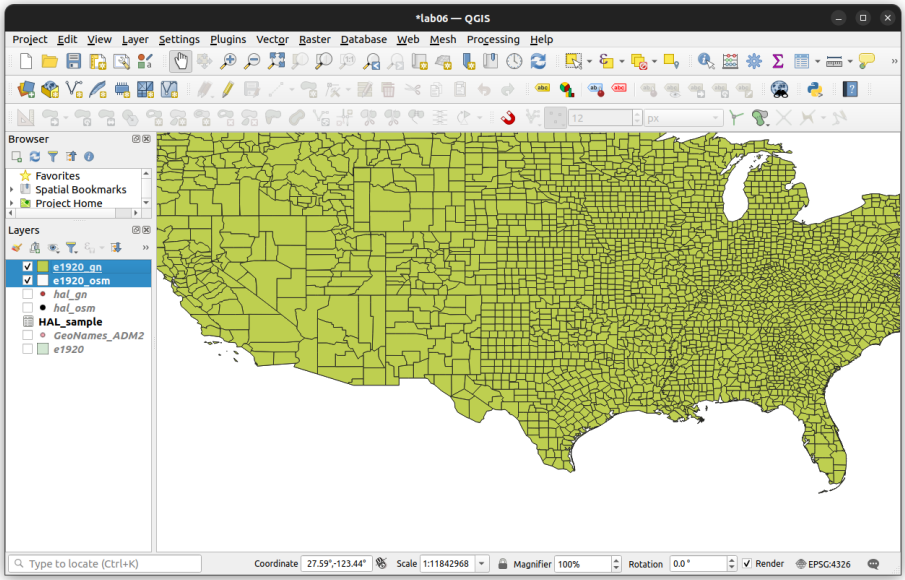
You may see a warning about “No spatial index exists. . . ”. You can ignore it here



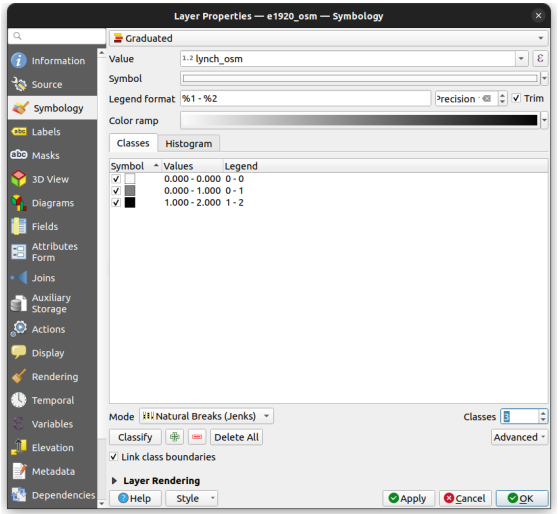
Repeat this process with `hal_gn` as the points layer. Name the count field `lynch_gn`, and save the output as `e1920_gn.geojson`



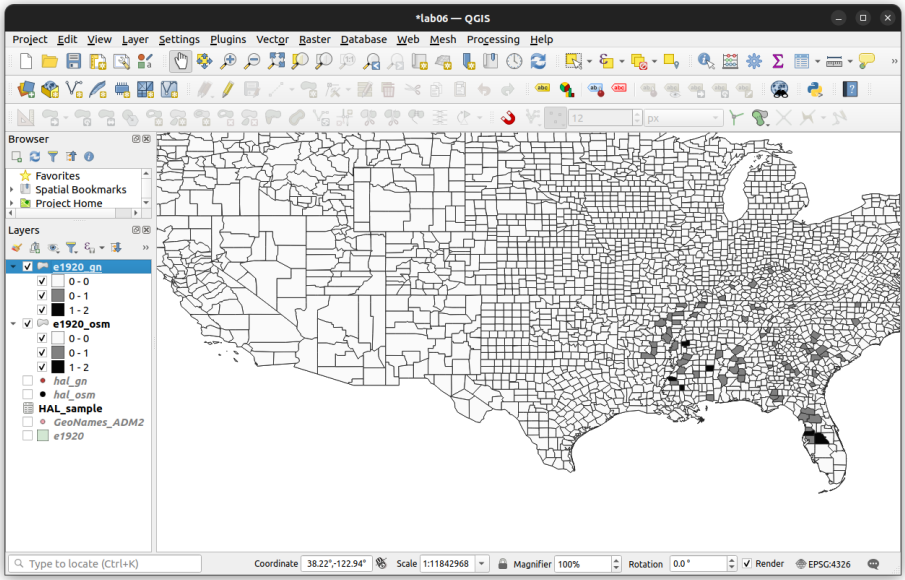
The two new layers `e1920_osm` and `e1920_gn` should appear in the project window



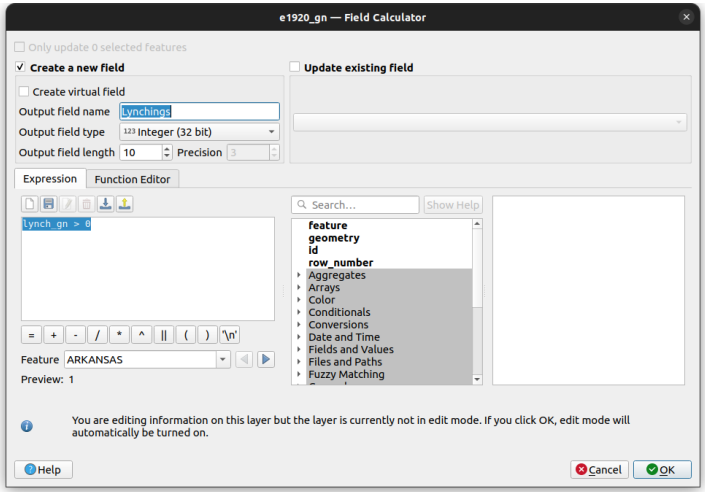
We can try plotting these new count variables through `Layer Properties` → `Symbology`. You will notice right away that there are not many unique values. I used `Natural Breaks` with 3 classes, but you can try other options.



