SCI-6354 Advanced Spatial Analysis - Basic Web Mapping with CARTO

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This workshop will introduce you to CARTO, the web-mapping service formerly known as CartoDB. CARTO makes it easy to visualize geospatial data (in a variety of formats) and share the result online in an interactive format; the service also offers more complex GIS capabilities for managing and analyzing data. We'll go through the basics of importing different kinds of data to CARTO and explore some of its many visualization features.

For this workshop, you'll need:

- A free CARTO account (signup here)
- *noise_data.csv*, a text file created from the our 311 dataset and available on Canvas
- *nypp_17a.zip*, a zipped shapefile of police precincts and available on Canvas

Additionally:

- Some basic intuition with HTML and CSS are helpful, although not necessary!
- For your final project, you may want to make use of Wordpress, Wix or Squarespace to embed your maps.

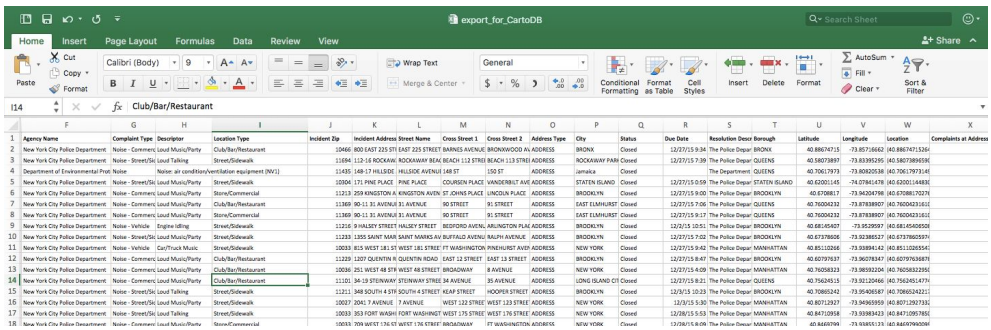
1. Prepare data for CARTO

CARTO stores two kinds of files: datasets (tabular data) and maps (representations of tabular data). A single map can reference and display information from multiple datasets, with each dataset as its own layer.

CARTO is smart enough to be able to open wide variety of file types — including CSV, Excel, shapefile, GeoJSON and KML — and translate them into datasets. Most file types are automatically generated by other applications during export or save, and you don't need to worry about preparing for import. Just remember to archive shapefiles into one ZIP file, prior to upload!

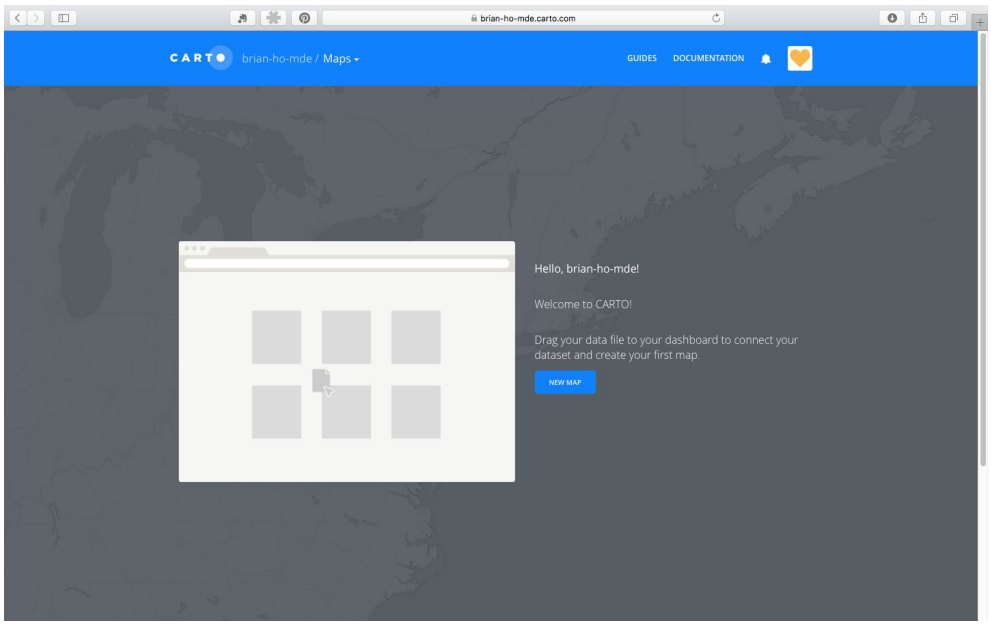
You may, however, want to import a custom CSV or Excel table. In that case you should be sure to include columns for latitude and longitude, or a unique identifier column you can use as a basis for joining to another dataset. While CARTO offers geocoding of text addresses, the service is limited and not always accurate.

