



## Introduction to GIS Fundamentals

Richard Dunks

Beth Pappas

Follow along: [http://bit.ly/dot\\_intro\\_gis](http://bit.ly/dot_intro_gis)

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## Goals for the class

- Describe the foundational concepts of spatial analysis and mapmaking
- Describe the general structure and purpose of Geographic Information Systems (GIS)
- Describe spatial data formats and sources of spatial data
- Apply concepts of spatial analysis using NYC Open Data to answer an NYC-related problem
- Discuss resources for further information and instruction on QGIS and other spatial analysis tools

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# Outcomes

- You will be familiar with the foundational concepts in spatial analysis and mapmaking
- You will understand the structure and purpose of GIS
- You will be practiced in applying spatial concepts to real-world problems
- You will be familiar with the differences between open source and proprietary software applications
- You will be familiar with resources for further information on how to use QGIS for spatial analysis and mapmaking

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# Goals for this morning

- Review basic geospatial principles and GIS tools
- Discuss spatial data formats
- Demonstrate and practice how to load, filter, and select data in QGIS
- Demonstrate and practice how to style spatial data
- Demonstrate and practice how to export data from QGIS

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# Types of Maps

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## General Reference Maps

- Show important physical features of an area
- Include natural and man-made features
- Usually meant to help aid in the navigation or discovery of locations
- Usually fairly simple
- Can be stylized based on the intended audience (tourists vs locals)

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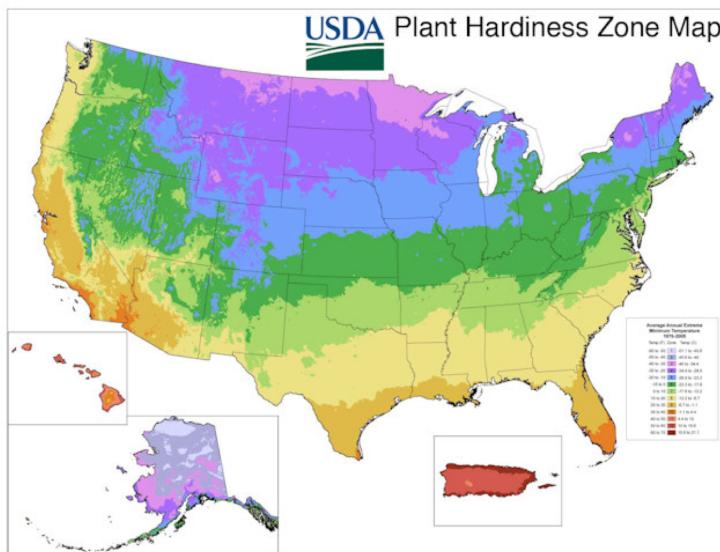
Source: [http://nationalmap.gov/small\\_scale/printable/reference.html](http://nationalmap.gov/small_scale/printable/reference.html)

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## Thematic Maps

- Focuses on a specific theme or subject area
- Features on the map represent the phenomenon being mapped
- Spatial features used for reference

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Source: <http://www.usna.usda.gov/Hardzone/ushzmap.html>

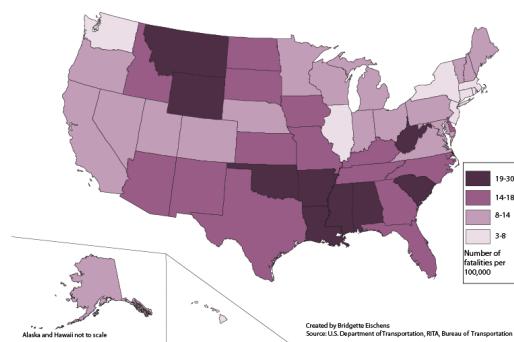
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## Choropleth

U.S. Motor Vehicle Fatalities, 2008

choropleth map using standard deviation classification

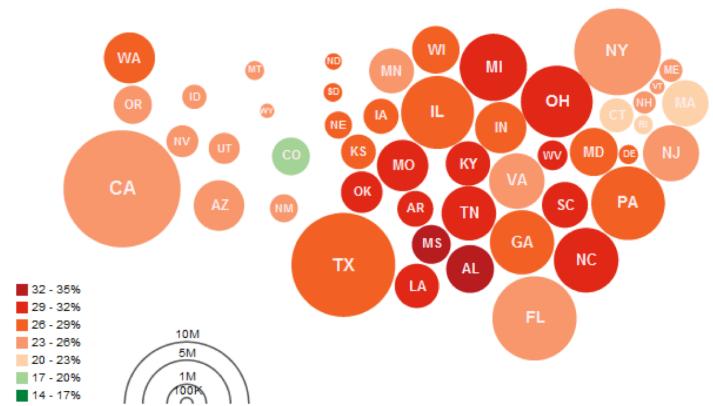


Source: <http://www.geogalot.com/myp-humanities/year-9/understanding-hazards/003---choropleth-mapping>

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# Dorling Cartogram – Obesity by State

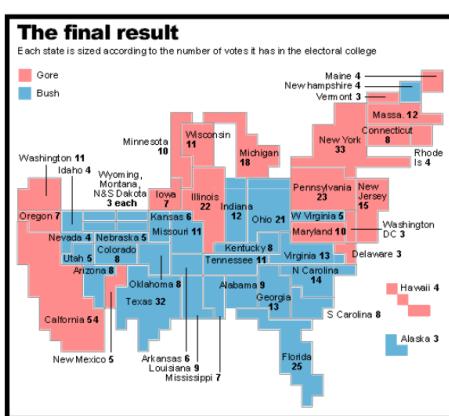


Source: <http://homes.cs.washington.edu/~jheer//files/zoo/>

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# Area Cartogram – Electoral Votes by State



Source: [http://training.fws.gov/courses/csp/csp7203/resources/Types\\_of\\_Maps\\_2013.pdf](http://training.fws.gov/courses/csp/csp7203/resources/Types_of_Maps_2013.pdf)

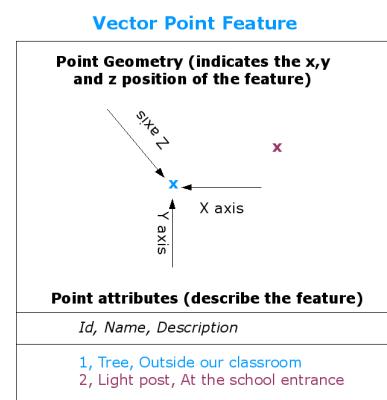
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# Basic Map Elements

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## Points



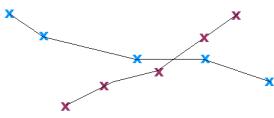
Source: [http://docs.qgis.org/2.8/en/docs/gentle\\_gis\\_introduction/vector\\_data.html#overview](http://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/vector_data.html#overview)

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# Lines

## Vector Polyline Feature

**Polyline Geometry (a series of connected vertices that do not form an enclosed shape)**



### Polyline attributes (describe the feature)

*Id, Name, Description*

- 1, Footpath 1, From class to the playground
- 2, Footpath 2, From the school gate to the hall

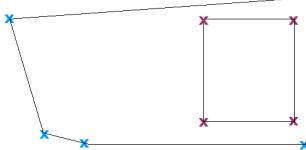
Source: [http://docs.qgis.org/2.8/en/docs/gentle\\_gis\\_introduction/vector\\_data.html#overview](http://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/vector_data.html#overview)

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# Polygons

## Vector Polygon Feature

**Polygon Geometry (a series of connected vertices that do form an enclosed shape)**



### Polygon attributes (describe the feature)

*Id, Name, Description*

- 1, School Boundary, Fenceline for the school
- 2, Sports Field, We play soccer here

Source: [http://docs.qgis.org/2.8/en/docs/gentle\\_gis\\_introduction/vector\\_data.html#overview](http://docs.qgis.org/2.8/en/docs/gentle_gis_introduction/vector_data.html#overview)

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# How do we make maps?

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## Geographic Information System (GIS)

“ Any system for capturing, storing, checking, and displaying data related to positions on the Earth's surface

- National Geographic Education Encyclopedia

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Or more simply

‘ In a GIS, you connect *data* with *geography*.

- [GISgeography.com](http://GISgeography.com)

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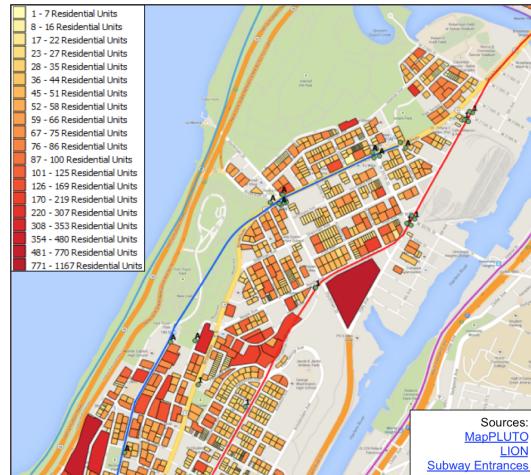
## Geographic Information Systems (GIS)

- Create interactive queries (user-created searches)
- Analyze spatial information
- Edit data in maps
- Present the results of all these operations

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## Basic Map Using QGIS



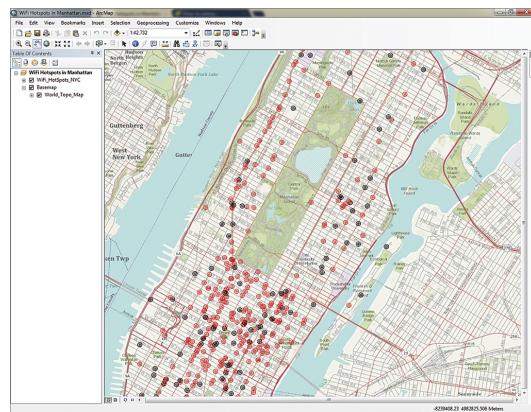
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## The Tools



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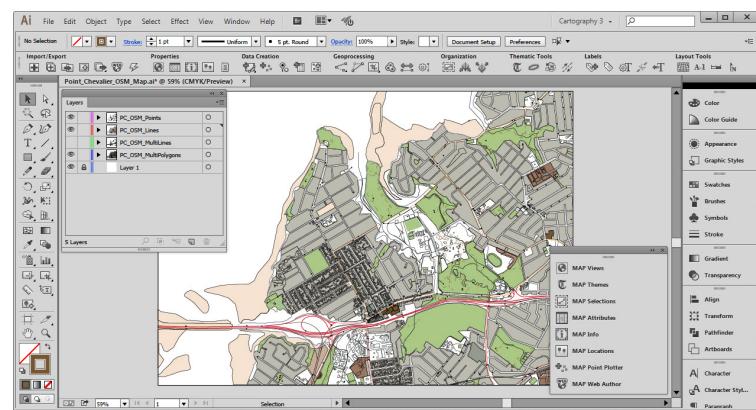
## ArcGIS



Source: <http://www.esri.com/news/arcuser/1012/a-workflow-for-creating-and-sharing-maps.html>

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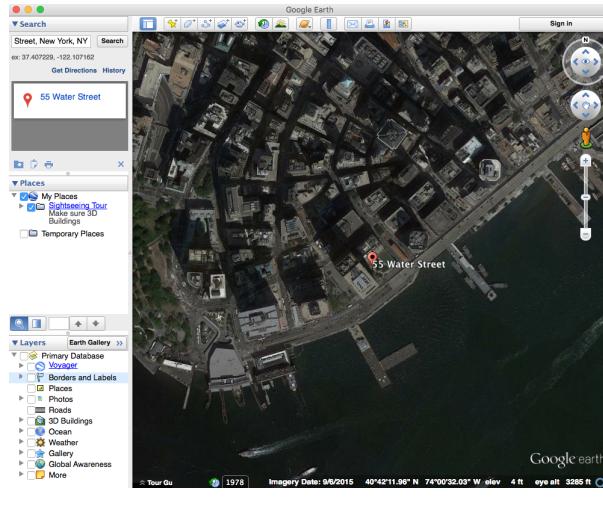
## Adobe Illustrator/Mapublisher