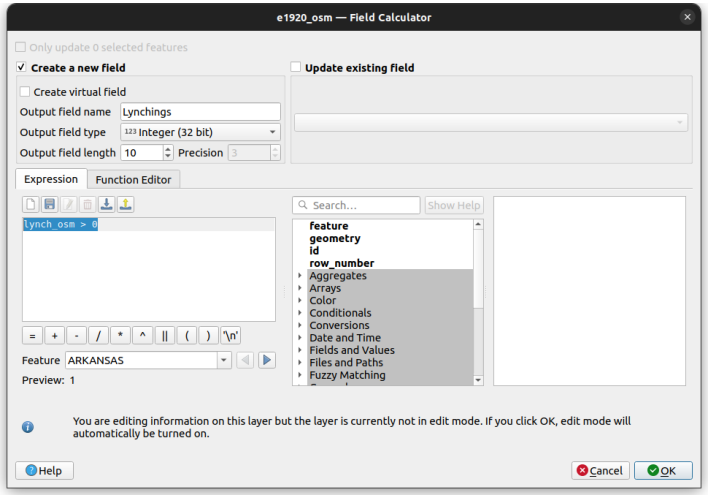
The resulting distribution should look something like this



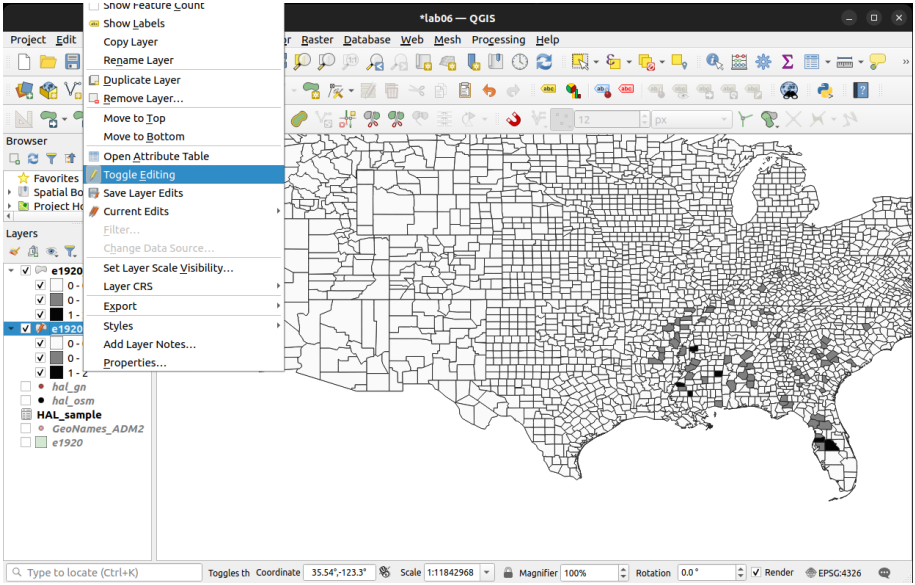
Let's create "dummy" variables indicating whether *at least one* lynching occurred in each county. Open `Field Calculator` for `e1920_gn`, create new field, `Lynchings` of type `Integer`, with `Expression` set to `lynch_gn > 0`. Click `OK`



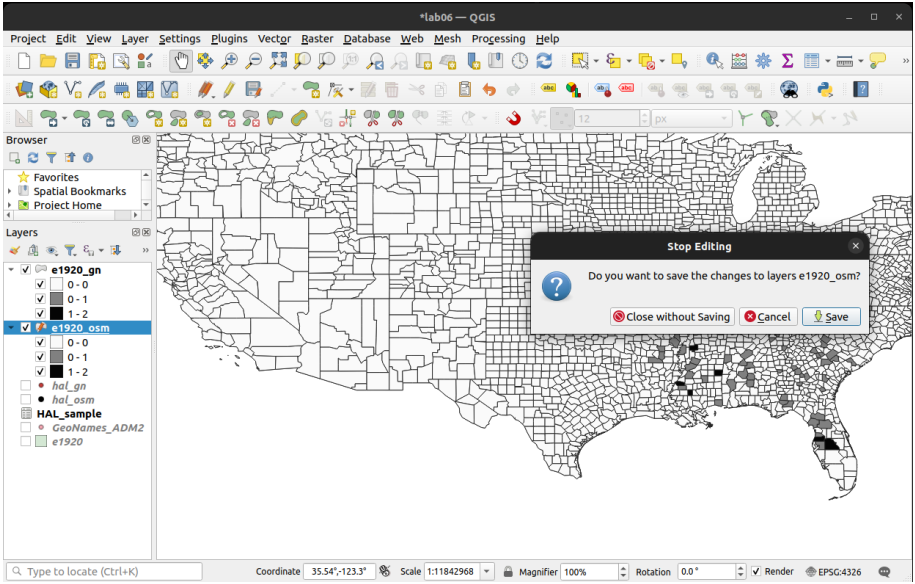
Do the same for `e1920_osm`, with `Expression` set to `lynch_osm > 0`



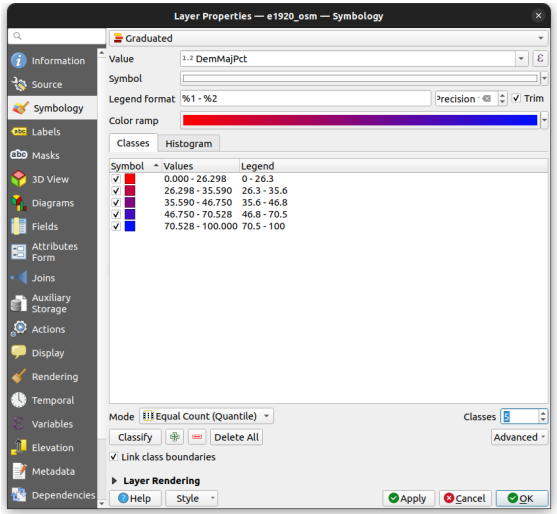
When finished, right-click on `e1920_osm` and `e1920_gn`, uncheck `Toggle Editing`



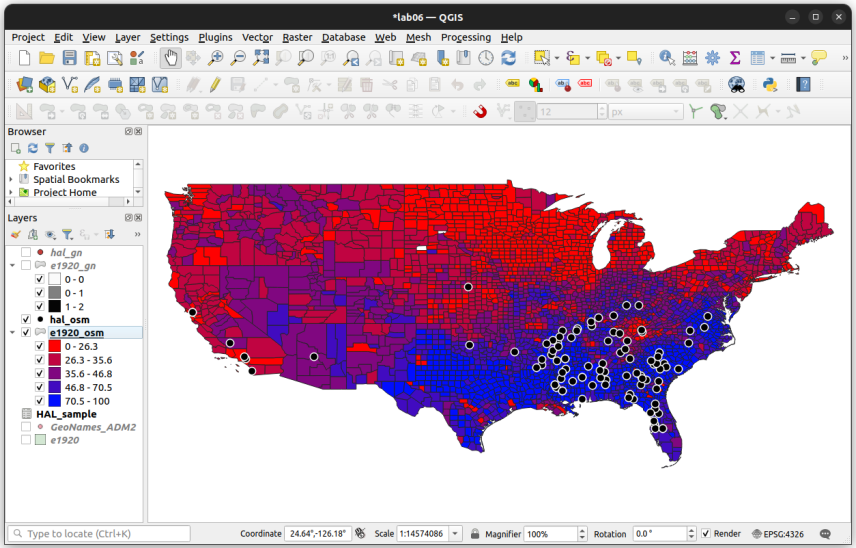
Save your changes when prompted. Do this for both layers