In this case, we'll use the *noise_data.csv* file, which was prepared in Python. If you look in Excel, you'll see columns for coordinates, as well as a column that contains the number of all complaints in the location.

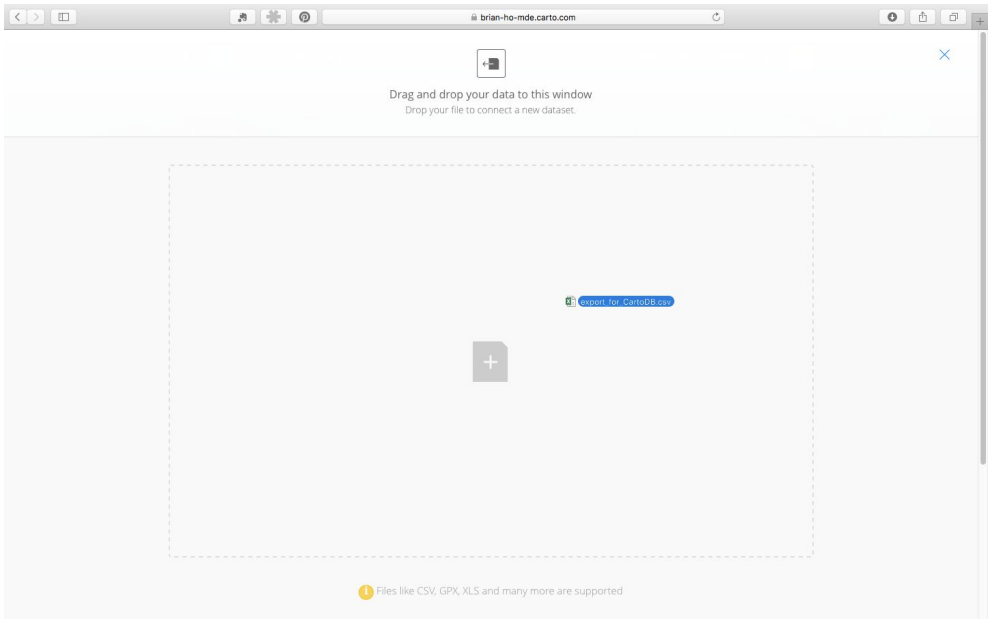


2. Import data

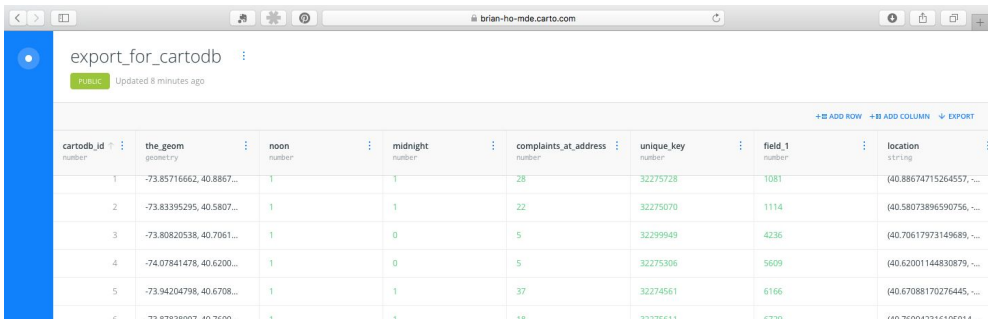
After creating your CARTO account and logging in, you'll see an empty home screen and a prompt to import some data. Assuming you've prepared your geospatial datasets appropriately in ArcMap, Excel or Python, you can bring them directly into CARTO.



Let's try it with our *noise_data.csv* file. You can import it with a simple drag-and-drop action. Alternatively, click on the top header to switch from the **Maps** to **Datasets** view, and follow the on-screen instructions after clicking **New Dataset**. Note that you can import from Google Drive, Dropbox, ArcGIS Server or even sync to a URL.



CARTO will open your file in its datasets view, organized in a tabular format. This lets you view, edit and organize the data itself. Note that CARTO automatically adds two columns, *cartodb_id* and *the_geom*: one with a unique number, and another containing the geometry positions as coordinates.