Source: <http://www.avenza.com/resources/blog/2011/06/28/how-get-open-street-map-data-adobe-illustrator-mapublisher>

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# Google Earth



# Google Fusion Tables



Google

Source: NYC Open Data 311 Noise Complaints, 1 Jan - 20 May 2014, Between Midnight and 4 am in the Bronx

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# Proprietary vs Open Source Software

- Proprietary software source code is owned by an individual or an organization and tightly restricted (usually for profit)
- Open source software source code is freely available to anyone for download, alteration, and republishing

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# Proprietary vs Open Source Software

- Proprietary software code is generally supported by a team of paid professionals working for the organization that owns the code
- Open source software code is generally supported by a mix of paid and volunteer professionals that contribute changes back to the community

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# Proprietary vs Open Source Software

- Proprietary software is often available only by purchasing a license
- Open source software is free to use though there generally a license that specifies the restrictions (if any) on its use and reuse
- Companies using open source software may charge for the use of the software through their proprietary implementations or via their infrastructure

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# Examples of Open Source Mapping Software

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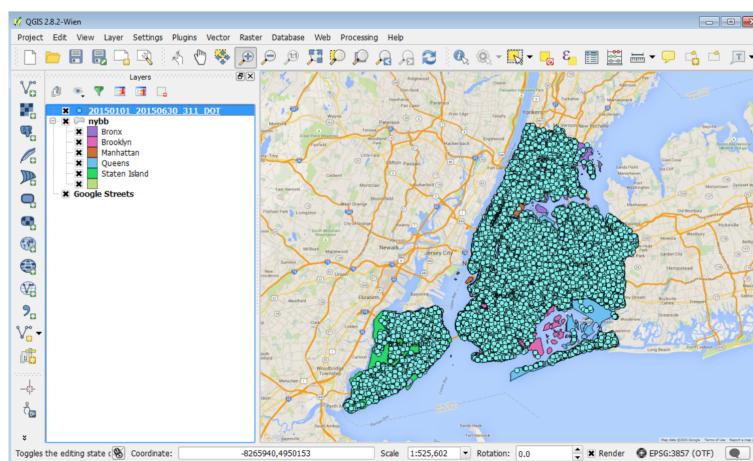


## CartoDB



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## QGIS



Source: NYC Open Data Portal 311 Service Requests, DOT Responsible Agency 1 January - 30 June 2015

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## **QGIS - The Good**

- Freely available desktop application
- Lots of features
- Works with different data types
- A strong community developing new features and plug-ins

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## **QGIS - The Bad**

- A bit bug-y sometimes
- Visual style is a little clunky
- Features change between versions
- It will crash (but so will ArcGIS)

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## QGIS - The Bug-y

- Sometimes things get jumbled -> zoom out then zoom back in
- Things don't work properly -> close and restart
- Other problems that we'll find in class

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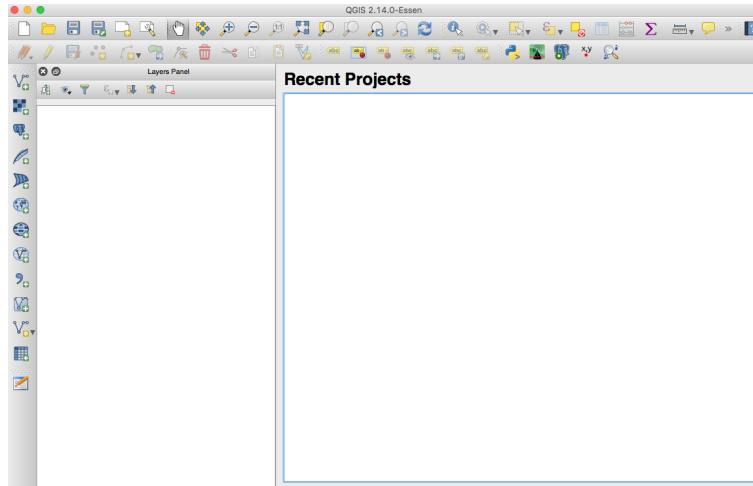
## Let's Get Started

1. Click this link and download the file to your desktop
2. Unzip the file
3. Open QGIS

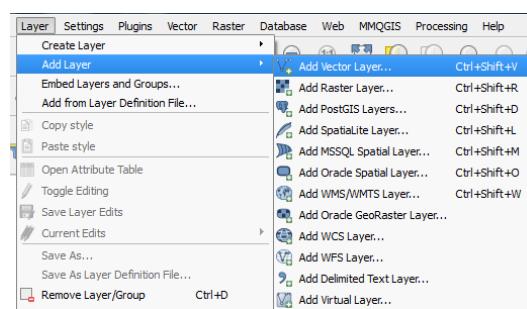


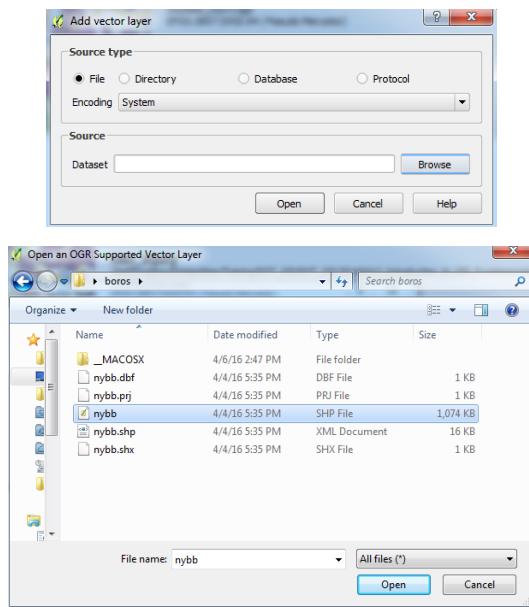
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# QGIS Getting Started



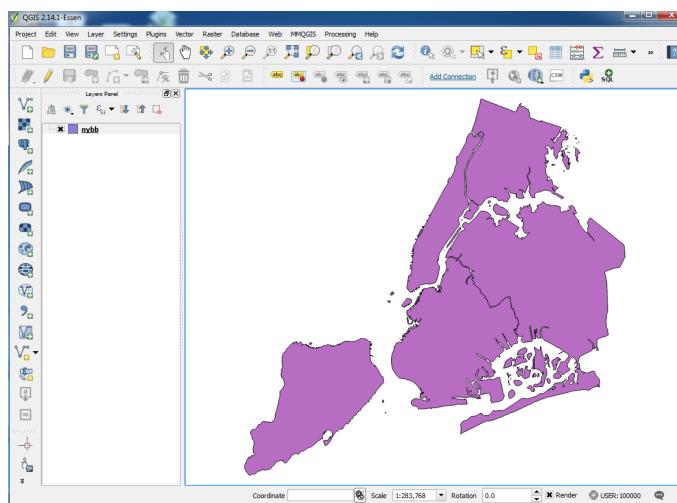
# QGIS Getting Started





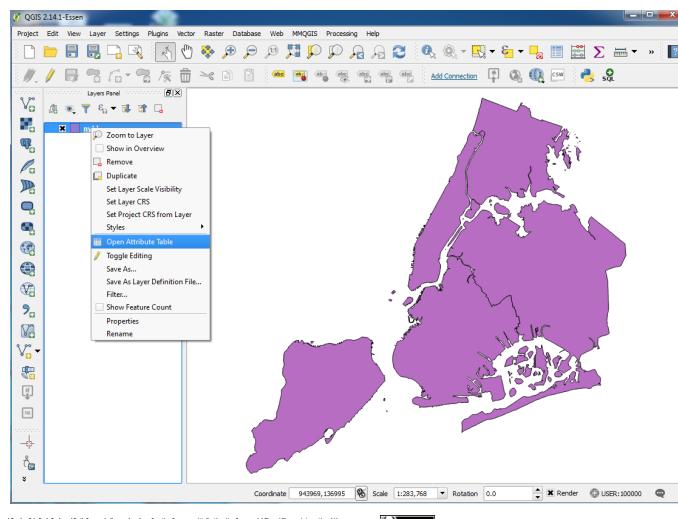
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## QGIS Getting Started



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## Attribute Table (Right click on layer)



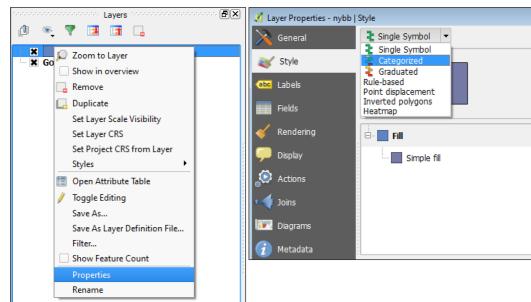
## Attribute Table

An attribute table dialog box titled 'Attribute table - nybb :: Features total: 5, filtered: 0, selected: 0'. The table contains the following data:

	BoroCode	BoroName	Shape_Leng	Shape_Area
3	1	Manhattan	358532.9564179...	636442167.4670...
4	2	Bronx	464517.8905529...	1186804144.789...
2	3	Brooklyn	726568.9463400...	1959432236.829...
1	4	Queens	861038.4792990...	3049947236.730...
0	5	Staten Island	330385.0369739...	1623853249.910...

# Styling Features

- Right-click the layer and select the Properties option
- Select "Style," and finally, choose "Categorized":

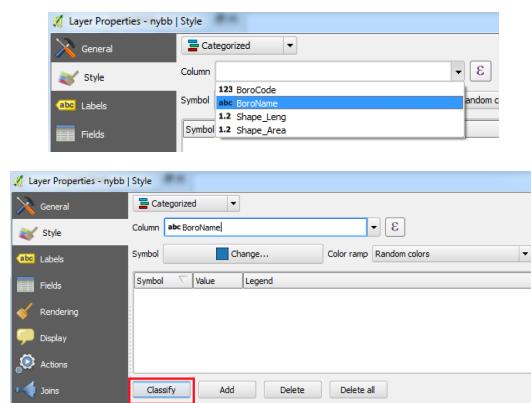


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# Styling Features

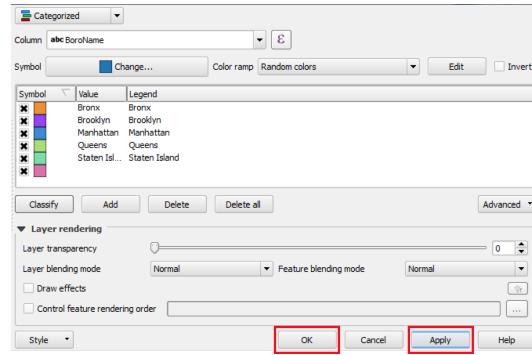
- Select the column that has the data you want to style:



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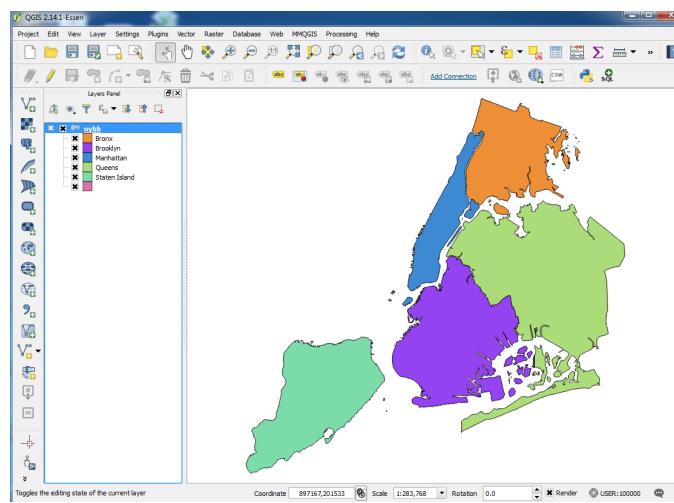