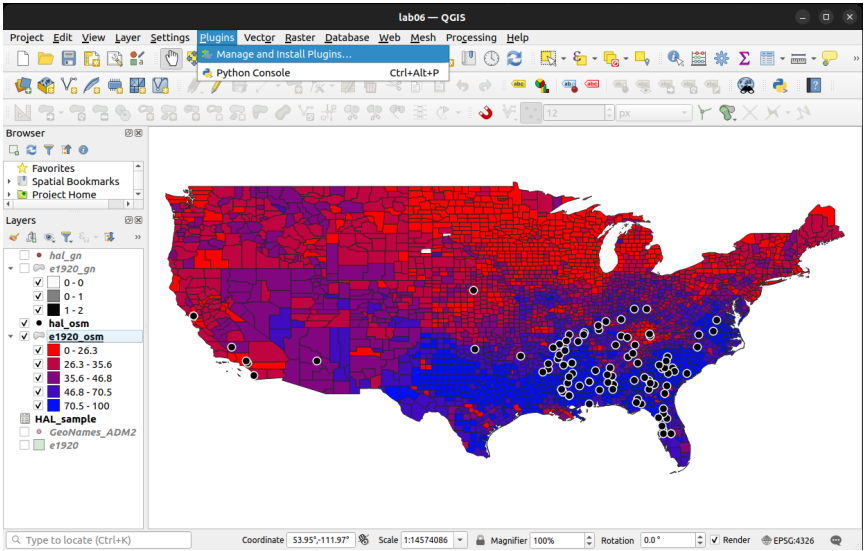
Let's examine the relationship between lynching locations and local electoral preferences. Plot the variable `DemMajPct` in `e1920_osm`, with a red-to-blue color ramp (`Equal Count` with 5 classes)



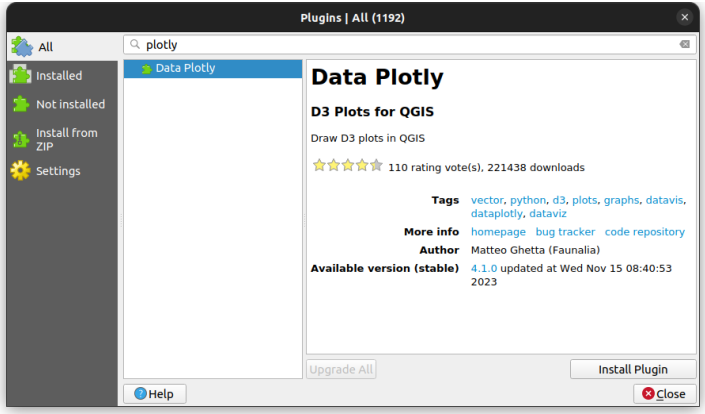
The lynching locations appear to be mostly in southern Democratic Party strongholds, but let's look at this more systematically



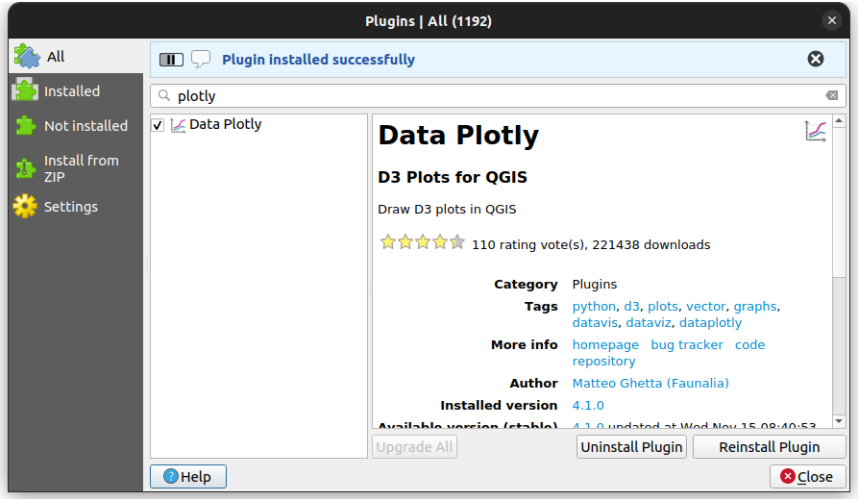
To enable a variety of statistical plotting functions in QGIS, we need to enable the *Data Plotly* plugin. Go to `Plugins` → `Manage and Install Plugins`



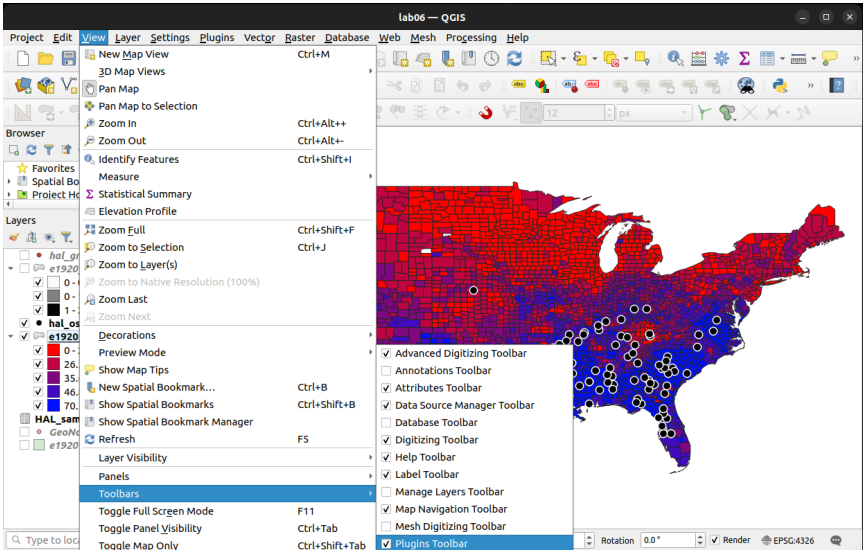
Search for `plotly` and install the plugin



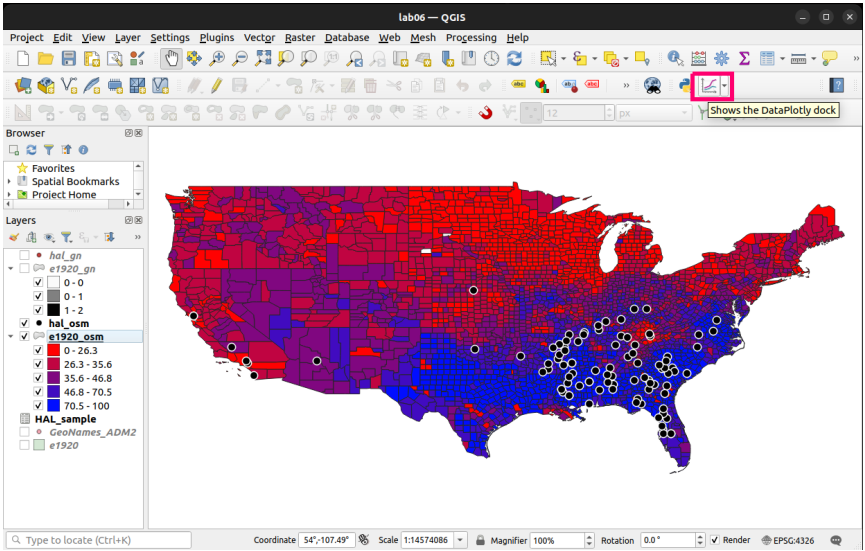
Make sure the the box is checked next to `Data Plotly` after installation