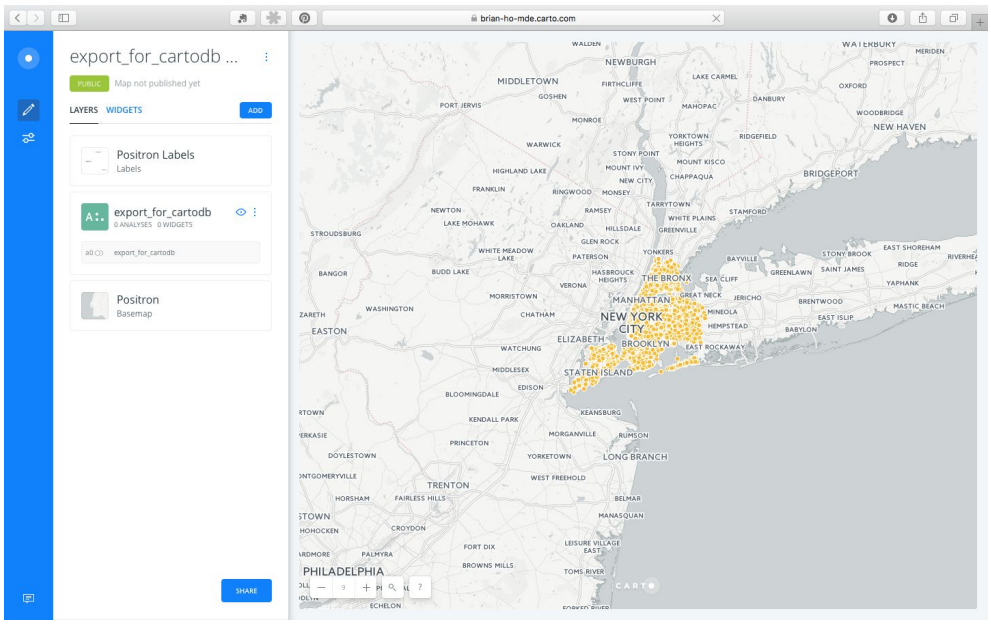


In addition to importing your own data, CARTO also let you add relevant data from its built-in **Data Library** — the collection is currently fairly small, but it does contain some datasets integrated from Open Data portals that support live updates.

Keep in mind that CARTO stores everything in a flat file structure. While a free account only has 250 MB of storage, it's still a good idea to keep things organized by name and with metadata. Clicking the **Edit metadata** option will allow you to add tags and descriptions.

3. Create a map

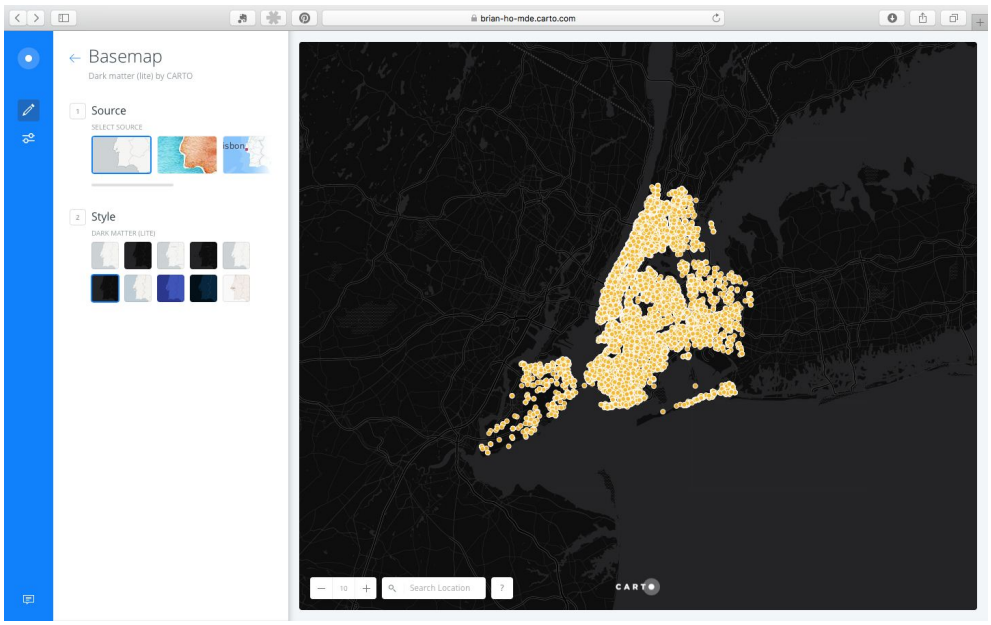
Let's create a map. From within the view of our sample dataset, click **Create Map** to create a new map with the dataset included as a layer. Alternatively, you can navigate through the top header to the **Maps** view, and create an empty new



map.