# Styling Features



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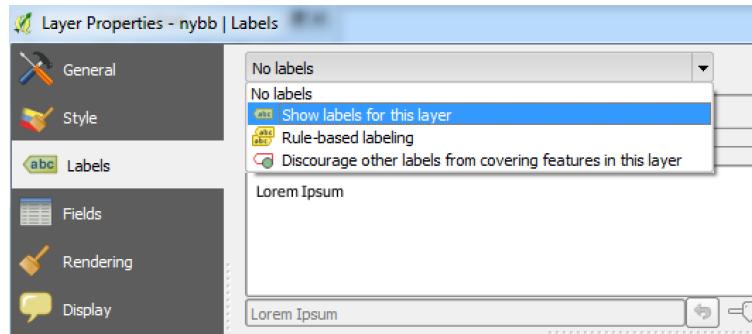
# Styling Features



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## Add labels to data

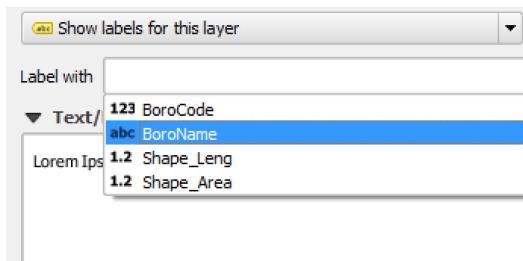
- From Properties, select "Labels", "Show labels for this layer"



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## Add labels to data

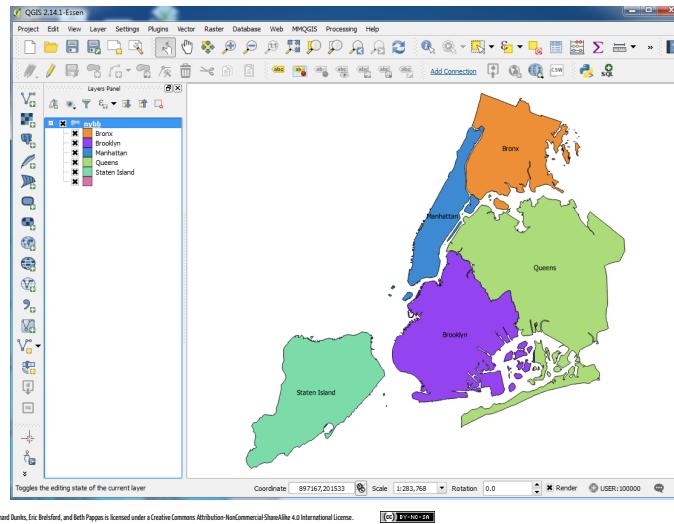
- Select the column that has the data you want to use for labels



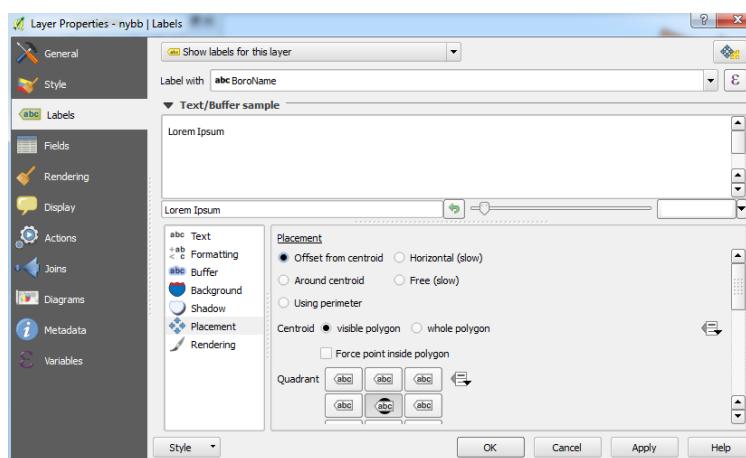
- Click "Apply", "Ok"

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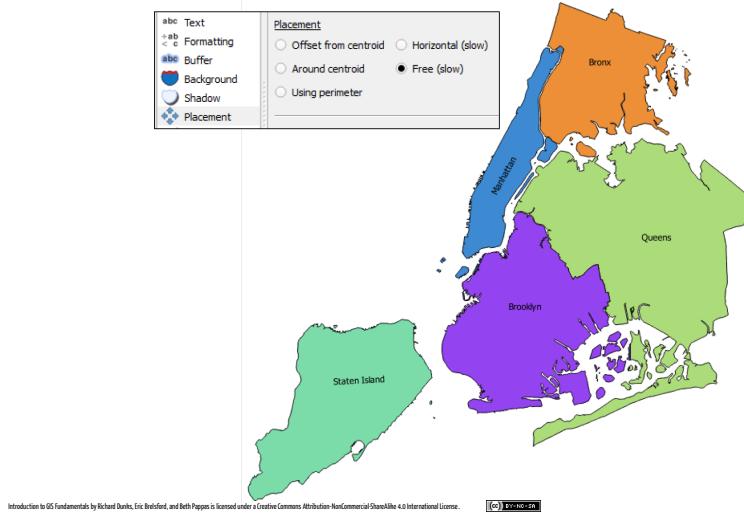
## Add labels to data



## Styling Labels



# Styling Labels



## Your turn

- Style the polygons however you'd like
- Change the outline color or add a pattern
- Style the labels
- Change the font, the font size, or other attributes

## Layers

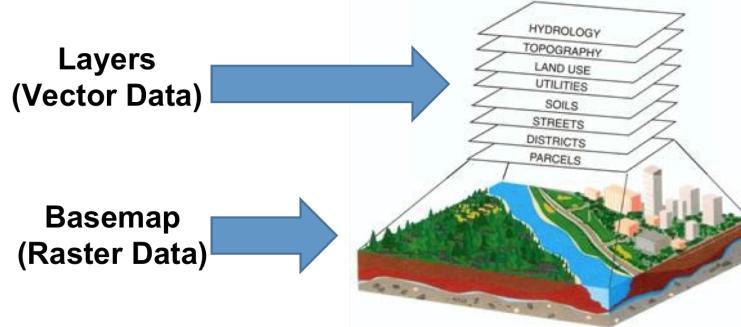
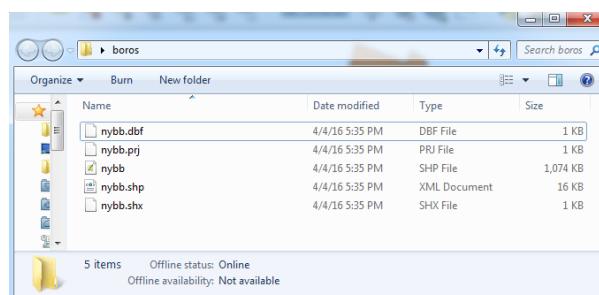


Image Source: <http://www.geocontrolling.com/co-je-gis.htm>

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## Shapefiles

- Basic file for storing map elements
- Stores spatial data, like points, lines, and polygons
- Multiple files comprise a "shapefile"



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# Shapefiles

- **.shp**—The main file that stores the feature geometry
- **.dbf**—The dBASE table that stores the attribute information of features
- **.prj**—The file that stores the coordinate system information
- **.shx**—The index file that stores the index of the feature geometry
- **.cpg**—Identifies the character set to be used
- **.sbn** and **.sbx**—The files that store the spatial index of the features

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# Shapefiles

- Have a few limitations
- One geometry type (Point, Line, Polygon) per shapefile
- So sometimes you end up with this:

Name	Size	Type	Modified
osm_line.dbf	24.7 MB	Document	Feb 4
osm_line.prj	143 bytes	Unknown	Feb 4
osm_line.shp	1.5 MB	Unknown	Feb 4
osm_line.shx	37.1 kB	Unknown	Feb 4
osm_point.dbf	4.8 MB	Document	Feb 4
osm_point.prj	143 bytes	Unknown	Feb 4
osm_point.shp	24.9 kB	Unknown	Feb 4
osm_point.shx	7.2 kB	Unknown	Feb 4
osm_polygon.dbf	939.4 kB	Document	Feb 4
osm_polygon.prj	143 bytes	Unknown	Feb 4
osm_polygon.shp	4.6 MB	Unknown	Feb 4
osm_polygon.shx	1.5 kB	Unknown	Feb 4

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## Shapefiles

- Column names can only be letters, numbers, and underscores "\_"
  - Column names can only be ten characters long

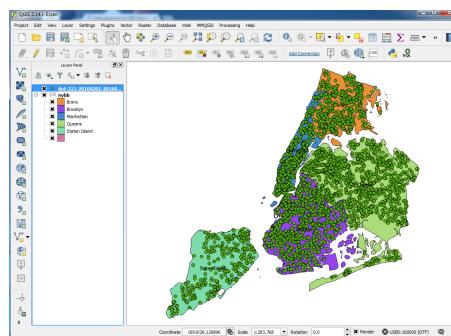
OBJECTID	C_DIG1	C_DIG1DESC	C_DIG2	C_DIG2DESC	C_DIG3	C_DIG3DESC	LU_CURRENT
40	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
41	3	Industrial	31	Industrial	0	NULL	2010
42	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
1	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
2	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
3	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
4	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
5	7	Park/Open ...	71	Park/Open ...	711	Park/Open ...	2011
6	9	Vacant or ...	92	Other/Unk...	0	NULL	2010
7	2	Residential	20	Residential	200	Residential	2010

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# 311 DOT Service Requests

- Download the data to your desktop
  - Unzip the file
  - Open in QGIS



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# 311 DOT Service Requests

Unique Key	Created Date	Closed Date	Agency	Agency Name	Complain	Descriptor	Location T	Incident Z	Incident A	Street Name
4025	3/29/2016 02/01/2016 01:0	0/0/2016 03:2...	DOT	Department of Tr...	Traffic Signal Con...	Controller	NULL	11217	NULL	NULL
4024	3/25/2016 02/01/2016 01:0	0/3/2016 08:5...	DOT	Department of Tr...	Broken Muni Meter	No Receipt	Street	10461	1586 WILLIAMS...	WILLIAMS RIDG...
4023	3/26/2016 02/01/2016 01:0	0/3/2016 08:5...	DOT	Department of Tr...	Broken Muni Meter	Out of Order	Street	11211	GRAND STREET	GRAND STREET
4022	3/27/2016 02/01/2016 01:0	0/3/2016 08:2...	DOT	Department of Tr...	Street Sign - Da...	Stop	Street	11222	NULL	NULL
4021	3/26/2016 02/01/2016 01:0	0/1/2016 01:5...	DOT	Department of Tr...	Street Light Con...	Street Light Out	NULL	10306	NULL	NULL
4020	3/27/2016 02/01/2016 01:0	0/2/2016 09:0...	DOT	Department of Tr...	Street Condition	Cave-in	Street	10013	91 MULBERRY ST...	MULBERRY STREET
4019	3/27/2016 02/01/2016 01:0	0/2/2016 11:1...	DOT	Department of Tr...	Street Condition	Pothole	NULL	11362	NULL	NULL
4018	3/26/2016 02/01/2016 01:0	0/3/2016 07:0...	DOT	Department of Tr...	Broken Muni Meter	Out of Order	Street	11415	92-04 LEFFERTS ...	LEFFERTS BOULE...
4017	3/27/2016 02/01/2016 01:1	0/2/2016 03:2...	DOT	Department of Tr...	Traffic Signal Con...	Controller	NULL	11217	NULL	NULL
4016	3/27/2016 02/01/2016 01:1	0/2/2016 12:0...	DOT	Department of Tr...	Street Light Con...	Street Light Out	NULL	11209	73 STREET	73 STREET
4366	3/27/2016 02/01/2016 01:1	0/2/2016 04:5...	DOT	Department of Tr...	Street Condition	Line-Marking - Fa...	Street	11234	NULL	NULL
4015	3/27/2016 02/01/2016 01:1	0/2/2016 12:0...	DOT	Department of Tr...	Street Condition	Pothole	NULL	11204	70 STREET	70 STREET
4014	3/27/2016 02/01/2016 01:2	0/1/2016 10:0...	DOT	Department of Tr...	Street Light Con...	Street Light Out	NULL	10309	NULL	NULL
4013	3/27/2016 02/01/2016 01:2	0/2/2016 10:4...	DOT	Department of Tr...	Street Light Con...	Flood Light Lamp	NULL	10309	NULL	NULL
4012	3/27/2016 02/01/2016 01:2	0/3/2016 10:2...	DOT	Department of Tr...	Broken Muni Meter	Out of Order	Street	10001	9 AVENUE	9 AVENUE
4011	3/27/2016 02/01/2016 01:2	0/2/2016 06:4...	DOT	Department of Tr...	Street Sign - Dan...	Do Not Enter	Street	11236	NULL	NULL
4010	3/28/2016 02/01/2016 01:2	0/1/2016 11:2...	DOT	Department of Tr...	Street Light Con...	Fixture,Luminaire	NULL	10309	NULL	NULL
4009	3/27/2016 02/01/2016 01:3	0/1/2016 12:4...	DOT	Department of Tr...	Street Light Con...	Street Light Out	NULL	10307	NULL	NULL
4008	3/28/2016 02/01/2016 01:3	0/3/2016 10:5...	DOT	Department of Tr...	Broken Muni Meter	Cor or Card Did	Street	11211	690 GRAND STR...	GRAND STREET
4007	3/28/2016 02/01/2016 01:3	0/3/2016 08:3...	DOT	Department of Tr...	Broken Muni Meter	Out of Order	Street	11211	712 GRAND STR...	GRAND STREET