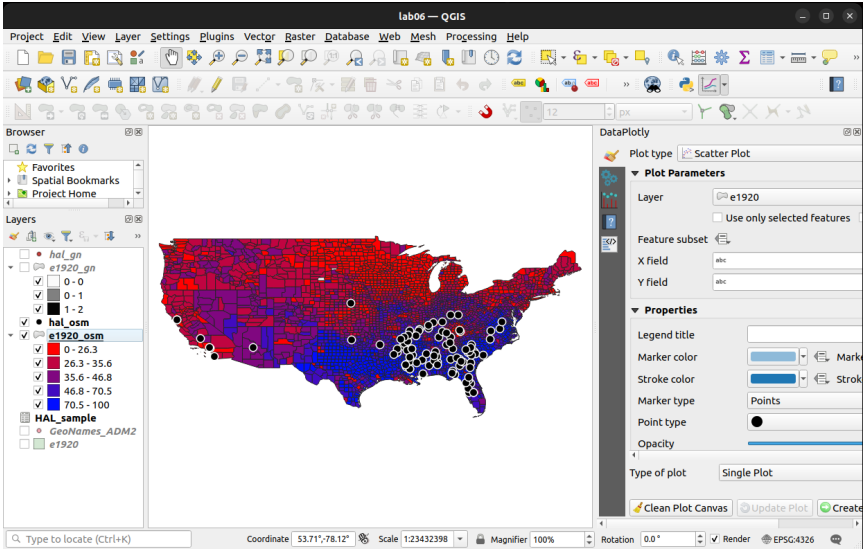
To access Data Plotly, activate the `Plugins Toolbar`.
Go to `View` → `Toolbars` → check box next to `Plugins Toolbar`



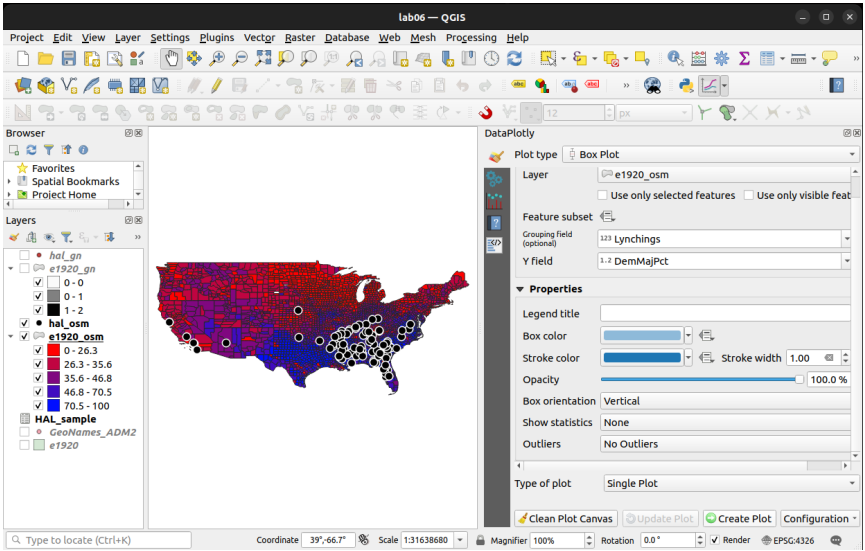
The icon for Data Plotly can be tricky to find.
Look for an icon that looks like a statistical graphic, as shown here ↓. Click on it



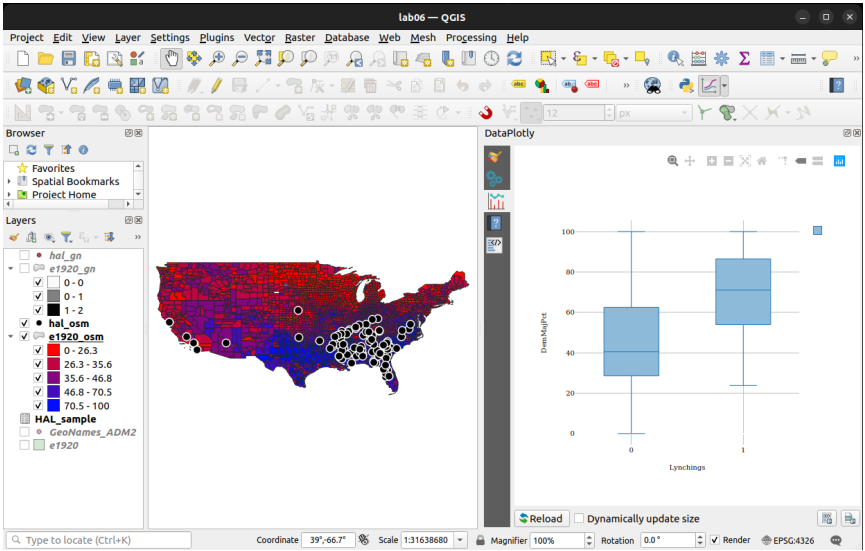
This should open a new DataPlotly panel in the project window.



Set `Plot type` = `Box Plot`, `Layer` = `e1920_osm`.
Set `Grouping` = `Lynchings`, `Y field` = `DemMajPct`. Click `Create Plot`

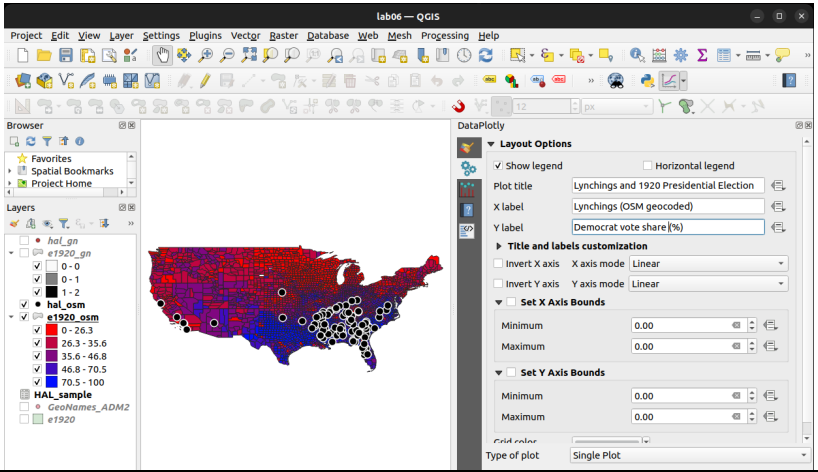


The average Democratic vote share was indeed significantly higher for counties with lynchings than counties without lynchings