CARTO's map editor — called Builder — has a pretty intuitive interface. If you are familiar with ArcMap, you will find CARTO's organization relatively similar. The left navigation drawer has two tabs: **Layers** and **Widgets**.

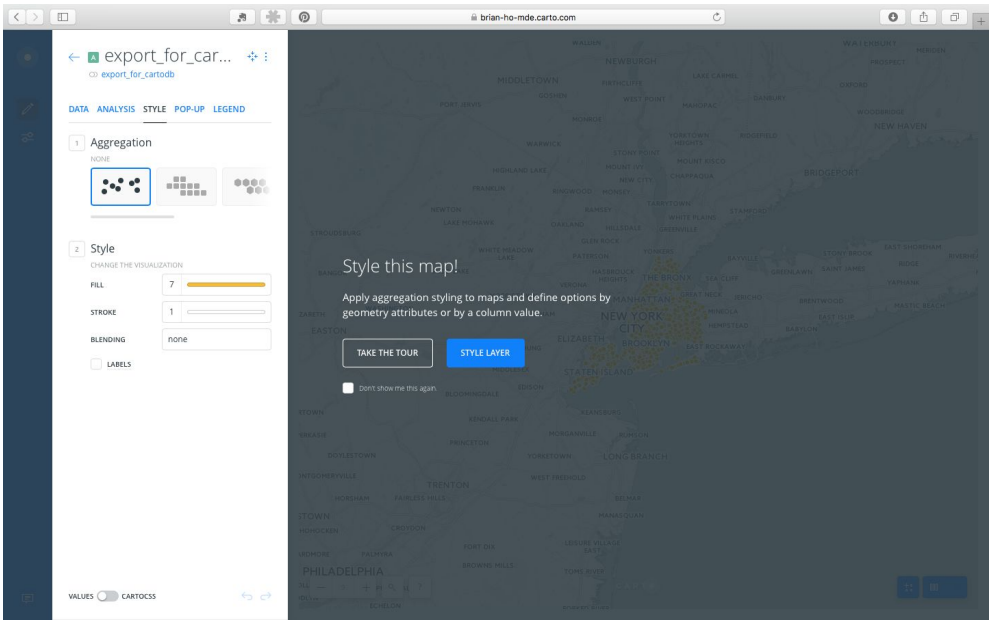
The **Layers** tab displays all layers (corresponding to individual datasets) in your map. You can reorder by dragging, and toggle visibility by clicking the eye icon. You'll see that CARTO automatically includes a basemap and labels (at the bottom and top of our layer stack). You can easily swap out the basemap for another set of map tiles, hosted by a variety of services — including custom tiles from Mapbox.



By default, CARTO displays our first dataset as a series of uniform points, based on the coordinates contained in the data. Fear not! We can easily style this layer.