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## Filter and Query

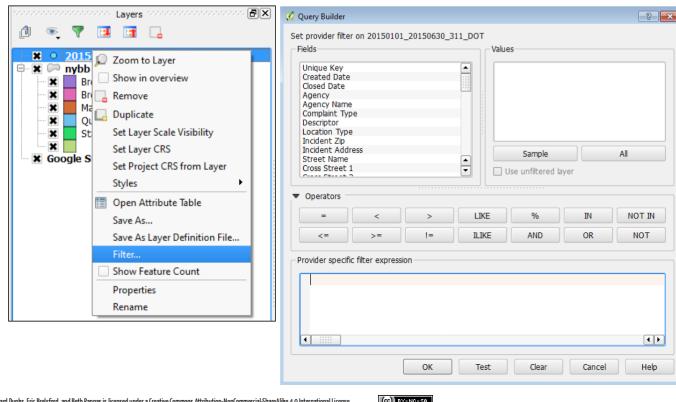
- We can filter the points based on the values in the attribute table

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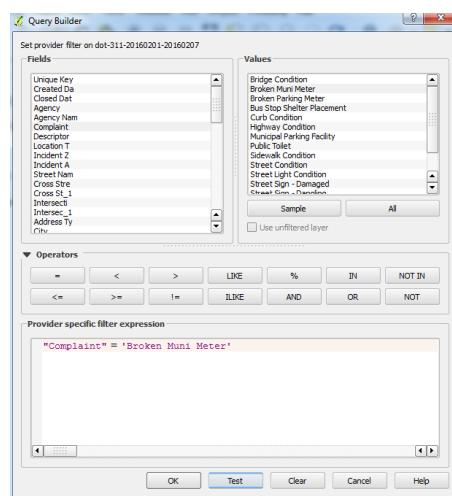
# Filter and Query

- Right-click on the layer and select "Filter" to open the Query Builder



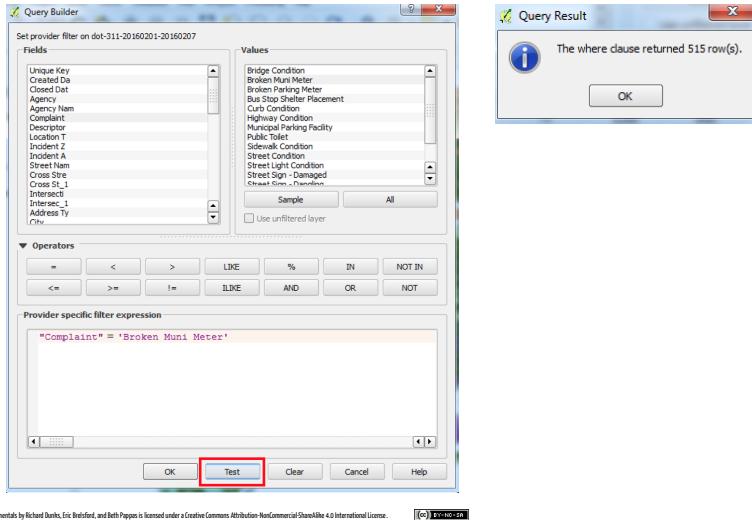
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# Filter and Query



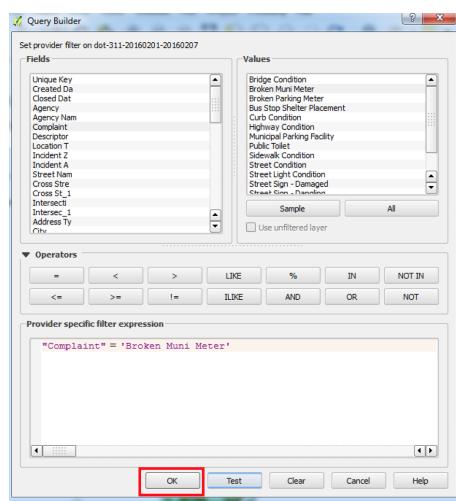
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## Filter and Query



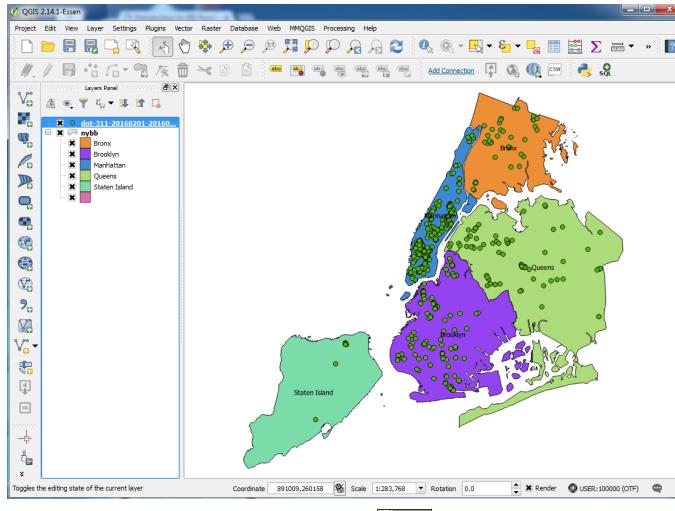
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## Filter and Query



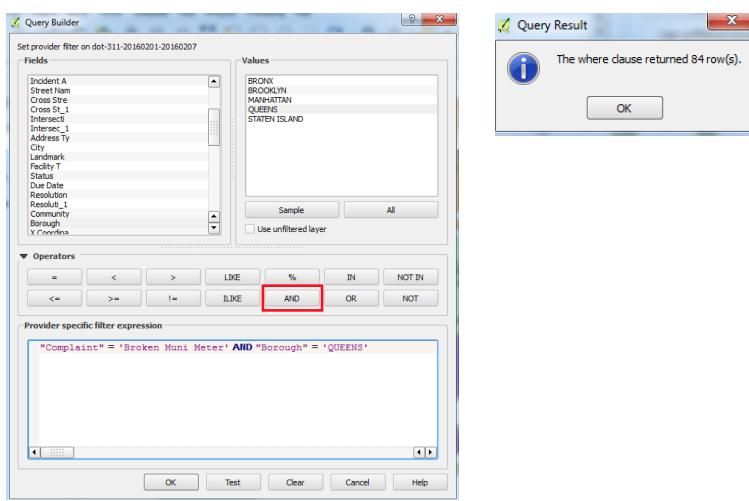
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# Filter and Query



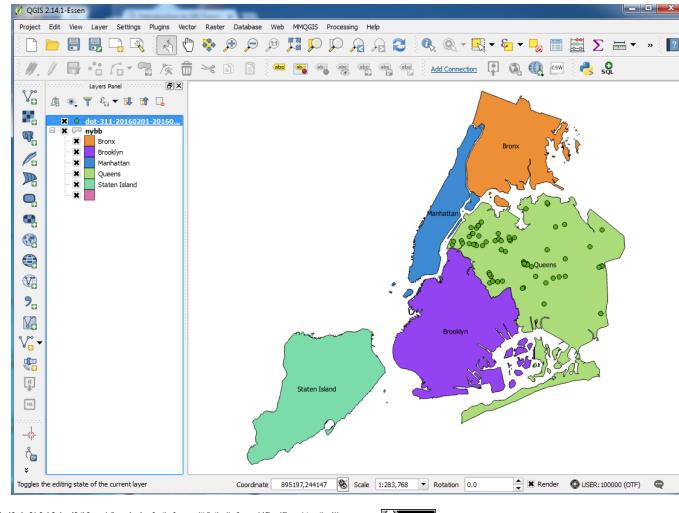
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## Filter and Query - Multiple Conditions

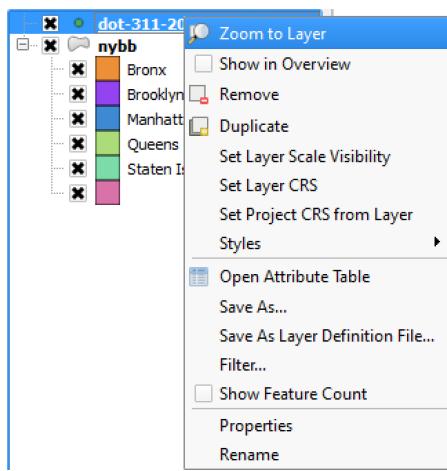


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## Filter and Query - Multiple Conditions

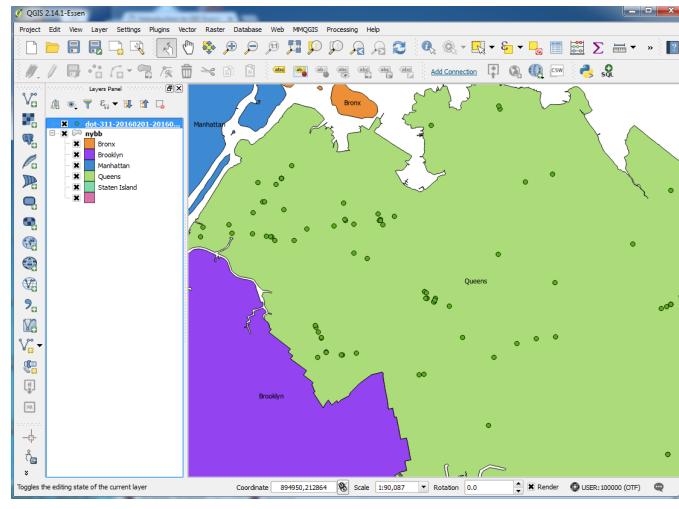


## Zoom to Layer

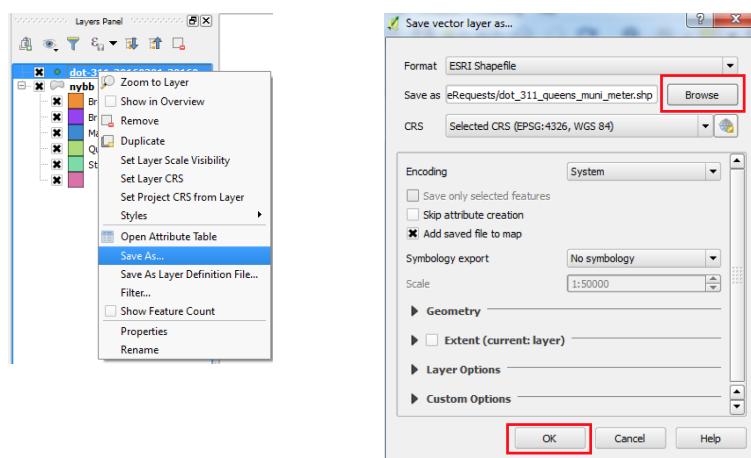


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## Zoom to Layer



## Exporting Data



## Your Turn

- Filter for service requests in your borough
- Try and find something interesting
- Change the style of the point, either to a different shape, color, or icon
- Export your selection as a new shapefile