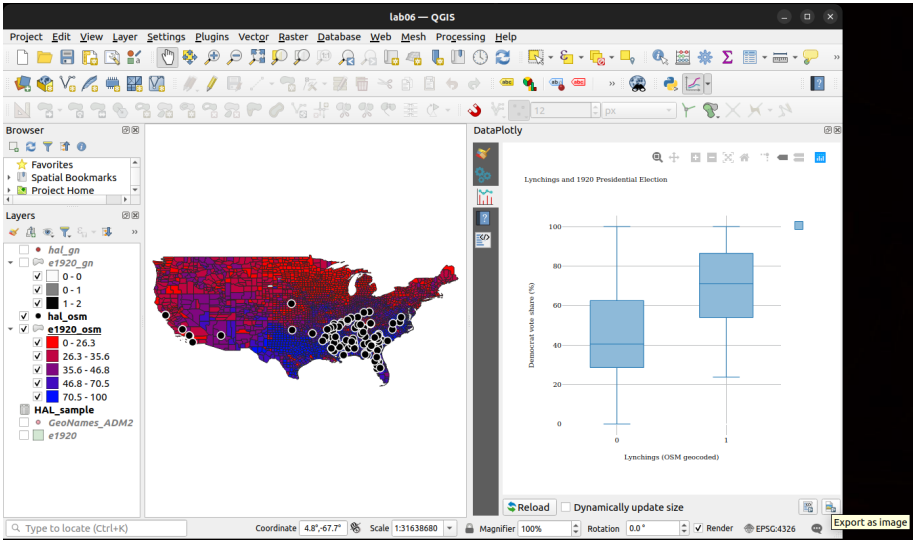


Let's clean up the axis labels. Click on the settings button (gears icon).

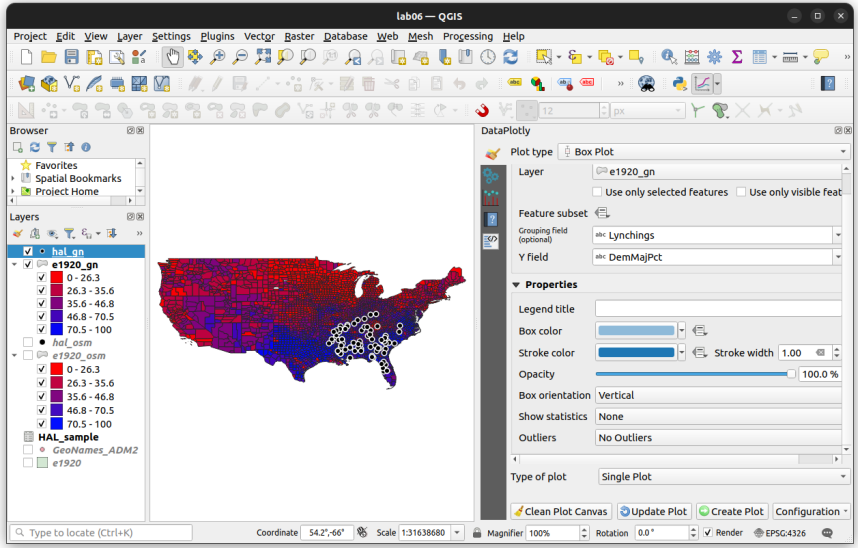
- Set `Plot Title` = `Lynchings and 1920 Presidential election`
- Set `X Label` = `Lynchings (OSM geocoded)` and `Y Label` = `Democratic vote share in 1920 (\%)` Click `Update Plot`



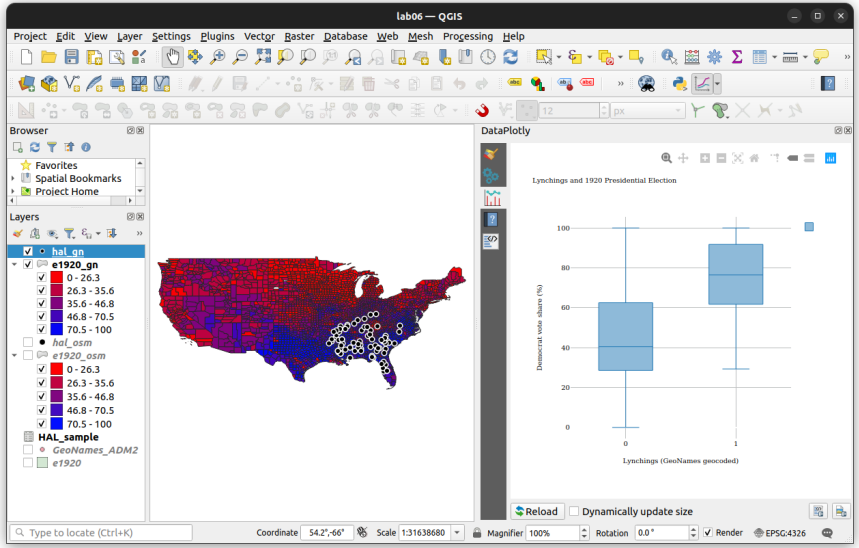
To export the box plot as a `.png` file, click on the icon in the lower-right corner. Name it `boxplot_osm.png`



Repeat this process for GeoNames-geocoded e1920_gn, with similar labels



Export the resulting image



Problem Set 6

Your assignment (if using QGIS): create a map to go along with the box plot

- make and export a box plot, as just demonstrated
  - name the file `boxplot_osm.png` or `boxplot_gn.png` (depending on which geocoder you're using)
- create and export a new map layout, showing:
  - points: lynching locations (either OSM- or GeoNames-geocoded)
  - polygons: counties colored by Democratic vote share (`DemMajPct`)
  - legend (only the layers you're using should be on legend)
  - scale bar (optional)
- name the file `map_osm.png` or `map_gn.png` (depending on which geocoder you're using)
- upload map and accompanying box plot (2 files total!) to Canvas
- AGAIN: you can do this with *either* OpenStreetMap or GeoNames, you are not required to do both

Either this:

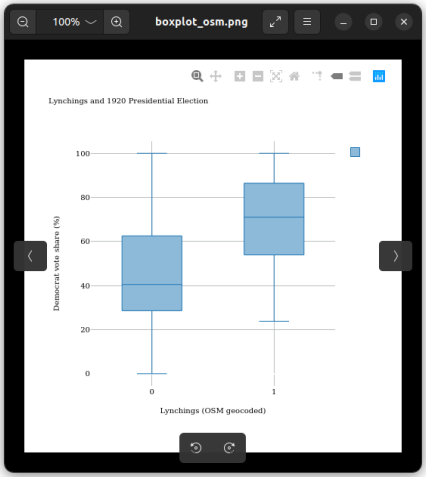


Figure 10: OSM boxplot

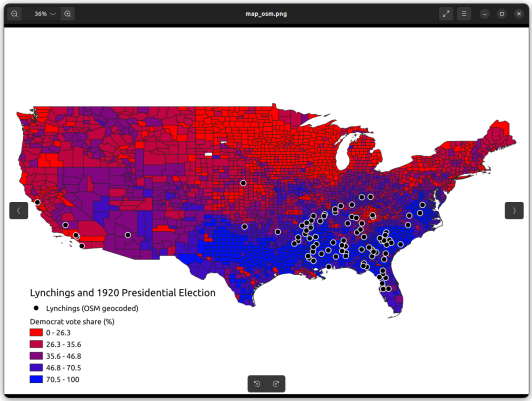


Figure 11: OSM map

. . . or this:

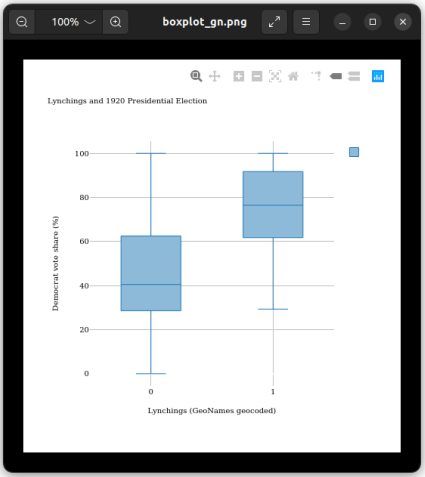


Figure 12: GeoNames boxplot

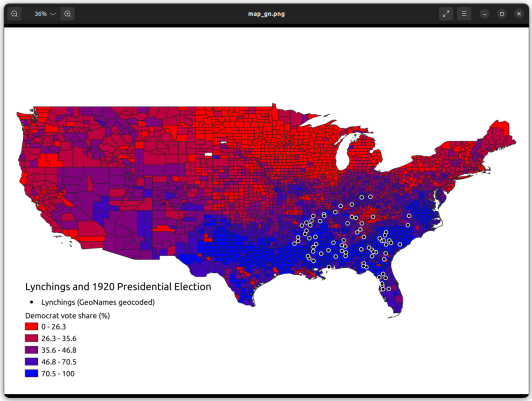


Figure 13: GeoNames map

R

Loading R packages

To implement these steps in R, we will be using the `sf` package, and two others (`RCurl`, `jsonlite`) that help R compose HTTP requests and process the results returned by online servers:

```
library(sf)
library(RCurl)
library(jsonlite)
```

NOTE: The code to produce the maps and boxplots in R is in `ps05_demo.R` on RStudio Cloud, and in `PS05.zip` (posted on Canvas).

Geocoding

As with QGIS, we will geocode in R using two methods:

1. Online, using a web service (OSM/Nominatum API)
2. Offline, using gazetteer data (GeoNames)

Method 1: Geocode the addresses using OSM/Nominatum

Step 1: define a function `url_geo()` that sends queries to OSM/Nominatum, and returns geographic information from server:

```
url_geo = function(query, return.call = "json", sensor = "false") {
  root = "https://nominatim.openstreetmap.org/search?q="
  sfxx = "&format=json&polygon=1&addressdetails=1"
  u = paste(root, query, sfxx,sep = "")
  return(URLencode(u))
}
```

Step 2: define a wrapper function geoCode_OSM(), that sends the query through url_geo() and parses the result:

```
geoCode_OSM = function(query,match.num=1){
  address=NA; longitude=NA; latitude=NA
  u = url_geo(query)
  doc = RCurl::getURL(u,httpheader = c('User-Agent' = "contact info"))
  if(nchar(doc)>2){
  dat = jsonlite::fromJSON(doc)
  if(nrow(dat)>0){
    address = dat$display_name[match.num]
    longitude = as.numeric(as.character(dat$lon[match.num]))
    latitude = as.numeric(as.character(dat$lat[match.num]))
  }}
  return(data.frame(
    address=address,longitude=longitude,latitude=latitude
    ))
}
```

Let's test the geocoding function!

```
geoCode_OSM("79 John F. Kennedy Street, Cambridge, MA")
```

```
##
## 1: 79, John F. Kennedy Street, Old Cambridge, Cambridgeport, Cambridge, Middlesex County, Mass
##    longitude latitude
## 1: -71.12136 42.37129
```

```
geoCode_OSM("Harvard Kennedy School")
```

```
##
## 1: Harvard Kennedy School Library, John F. Kennedy Street, Old Cambridge, Cambridgeport, Cambr
##    longitude latitude
## 1: -71.12165 42.37117
```

```
geoCode_OSM("Harvard")
```

```
##
## 1: Harvard University, Western Avenue, Barry's Corner, Allston, Boston, Suffolk County, Massa
##    longitude latitude
## 1: -71.12221 42.36574
```

```
geoCode_OSM("Harvard", match.num=2)
```

```
##                                          address longitude latitude
## 1: Harvard, McHenry County, Illinois, United States -88.61371 42.42224
```

Load, pre-process Project HAL data

Load the tabular dataset using `read.csv()`, and preview the first few rows:

```
hal = read.csv("Data/HAL/HAL_sample.csv")
head(hal)
```

```
##   State Year Mo Day           Victim     County Race  Sex Mob            Offense
## 1    SC 1921  9   8 Mansfield Butler      Aiken  Blk Male      Muderous assault
## 2    FL 1897  1  24   Pierson Taylor       Leon  Blk Male        Attempted rape
## 3    MS 1898 11  26    Unnamed Negro Lauderdale  Blk Male              Assault
## 4    AL 1888  3  29    Theo Calloway    Lowndes  Blk Male               Murder
## 5    FL 1899  6  11    Unnamed Negro     Marion  Blk Male Blk Aided in lynching
## 6    NC 1900  3  20    George Rittle      Moore  Blk Male             Informer
##        Note     X2nd.Name X3rd.Name      County_full
## 1                                      Aiken county
## 2                                       Leon county
## 3 Uncertain                        Lauderdale county
## 4                                     Lowndes county
## 5                                      Marion county
## 6          George Ritter               Moore county
```

Create new field for "county, state" and placeholders for coordinates

```
hal$address = paste0(hal$County_full,", ",hal$State)
hal$longitude = NA
hal$latitude = NA
```

To geocode as a batch processing routine, we will write a `for()` loop, which runs the `geoCode_OSM()` function for each address in `hal` and stores the result:

```
for(i in 1:nrow(hal)){
  # Skip past errors
  tryCatch({
    address_geo = geoCode_OSM(hal$address[i])
    # Add coordinates to dataset
    hal$longitude[i] = address_geo$longitude
    hal$latitude[i] = address_geo$latitude
    # Report progress
    print(paste0(i,"/",nrow(hal),"; ",address_geo$address))
  },error=function(e){
    print(paste("Unable to geocode",hal$address[i]))
  })
}
```