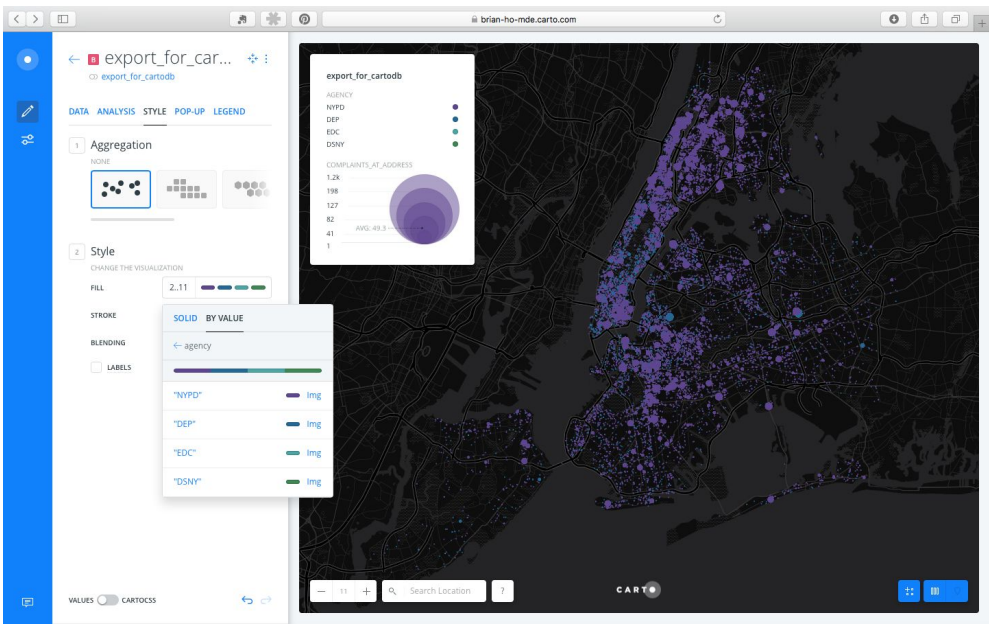
4. Style the map

Click on the layer to enter the layer pane — which now contains detailed information about the layer across five tabs (**Data**, **Analysis**, **Style**, **Pop-Up**, and **Legend**). Note that depending on where you clicked on the layer card, you may be looking at either the **Data** or **Style** tabs.

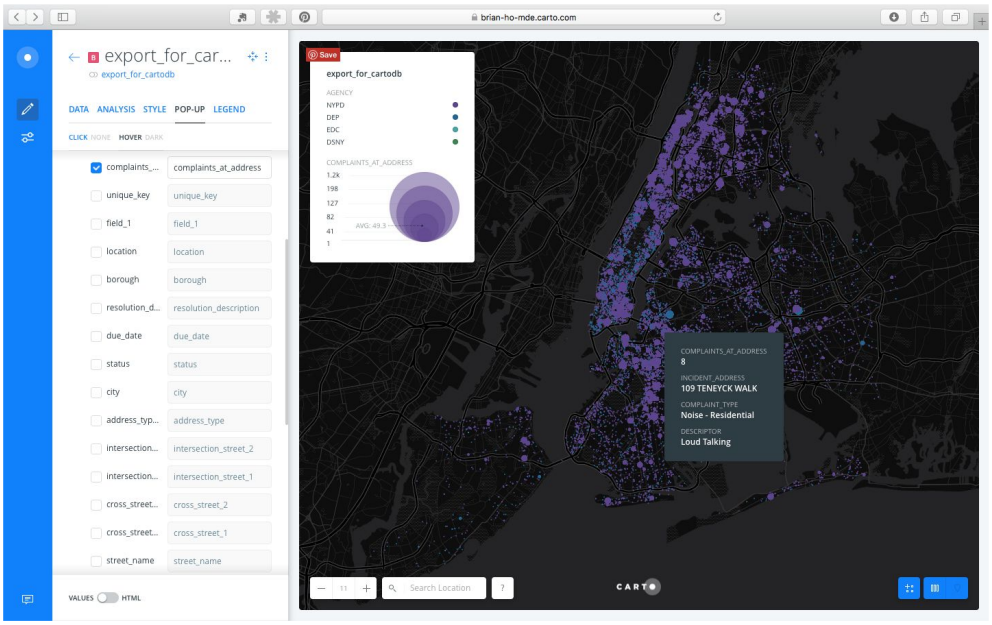


Let's start with the **Style** tab. For point data, you'll see a few aggregation options, which essentially change the symbology method for the layer. Depending on your selected aggregation option, you'll then see different visualization properties. As with ArcMap, you can set a fixed fill, stroke and size — or match them to a column within the data, using the **By Value** options.

Let's scale the size of our 311 complaints to match the frequency of complaints (the *complaints_at_address* column) at that location, and set the color to match the responding city agency (the *agency* column).



To add some basic interaction, we can also set a tooltip through the **Pop-Up** tab. Here you can create and customize a tooltip for either or both click and hover states. After picking a base style, you can select, rename and reorder various fields, each corresponding to a column in your dataset.