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## Let's add another layer

- Right click this link
- Select "Save link as"
- Save the file (`Parking_Facilities.csv`) to your desktop

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# What is a CSV file?

```
1 fac_type,lic_num,park_num,X,Y
2 Parking Garage,363056,40,-73.97968154,40.66555725
3 Parking Lot,363308,50,-73.91327186,40.76286893
4 Parking Lot,363400,25,-73.88334858,40.70122489
5 Parking Lot,363464,25,-73.95817675,40.71158977
6 Parking Garage,363695,5,-73.94612061,40.72436988
7 Parking Lot,363732,75,-73.96946773,40.69110093
8 Parking Garage,363740,165,-73.97968154,40.66555725
9 Parking Garage,363809,200,-73.93339948,40.68366871
10 Parking Garage,363881,85,-73.96807185,40.6941565
11 Parking Garage,363961,90,-73.99836234,40.69206331
12 Parking Garage,364407,25,-73.98705379,40.68702658
13 Parking Lot,364804,15,-73.92715985,40.68438847
14 Parking Lot,365110,75,-73.73864032,40.70991312
15 Parking Lot,365142,40,-73.97956719,40.6823121
16 Parking Lot,365547,300,-73.92054135,40.74489337
17 Parking Lot,365559,90,-73.87206493,40.67401318
18 Parking Lot,365621,45,-73.96939604,40.69073651
19 Parking Garage,365792,80,-73.8462843,40.72070726
20 Parking Lot,365949,50,-73.93866903,40.74570245
21 Parking Lot,366200,30,-73.99409469,40.68945359
22 Parking Lot,366315,20,-73.98911607,40.68783411
23 Parking Lot,366601,20,-73.95389812,40.73236869
24 Parking Lot,366728,16,-73.98992087,40.69467826
25 Parking Lot,366735,24,-73.98939319,40.68151354
```

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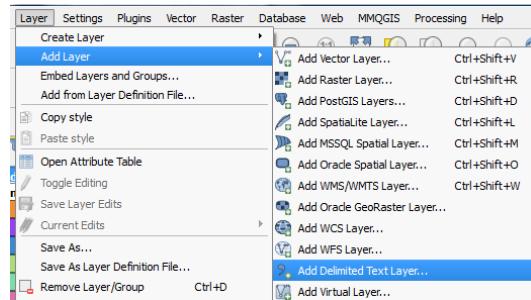
# What is a CSV file?

```
1 IncidentID,Dispatcher,Officer,Post,DateEntered,IncidentDate,IncidentTime,AddressNum,OnStreet,CrossStreet1,CrossStreet2,Corner,Condition,SubCondition,SubSubCondition,OtherCondition,Disposition,Remarks,latitude,longitude
2 14-016213,dblackwell,"MELNIK, LYUDMILA",VEH-1-AM,2014-07-06T01:21:58Z,2014-07-06T00:00:00Z,1899-12-31T00:00:00Z,I/F/O,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,NO ENCLAVE,,,PUBLIC SAFETY,I/F/O 1 HOMELESS 1/S/0
3 14-017149,jpambua,"MARCUS JERRY",113-PM,2014-07-16T04:51:45Z,2014-07-16T00:00:00Z,1899-12-31T02:47:45Z,40.705284617,-74.0077436661
4 14-016596,jrivera,"MATIAS JOSE ",109-AM,2014-07-10T07:05:34Z,2014-07-10T00:00:00Z,1899-12-31T07:08:44Z,45.0,EXCHANGE PL ,I/F/O,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,PUBLIC SAFETY,I/F/O 40 EXCHANGE PL 2 HOMELESS OUTSTRETCHED,40.7059382815,-74.0102829106
5 14-016597,jrivera,"LEGENT, JACQUES",109-AM,2014-07-10T07:05:34Z,2014-07-10T00:00:00Z,1899-12-31T07:08:44Z,45.0,JOHN ST ,,,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,BRC,"45 JOHN ST 1 HOMELESS MALE OUTSTRETCHED NTFO BRC SPOKE W/FRANCIS. BRC O/S, NO CLIENT FOUND.",40.7074504859,-74.0119459041
6 14-017180,jpambua,"THOMAS RODRIGUE",109-AM,2014-07-15T08:54:23Z,2014-07-15T00:00:00Z,1899-12-31T08:54:23Z,45.0,THOMAS RODRIGUE,17/F/O,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,BRC,2 HOMELESS MALES OUTSTRETCHED BRC O/S INDIVIDUALS REFUSED TO DEPART,40.7092404135,-74.00800023249M,40.7023917277,-74.0133732039
7 14-016215,dblackwell,"MELNIK, LYUDMILA",VEH-1-AM,2014-07-06T01:27:10Z,2014-07-06T00:00:00Z,1899-12-31T01:27:10Z,1.0,BROADWAY, GREENWICH ST ,I/F/O,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,PUBLIC SAFETY,1 HOMELESS ON THE GREENWICH ST SIDE OF 1 BWAY,40.7047850763,-74.0140986329
8 14-016579,jpambua,"BONNAIRE , RODRIGUE",104-AM,2014-07-11T04:44:37Z,2014-07-11T00:00:00Z,1899-12-31T03:31:37Z,8.0,STATE ST ,,,I/F/O,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,PUBLIC SAFETY,I/F/O 8 STATE ST HOMELESS OUTSTRETCHED,40.7023917277,-74.0133732039
9 14-017584,golmbaro,"MELNIK, LYUDMILA",VEH-1-AM,2014-07-21T01:44:20Z,2014-07-21T00:00:00Z,1899-12-31T01:44:20Z,WHITEHALL ST,PEARL ST ,S/W/C,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,PUBLIC SAFETY,"S/W/C WHITHALL ST & PEARL ST , 1 HOMELESS OUTSTRETCHED I/S/0 SLEEPING BAG, HOMELESS REFUSED TO DEPART & SERVICES",40.7030999202,-74.0129982575
10 14-016599,jriovera,"LEGENT, JACQUES",108-AM,2014-07-10T07:12:03Z,2014-07-10T00:00:00Z,1899-12-31T00:00:00Z,FRONT ST,JOHN ST ,N/E/C,HOMELESS OUTSTRETCHED,NO ENCAMPMENT,,BRC,N/E/C FRONT ST & JOHN ST 2 HOMELESS OUTSTRETCHED ON BENCHES NTFO BRC SPOKE W/FRANCIS. BRC O/S, NO CLIENT FOUND.",40.7064000052,-74.0045389356
```

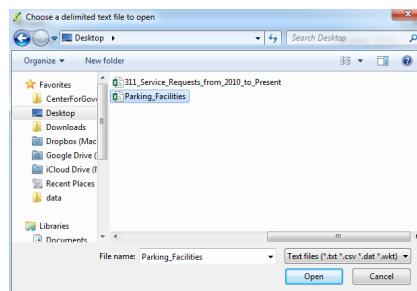
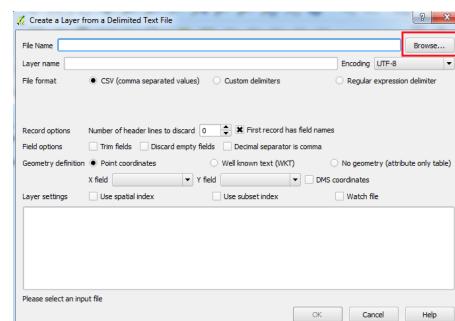
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# Adding CSV Data



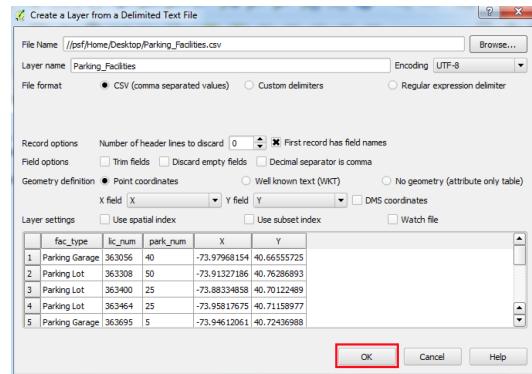
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# Adding CSV Data



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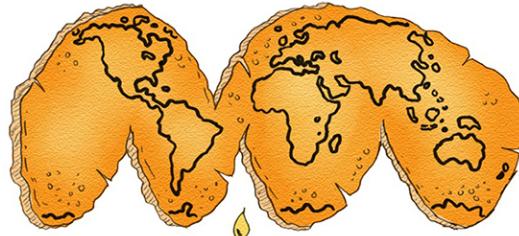
## So what is a Coordinate Reference System?

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# Projections

- No one's favorite part of GIS
- But a necessary part of it nonetheless
- Convert points on the 3-dimensional Earth (**latitude and longitude**) to x and y coordinates on a 2-dimensional map



Digital Coast Geozone

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# Projections

- Every projection distorts some part of your map

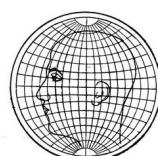


FIG. 42.—Man's head drawn on globular projection.

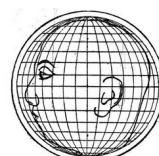


FIG. 43.—Man's head plotted on orthographic projection.

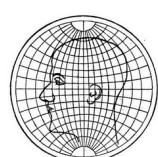


FIG. 44.—Man's head plotted on stereographic projection.

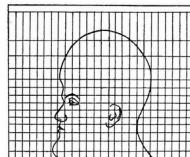


FIG. 45.—Man's head plotted on Mercator projection.

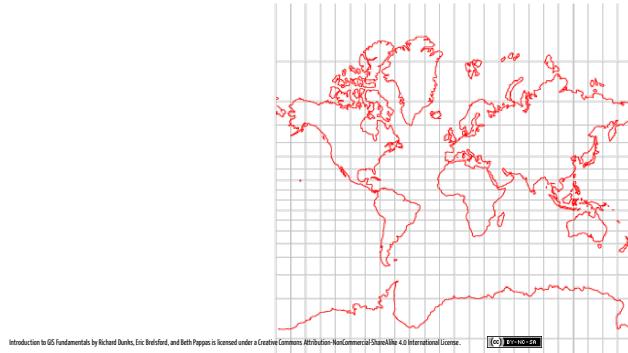
FlowingData

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# Mercator Projections

- A common map projection
- Makes geometries near poles look bigger than geometries near the equator

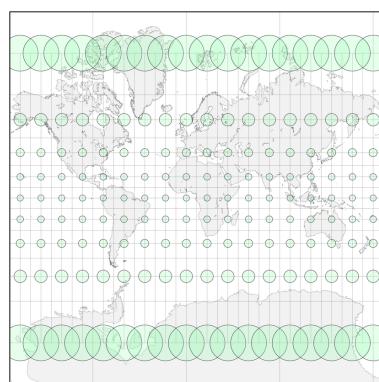


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# Projections Matter

- These circles are all the same size on the globe:



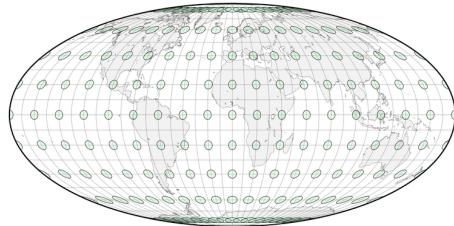
Progonos

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# Projections Matter

- As are these:



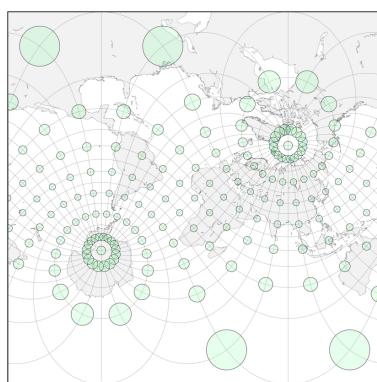
Progonos

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# Projections Matter

- And these:

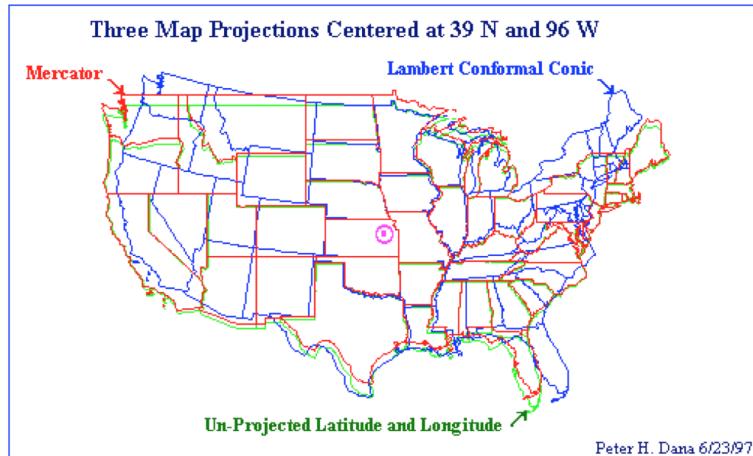


Progonos

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# Projections Matter



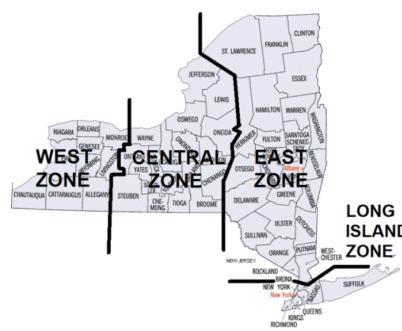
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# Projections

- For the most part we will work in WGS 84 (latitude and longitude)
  - In NYC, we use a more accurate projection **NY State Plane/Long Island Zone**

Source: <https://alidade.wikispaces.com/New+York+SPCS+Zones>



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# Projections

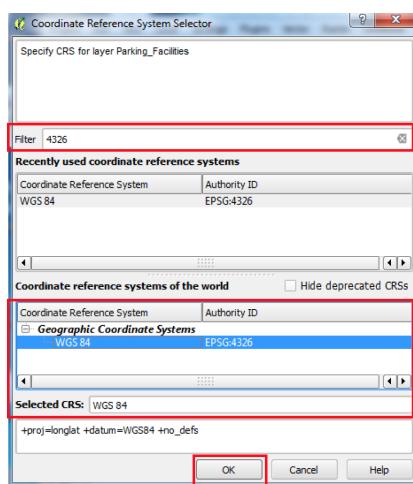
- Identified by unique IDs that make it easier to talk about them
- WGS 84 is referred to as **EPSG:4326**
- State Plane Long Island is referred to as **EPSG:2263**

Remember these two and you should be set

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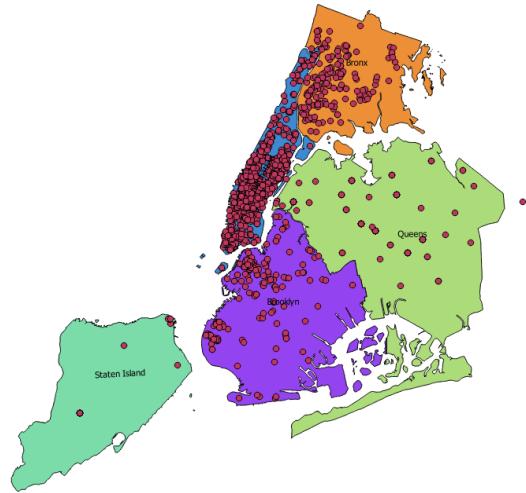
# Adding CSV Data



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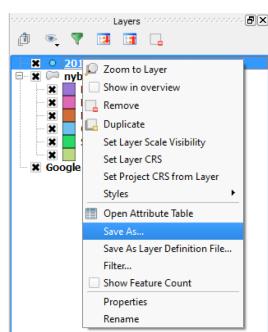
## Adding CSV Data



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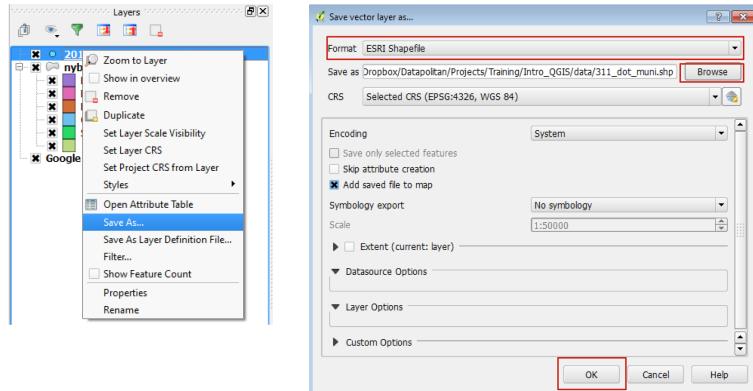
## Saving CSV Data as a Shapefile



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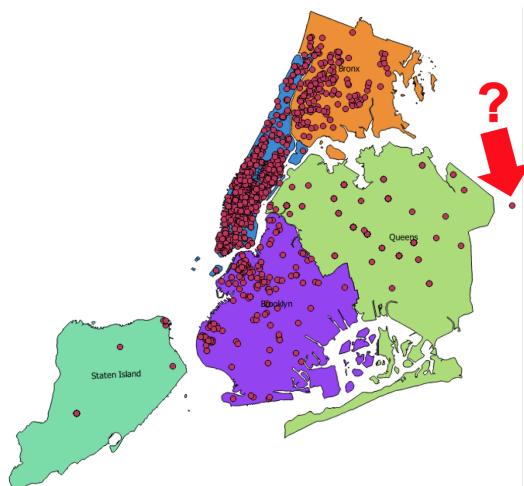


## Saving CSV Data as a Shapefile



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## Selecting Points

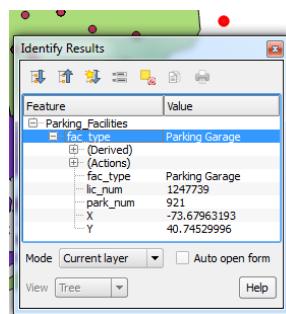


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## Selecting Points



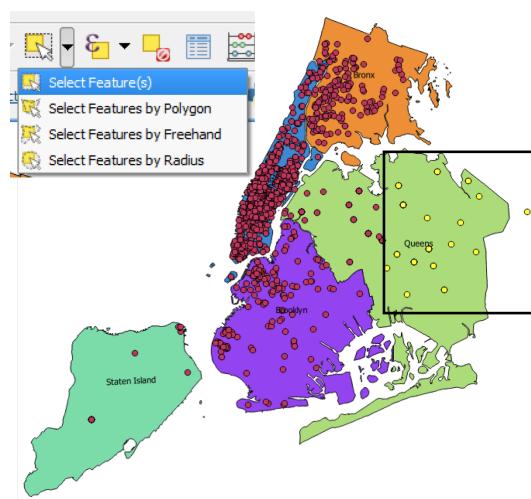
- Click the point



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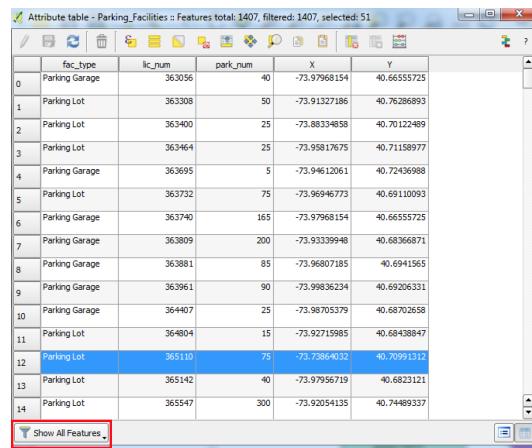
## Selecting Points



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## Selecting Points - Attribute Table

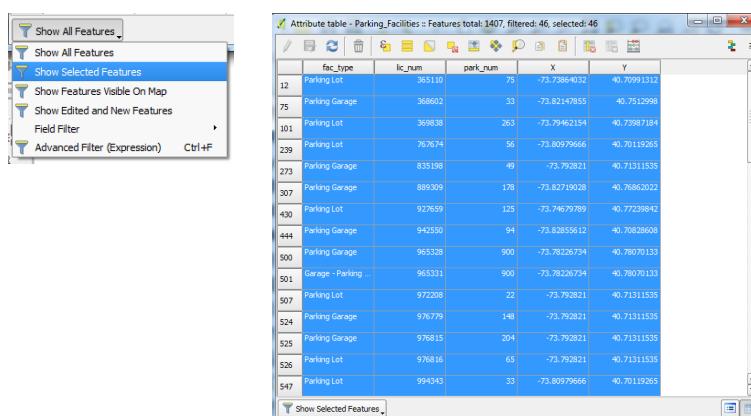


	fac_type	lic_num	park_num	X	Y
0	Parking Garage	363056	40	-73.97968154	40.66555725
1	Parking Lot	363308	50	-73.91327186	40.76286893
2	Parking Lot	363400	25	-73.88348588	40.70122489
3	Parking Lot	363464	25	-73.95817675	40.71158977
4	Parking Garage	363695	5	-73.94612061	40.72436988
5	Parking Lot	363732	75	-73.96946773	40.69110093
6	Parking Garage	363740	165	-73.97968154	40.66555725
7	Parking Garage	363809	200	-73.93339948	40.68366671
8	Parking Garage	363881	85	-73.96807185	40.6941565
9	Parking Garage	363961	90	-73.99836234	40.69206331
10	Parking Garage	364407	25	-73.98705379	40.68702658
11	Parking Lot	364804	15	-73.92715985	40.68438847
12	Parking Lot	365110	75	-73.73864032	40.70991312
13	Parking Lot	365142	40	-73.97956719	40.6823121
14	Parking Lot	365547	300	-73.92054135	40.74889337

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## Selecting Points - Attribute Table

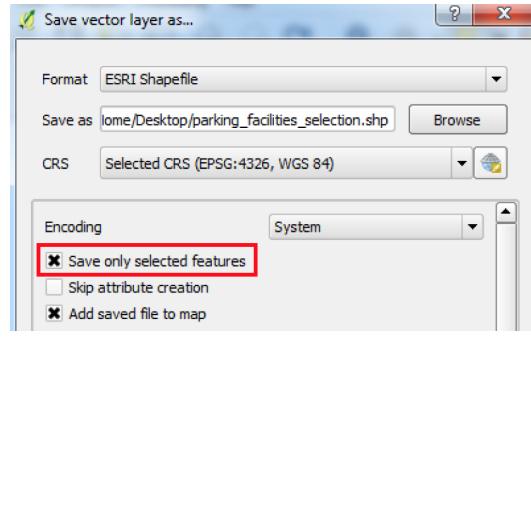


	fac_type	lic_num	park_num	X	Y
12	Parking Lot	365110	75	-73.73864032	40.70991312
25	Parking Garage	368602	33	-73.82147855	40.7512998
101	Parking Lot	369838	263	-73.79462154	40.73887184
239	Parking Lot	767674	56	-73.80979666	40.70119265
273	Parking Garage	835108	49	-73.928211	40.71311535
307	Parking Garage	889309	178	-73.82719028	40.76862022
430	Parking Lot	927659	125	-73.74679789	40.77739642
444	Parking Garage	942550	94	-73.82855612	40.70828608
500	Parking Garage	965338	900	-73.78226794	40.78070133
501	Garage - Parking	965331	900	-73.78226794	40.78070133
507	Parking Lot	972208	22	-73.792821	40.71311535
524	Parking Garage	976779	148	-73.792821	40.71311535
525	Parking Garage	976815	204	-73.792821	40.71311535
526	Parking Lot	976816	65	-73.792821	40.71311535
547	Parking Lot	994243	33	-73.80979666	40.70119265

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## Selecting Points - Saving Selection

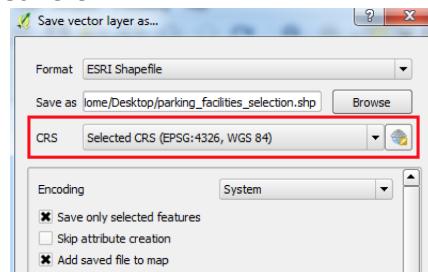


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## Selecting Points - Saving Selection

- If we wanted to reproject the data into a different CRS, we could do that here



- Pick the new projection in the CRS field (like when we imported the CSV)

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## Your Turn

- Create a new shapefile of just the 311 service requests in your borough
- Outline the borough using the polygon selection
- Save the shapefile to your desktop for us to use later

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## What We've Covered

- What is GIS
- Basic GIS concepts and tools
- Adding, styling, and labeling data in QGIS
- Projections
- Selecting features
- Exporting data

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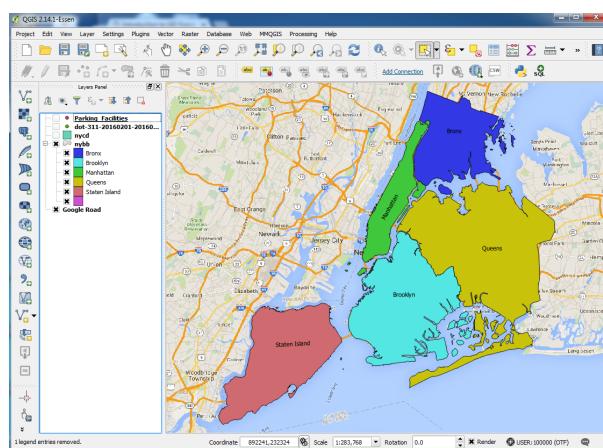


## Goals for the Afternoon

- Add reference data to our maps
- Learn how to join features in QGIS
- Create printable maps in QGIS
- Share resources for further learning

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## What have our maps been lacking?