Inspect the results of OSM geocoding:

```
head(hal)
```

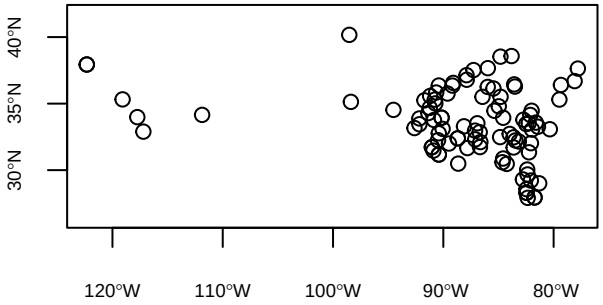
```
##   State Year Mo Day           Victim     County Race  Sex Mob            Offense
## 1    SC 1921  9   8 Mansfield Butler      Aiken  Blk Male      Muderous assault
## 2    FL 1897  1  24   Pierson Taylor       Leon  Blk Male        Attempted rape
## 3    MS 1898 11  26    Unnamed Negro Lauderdale  Blk Male               Assault
## 4    AL 1888  3  29    Theo Calloway    Lowndes  Blk Male                Murder
## 5    FL 1899  6  11    Unnamed Negro     Marion  Blk Male Blk Aided in lynching
## 6    NC 1900  3  20    George Rittle      Moore  Blk Male              Informer
##        Note     X2nd.Name X3rd.Name      County_full              address
## 1                                       Aiken county      Aiken county, SC
## 2                                        Leon county       Leon county, FL
## 3 Uncertain                         Lauderdale county Lauderdale county, MS
## 4                                     Lowndes county    Lowndes county, AL
## 5                                      Marion county     Marion county, FL
## 6           George Ritter               Moore county      Moore county, NC
##   longitude latitude
## 1 -81.61821 33.57232
## 2 -84.25491 30.46831
## 3 -88.68964 32.39052
## 4 -86.64025 32.10881
## 5 -82.06269 29.21825
## 6 -79.47612 35.30546
```

Drop observations with missing coordinates:

```
hal_osm = hal[which(!is.na(hal$longitude)),]
```

Convert results to sf object and plot on a map:

```
hal_osm = sf::st_as_sf(hal_osm,
                       coords=c("longitude","latitude"),crs=4326)
plot(hal_osm["geometry"],axes=TRUE)
```



Method 2: Geocode the addresses using GeoNames gazetteer

Load gazetteer data:

```
gn = read.csv("Data/GeoNames/GeoNames_ADM2.csv")
```

Create common variables for matching:

```
gn$address_gn = tolower(paste0(gn$asciiname,", ",gn$admin1_code))
hal$address_gn = tolower(paste0(hal$County_full,", ",hal$State))
```

Rename OSM coordinates to avoid confusion:

```
hal$longitude_osm <- hal$longitude; hal$latitude_osm <- hal$latitude
hal$longitude <- hal$latitude <- NULL
```

Geocode addresses (i.e. join the datasets):

```
hal_gn = merge(x = hal, y = gn, by = "address_gn")
```

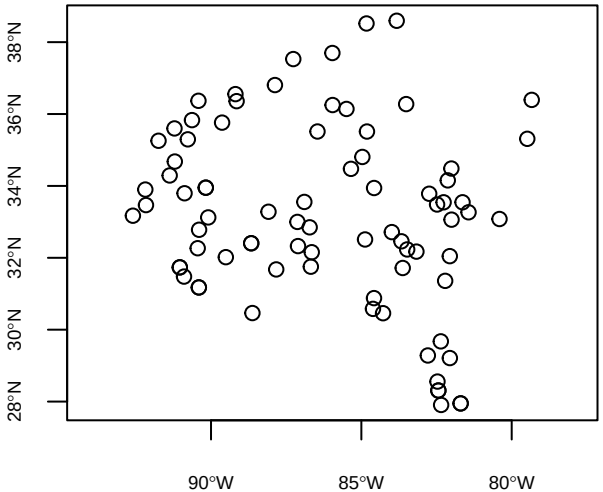
Inspect the results:

```
head(hal_gn)
```

```
##            address_gn State Year Mo Day           Victim   County Race  Sex Mob
## 1    aiken county, sc    SC 1921  9   8 Mansfield Butler    Aiken  Blk Male
## 2  alachua county, fl    FL 1892  9   6    Unnamed Negro  Alachua  Blk Male
## 3 arkansas county, ar    AR 1891 12  21       J.A. Smith Arkansas  Wht Male
## 4 barnwell county, sc    SC 1890  1   7        Wm. Black Barnwell  Blk Male
## 5  bedford county, tn    TN 1912  2  19       Watt Greer  Bedford  Blk Male
## 6     bibb county, al    AL 1904  6  23        Joe Scott     Bibb  Blk Male Blk
##            Offense longitude_osm latitude_osm geonameid longitude latitude
## 1 Muderous assault     -81.61821     33.57232   4569073 -81.63474 33.54437
## 2            Arson     -82.36401     29.67557   4145709 -82.35770 29.67476
## 3           Murder     -91.35985     34.29025   4099679 -91.37491 34.29081
## 4         Burglary     -81.41908     33.26410   4570020 -81.43502 33.26606
## 5           Murder     -86.45072     35.50995   4829092 -86.45889 35.51380
## 6           Murder     -87.12271     32.97108   4049189 -87.12644 32.99864
```

Convert results to `sf` object and plot on a map:

```
hal_gn = sf::st_as_sf(hal_gn,
                      coords=c("longitude","latitude"),crs=4326)
plot(hal_gn["geometry"],axes=TRUE)
```



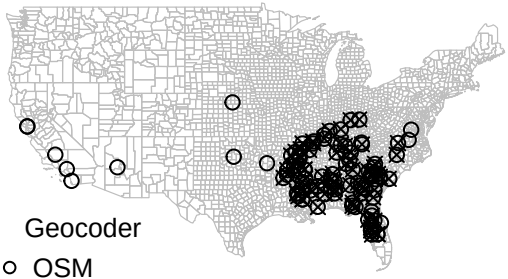
Boxplot

Load 1920 US county boundaries:

```
e1920 = sf::read_sf("Data/Counties/e1920.geojson")
```

Plot overlay with geocoded lynchings

```
plot(e1920["geometry"],border="gray",reset=FALSE)
plot(hal_osm["geometry"],col="black",pch=1,add=TRUE)
plot(hal_gn["geometry"],col="black",pch=4,add=TRUE)
legend("bottomleft",pch=c(1,4),col=c("black","black"),
  legend=c("OSM","GeoNames"),title="Geocoder",bty="n")
```



Point-in-polygon analysis

Overlay points objects (`hal_*`) and polygons (`e1920`)