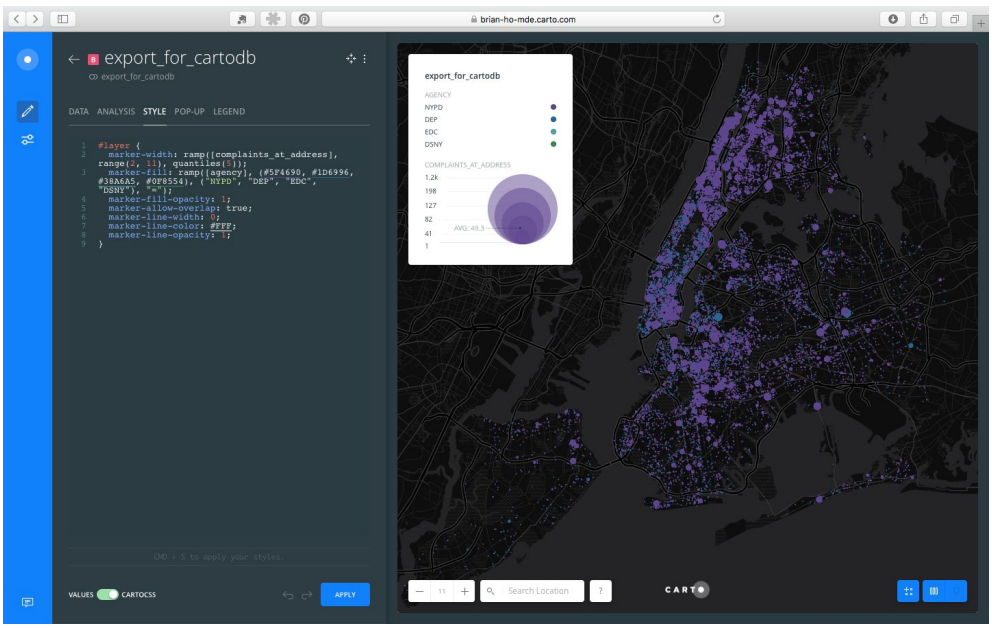


The **Legend** tab allows for customization of the legend entry for each layer. The **Data** tab contains summary info about each column in the dataset: the column name/header, datatype, percent null and some graphical plot if the column is quantitative. You can also opt to make some of these columns into selection widgets, which appear as an overlay.

With minimal effort, we've made a simple interactive web map of our 311 dataset!

5. Further customization

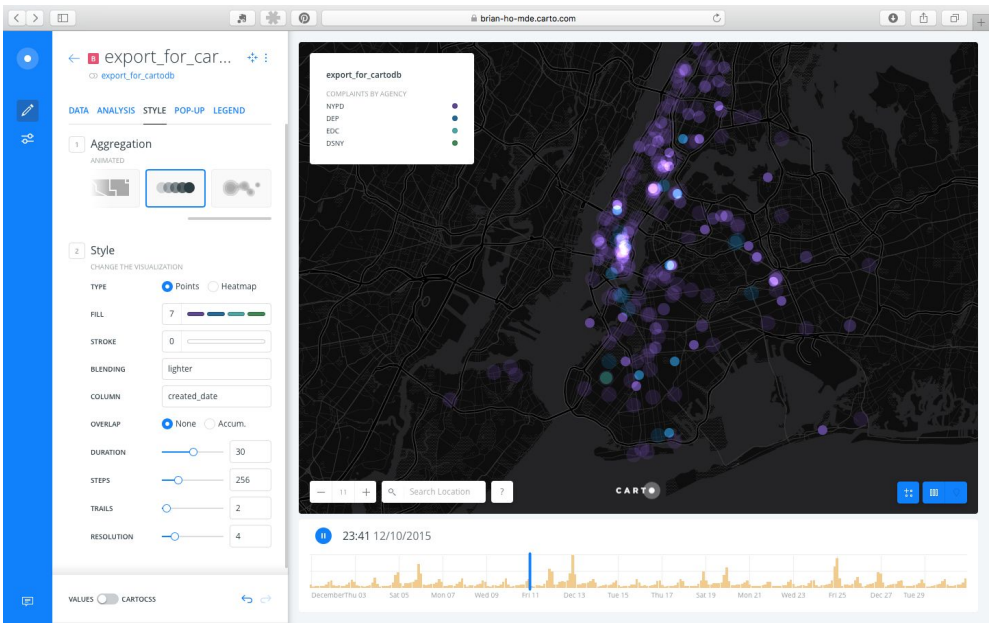
For those with some HTML/CSS experience, note that CARTO also includes a toggle within the layer pane to enable CartoCSS — a styling syntax language mostly analogous to normal CSS. If you'd prefer to have more control over visualization than what the GUI provides, go ahead and adjust the CartoCSS properties for the appropriate selector.