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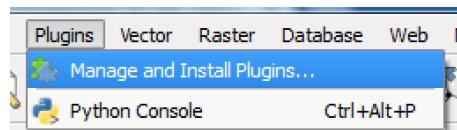
## Base Maps

- Adding base maps will give your map context
- In QGIS, you need a plugin to use base maps
- There are several, but we're only going to use one of them

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## Base Map Plugin

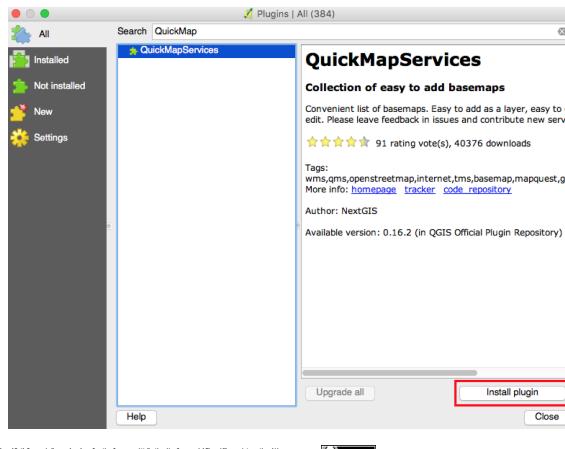
- From the Plugins menu, select "Manage and Install Plugins"



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# Base Map Plugin

- Search for the QuickMapServices plugin and install it

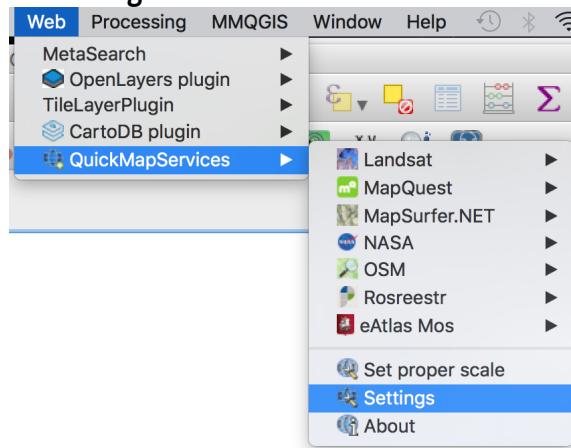


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# Setting Up QuickMapServices Plugin

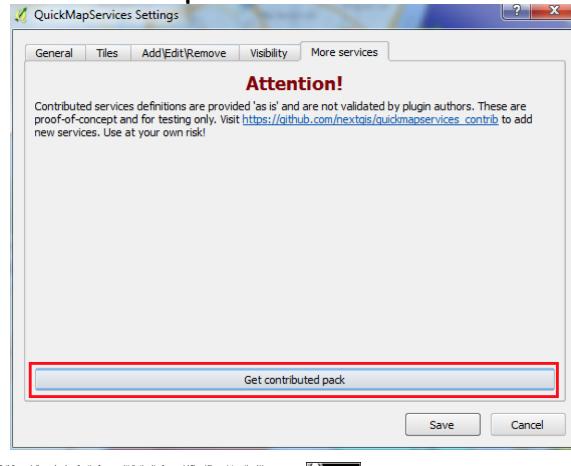
- Go to the Settings Menu



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# Setting Up QuickMapServices Plugin

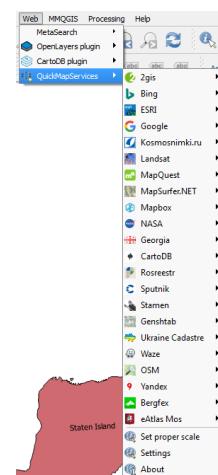
- Get the contributed packs



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# Setting Up QuickMapServices Plugin

- Revel in all the beautiful base maps



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## Your Turn

- Find a good base map for your data
- Don't be afraid to play around

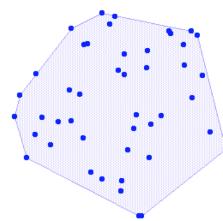
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## Basic Spatial Joins

### Point to Polygon

- Relate points inside a polygon to that polygon (ex. count the number of points)



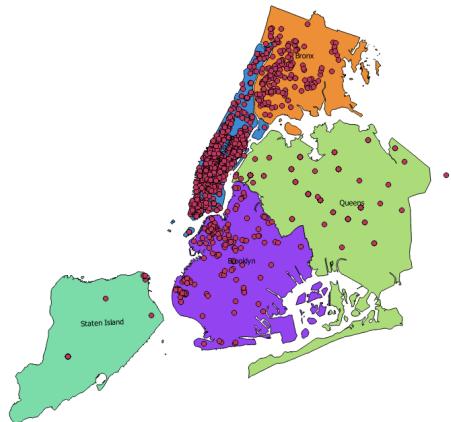
### Polygon to Point

- Points can take on value of enclosing polygon

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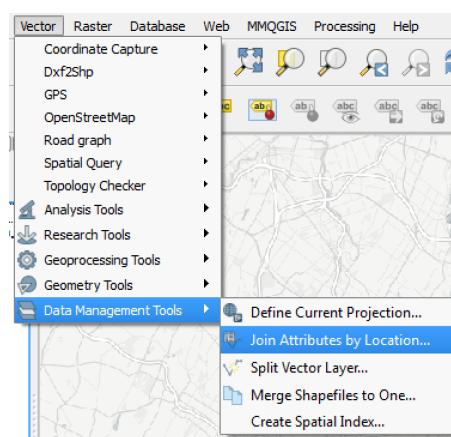
What are some of the spatial joins we could do with this data?



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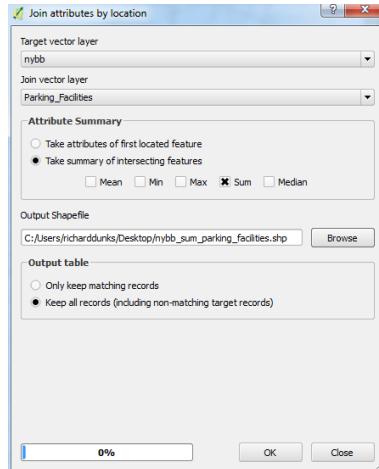
## Parking facilities by borough



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# Parking facilities by borough



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# Parking facilities by borough

CRS warning!

Warning: Input layers have non-matching CRS.  
This may cause unexpected results.

OK

Spatial Join

Created output shapefile:  
C:/Users/richarddunks/Desktop/nybb\_sum\_parking\_facilities.shp

Would you like to add the new layer to the TOC?

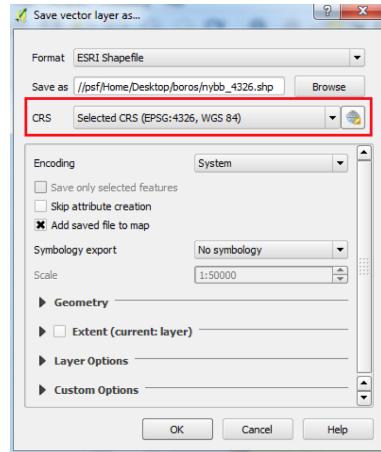
Yes No

	BoroCode	BoroName	Shape_Leng	Shape_Area	SUMlic_num	SUMpark_nu	SUMX	SUMY	COUNT
0	5	Staten Island	330385.0369739...	1623853249.910...	NULL	NULL	NULL	NULL	NULL
1	4	Queens	861038.4792990...	3049947236.730...	NULL	NULL	NULL	NULL	NULL
2	3	Brooklyn	726568.9463400...	199432236.829...	NULL	NULL	NULL	NULL	NULL
3	1	Manhattan	358532.9564179...	636442167.4670...	NULL	NULL	NULL	NULL	NULL
4	2	Bronx	464517.9905529...	1186804144.789...	NULL	NULL	NULL	NULL	NULL

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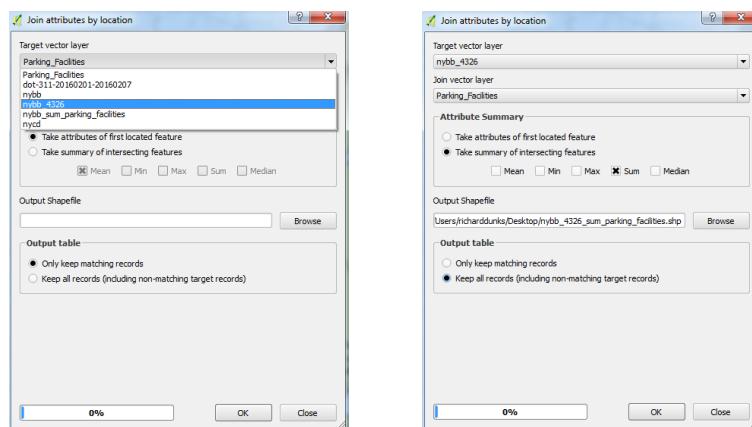


# Reproject the boroughs shapefile into 4326



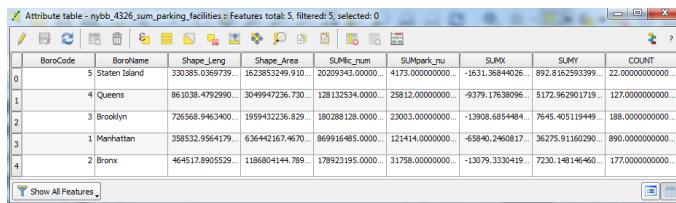
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## Parking facilities by borough



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# Parking facilities by borough



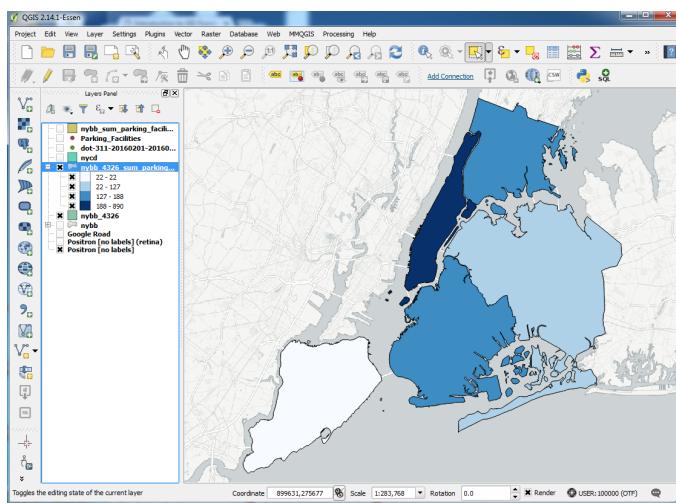
The screenshot shows the QGIS attribute table for the 'nybb\_4326\_sum\_parking\_facilities' layer. The table has 5 features and 9 columns. The columns are: BoroCode, BoroName, Shape\_Leng, Shape\_Area, SUMfc\_num, SUMpark\_nu, SUMX, SUMY, and COUNT.