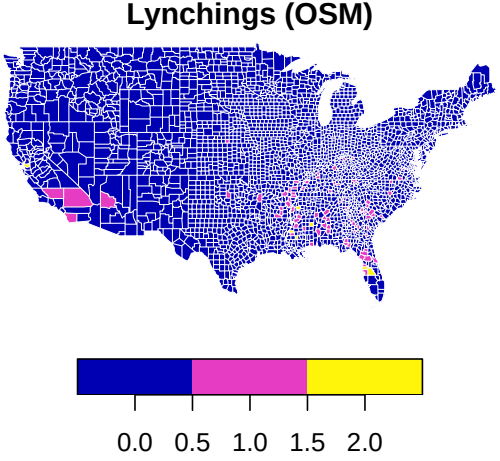
```
o_osm = sf::st_intersects(x = e1920, y = hal_osm)
o_gn = sf::st_intersects(x = e1920, y = hal_gn)
```

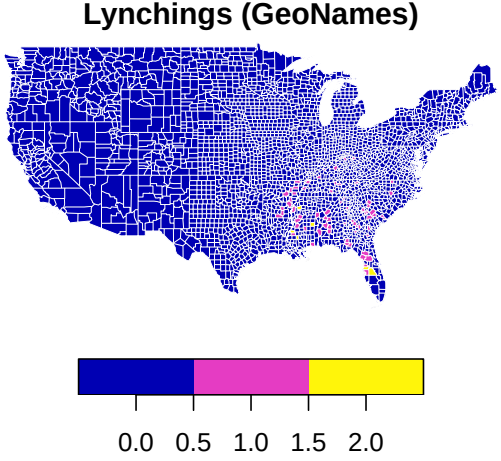
Assign counts to new variables

```
e1920$lynchings_osm = lengths(o_osm)
e1920$lynchings_gn = lengths(o_gn)
```

Plot the results

```
plot(e1920["lynchings_osm"], main = "Lynchings (OSM)")
plot(e1920["lynchings_gn"], main = "Lynchings (GeoNames)")
```





Calculate new field (at least one lynching per county)

```
e1920$lynchings_osm_1 = 1*(e1920$lynchings_osm>0)
e1920$lynchings_gn_1 = 1*(e1920$lynchings_gn>0)
```

Number of counties with lynching, according to OSM vs. GeoNames

```
sum(e1920$lynchings_osm_1)
```

```
## [1] 89
```

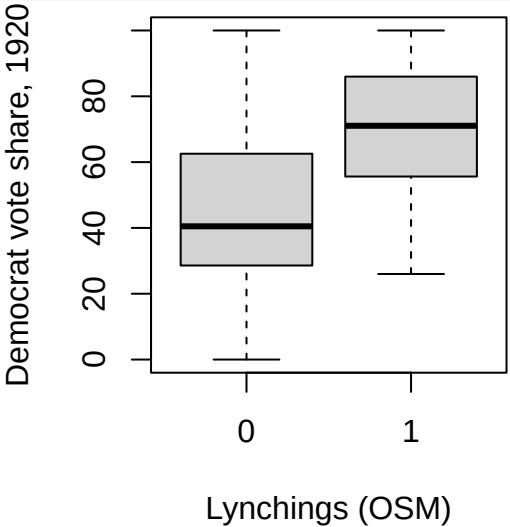
```
sum(e1920$lynchings_gn_1)
```

```
## [1] 74
```

Extra credit for anyone who figures out the source of the discrepancy and (partially) fixes it. Hint: it has to do with pelicans and beignets.

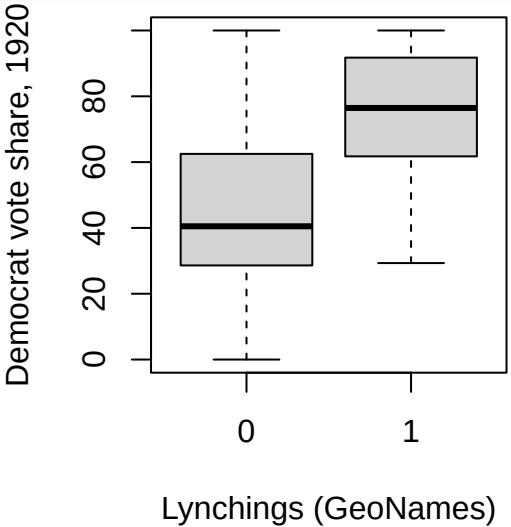
Create box plot for OSM-geocoded data

```
boxplot(DemMajPct ~ lynchings_osm_1, data = e1920,
  xlab = "Lynchings (OSM)", ylab = "Democrat vote share, 1920")
```



Create box plot for GeoNames-geocoded data

```
boxplot(DemMajPct ~ lynchings_gn_1, data = e1920,
  xlab = "Lynchings (GeoNames)", ylab = "Democrat vote share, 1920")
```

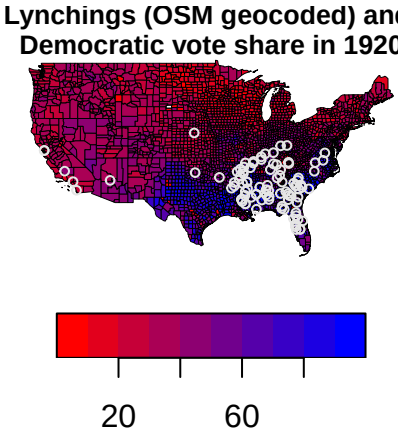


Create red-to-blue color ramp for maps

```
ramp = colorRampPalette(c("red","blue"), space = "rgb")
```

Map the OSM-geocoded locations:

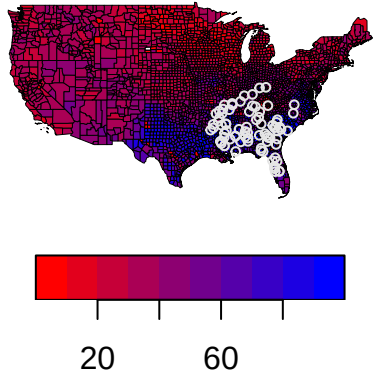
```
plot(e1920["DemMajPct"], pal=ramp(10), reset = FALSE,
  main = "Lynchings (OSM geocoded) and Democratic vote share in 1920")
plot(hal_osm["geometry"], add=T, col="grey90", pch=1)
```



Map the GeoNames-geocoded locations:

```
plot(e1920["DemMajPct"], pal=ramp(10), reset = FALSE,
  main = "Lynchings (GeoNames) and Democratic vote share in 1920")
plot(hal_gn["geometry"], add=T, col="grey90", pch=1)
```

Lynchings (GeoNames geocoded) and Democratic vote share in 1920



Problem Set 6

Your assignment (if using R):

- create *one* of these boxplots (for OSM or GeoNames)
- ... and *one* of these maps (for OSM or GeoNames)
- save the graphics as `boxplot_osm_R.png` (`boxplot_gn_R.png`) and `map_osm_R.png` (`map_gn_R.png`)
- upload these files to Canvas (by next Wednesday)