You can also click a toggle to edit or write custom HTML to define the tooltips and legend. You'll notice a similar toggle within the dataset view, which enables SQL queries to filter the dataset.

5. Animation

CARTO also has the advantage of making animated web mapping easy. Let's try to show our 311 complaints develop over time. Click into the layer pane, and then set the aggregation style to **Animated**. You'll see the data start to cycle..



As before, there are options to set fixed properties, or match properties to columns in the data. Of greatest importance, however, is the **Column** field. This indicates which column determines the animation order and frequency. Set the field to *created_date* to align the animation with the actual dates and times of the complaints.

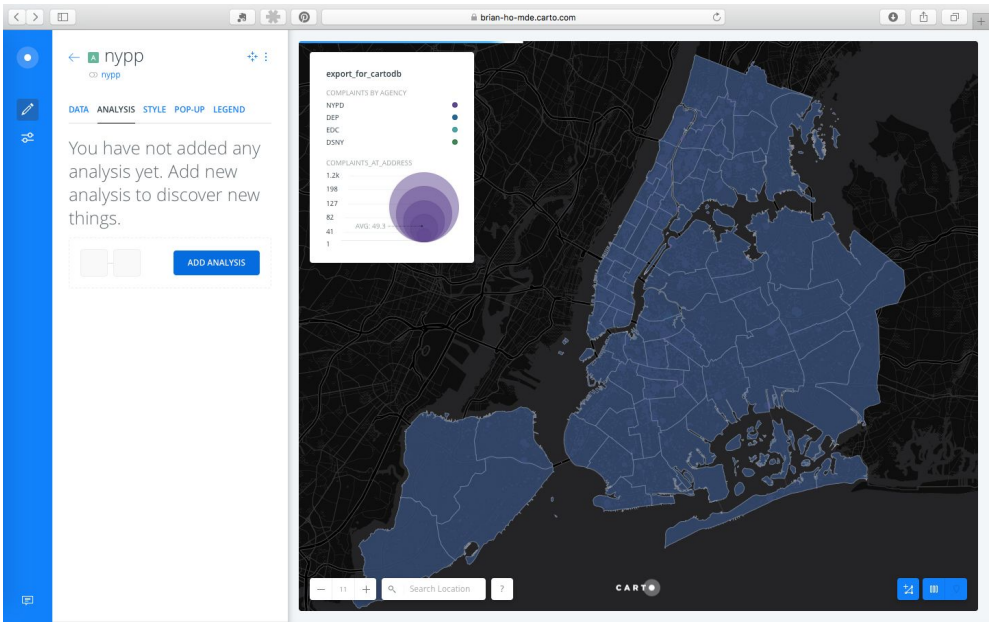
Staying in the layer pane, if you switch back to the **Data** tab you should be able to add the *created_date* column as a widget. This will give you an interactive timeline of all complaints in the dataset, with support for both controlling the animation and filtering by a selection of time. Note that this may appear automatically when you create the animation.

6. Analysis

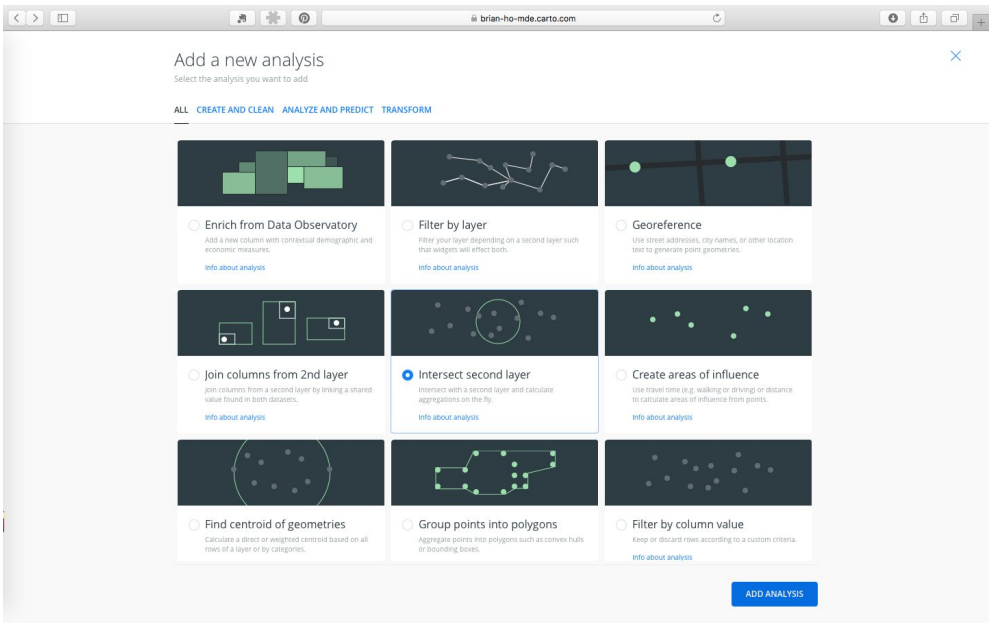
A new feature of CARTO's online product are the analysis modules. These are individual operations that can be performed on datasets in the map. Many of them will be reminiscent of the geoprocessing tools available in ArcMap: geocoding, spatial joins, intersections, lines from points, clustering.