	BoroCode	BoroName	Shape_Leng	Shape_Area	SUMfc_num	SUMpark_nu	SUMX	SUMY	COUNT
0	5	Staten Island	330385.0369729...	1623853249.910...	2029343.000000...	4173.00000000...	-1631.36844026...	892.8162593399...	22.0000000000...
1	4	Queens	861038.4792990...	3049947236.730...	128132534.0000...	25912.00000000...	-9376.17638096...	5172.962901719...	127.0000000000...
2	3	Brooklyn	726568.9463400...	1959432236.829...	180280128.0000...	23003.00000000...	-13908.6854484...	7645.405119449...	188.0000000000...
3	1	Manhattan	358532.9564179...	636442167.4670...	869916485.0000...	121414.00000000...	-45840.2460817...	36275.91160290...	890.0000000000...
4	2	Bronx	46417.8905529...	1186804144.789...	178923195.0000...	31758.00000000...	-13079.3330419...	7230.19146460...	177.0000000000...

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# Parking facilities by borough



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## Your Turn

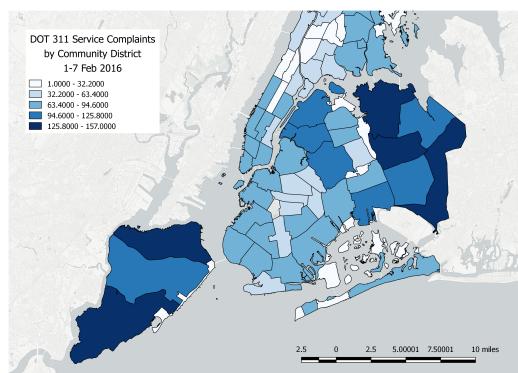
- Count the number of DOT 311 service requests in each community district in your borough
- Style the community districts by the number of service requests

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## Print Composer

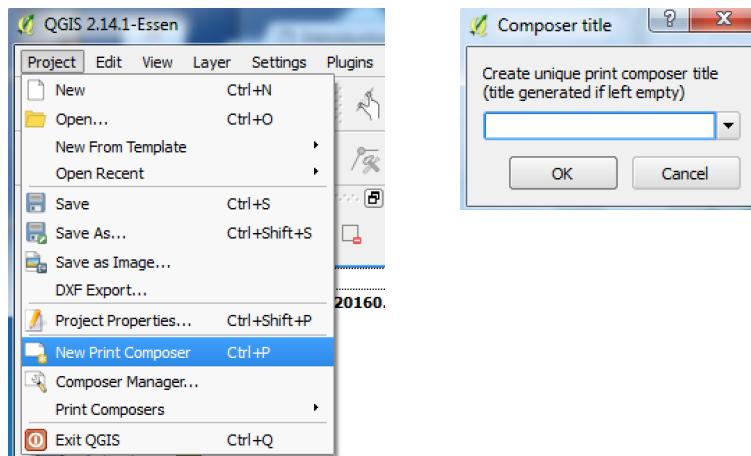
- How you make exportable and printable maps in QGIS
- Able to add map elements (legends, scales, text, etc)



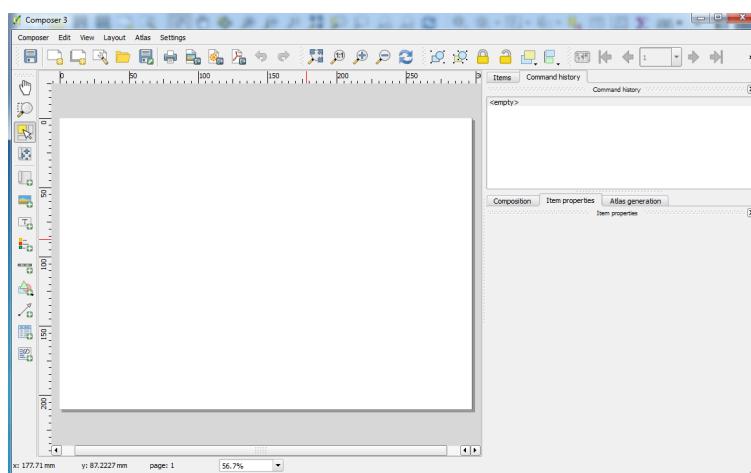
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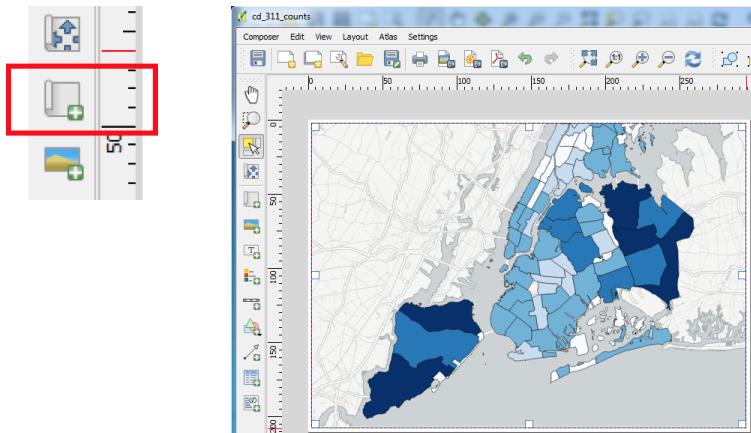
## Create a new print composer



You are greeted with a blank slate



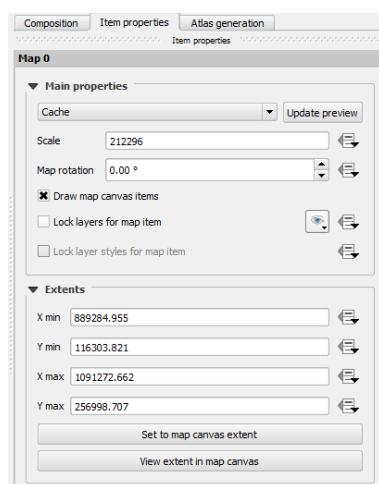
## Add New Map tool will add your current map



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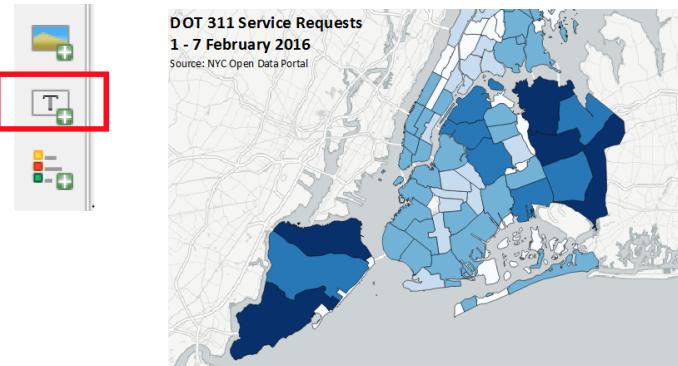
## Customize item properties on the right



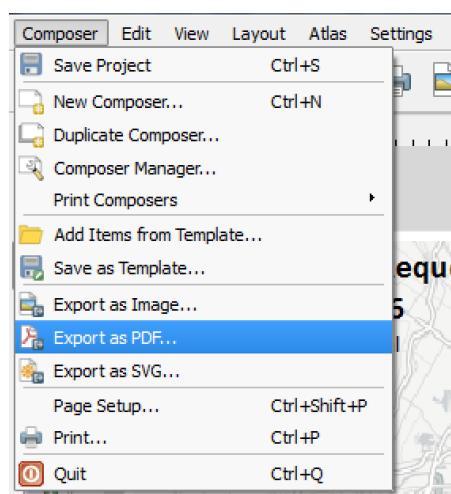
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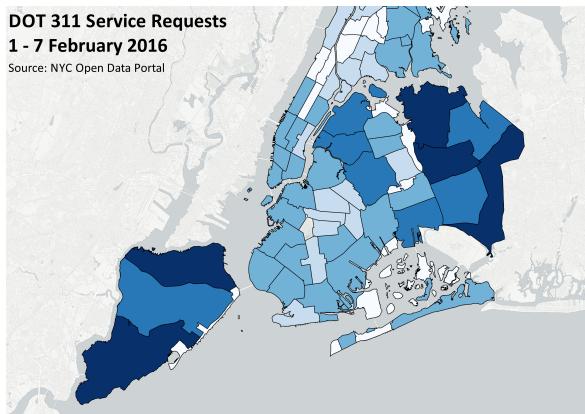
# Don't forget a title and your sources



# There are a few exporting options



# Now you can share your map or print it



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## Print Composer Problems

- Map extent -> "Use current map extent"
- Moving map around -> Adjust with arrows
- "North" arrow -> need to manually align

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## Your Turn

- Working in groups, create a map of DOT 311 Service Requests for the Community Districts in your borough
- Decide on the colors you want and how you want to represent the values
- Open print composer and add your map elements
- Decide on the map elements you want to include (legend, scale, north arrow, etc.)
- Save your map as a PDF to present it to the class
- We'll all be available to help as needed
- Have fun!

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## What We've Covered This Afternoon

- Adding base maps to QGIS
- Installing plug-ins
- Joining data
- Creating a printable map in print composer

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## A Few Things We Didn't Talk About

- Normalizing data for choropleths (see this video)
- Buffering features
- Geocoding
- Spatial databases
- Other spatial data types (KML, GeoJSON, GeoTIFF)
- Editing data

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## QGIS - The Good

- Open-source software that's freely available
- Works with lots of different data types, including shapefiles, KML (Google Earth), GeoJSON, and text files
- Works with various spatial databases
- Strong community developing features and plug-ins

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## QGIS - The Bad

- Not an enterprise software like ESRI ArcGIS
- The visual style is a little clunky
- Features tend to change between versions (moving around, menu option changes, etc)
- Major versions tend to have major feature changes
- Plug-ins tend not to work with newer versions
- And it crashes (as you've probably already experienced)

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## QGIS - The Bug-y

- Projects with different CRS layers tend to get misaligned when zooming
- *Zoom in and then back out to fix*
- Google base maps tend not to appear on load
- *Have to zoom in to get them to appear*
- Other odd behavior that they're hopefully working on
- *File them here: <https://hub.qgis.org/wiki/17/Bugreports>*

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## Good Resources for Further Information

- GIS Stack Exchange: <http://gis.stackexchange.com/>
- Learning QGIS: <https://www.packtpub.com/application-development/learning-qgis-20>
- QGIS Map Design: <http://locatepress.com/qmd>
- QGIS online manual Gentle GIS Introduction: [http://docs.qgis.org/2.8/en/docs/gentle\\_gis\\_introduction](http://docs.qgis.org/2.8/en/docs/gentle_gis_introduction)
- QGIS Tutorials and Tips: <http://www.qgistutorials.com/en/index.html>
- Free and Open Source GIS Ramblings: <https://anitagraser.com/>

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## Reminders

- Know your layer CRS
- When in doubt, zoom in and then zoom out
- If you're working with a CSV file and run into an error, export as a shapefile and try it again
- Save your project often
- Choose good file names

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## Final Thoughts

- Maps are a great way to visualize and explore spatial data
- Some data is only intelligible when mapped
- QGIS is a cheap (as in free) way to get started
- There are many resources online for how to use QGIS and other GIS applications
- Share what you know with others -> Data wants to be mapped

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## Thank You

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- [@bethpappas](https://twitter.com/bethpappas)

### Bernardo Loureiro, TA

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