Let's try out a spatial join — what CARTO calls a "second layer intersect."

First, let's import the *nypp_17a.zip* file, containing a shapefile of NYC police precincts. You can do this from within the map itself by clicking on **Add** in the left navigation drawer. From here, you'll want to select **Connect Dataset**, and then import the relevant files.

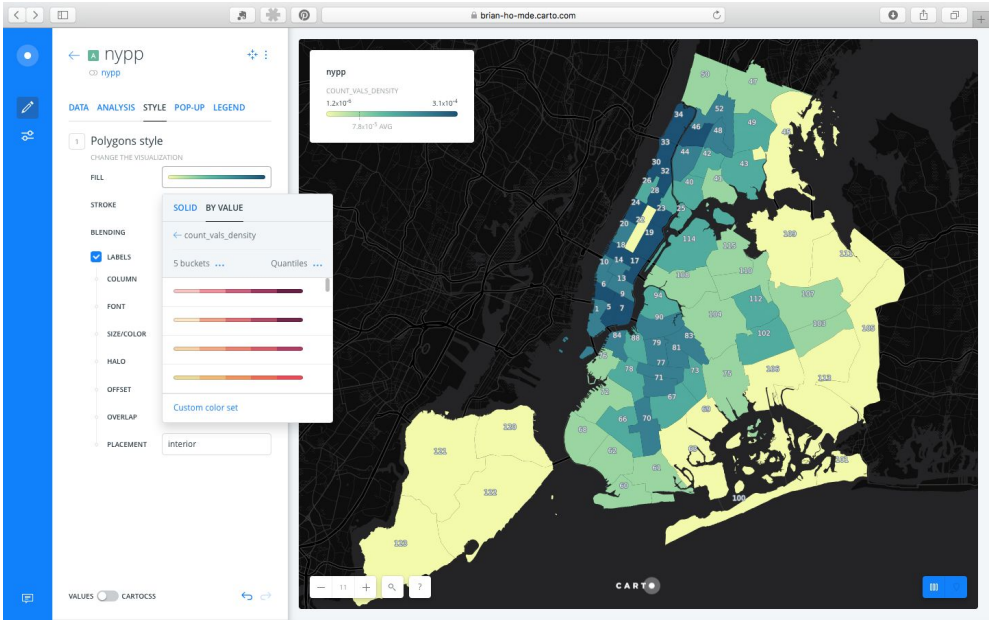


You'll see the polygons appear on your map. Click into the layer, and then on **Analysis** from within the layer pane. Click **Add analysis** and then on **Intersect second layer**, followed by **Add analysis**.



Back in the layer pane, you'll see an empty field for the **Intersect layer** — this is the layer you want to aggregate measures from. In our case, select the sample 311 dataset. You'll also need to specify an aggregation option. Select **Count**, then apply the analysis.

After a moment, CARTO will notify you that it's added new columns to the dataset as the output of the analysis. In this example, the *count_val* gives the number of original complaints in each police precinct, while the *count_vals_density* normalizes that measure. You can use either column to then style the layer, as before!



7. To the wider web!

After creating your first CARTO map, it's time to share it with a wider audience. Hitting the **Share** gives you an option for either a URL address or some HTML embed code. In either scenario, make sure to click **Publish** on your map, and if you make any changes remember to click **Update** to refresh externally accessibly content..

Implementing a full website is beyond the scope of this tutorial, but feel free to take advantage of site creation services like Wordpress, Wix or Squarespace. The embed code from CARTO can be place into the HTML of any of these site with the <iframe> tag — for example, in this quick Wordpress site (of course, your maps will be a bit more coherent!).