

Development document for:

Montréal Market Vendors ca 1880 web-map - Based on Lovell's City Directory 1880-81 database from Montréal, l'avenir du passé (MAP) project: http://www.mun.ca/mapm/eng/about_frame.html

Using: QGIS <https://www.qgis.org> and **Carto** <https://carto.com/>

Link to webmaps: The final maps are viewable at:

All Layers – Lovell City Directory 1880-81 base map

<https://canadian-hgis.carto.com/builder/70212344-415a-11e7-9fef-0e3ff518bd15/embed>

Final Map of Market Vendors – With Widgets

<https://canadian-hgis.carto.com/builder/a20b5b37-52ed-417b-b6fa-f73d618d6fcd/embed>

GOAL: To demonstrate one example of investigative study of a GIS database using publicly available online tools for GIS analysis and mapping.

Explanation: The "Montréal, l'avenir du passé" ("MAP") project has published a number of databases based on original source documents for Montréal in the 19th century. An exercise for studying the nature of public markets in Montréal based on vendors as identified in the Lovell's City Directory 1880-81 was developed by Prof. Robert Sweeny of Memorial University to be done by students using GIS software (QGIS). The goal was to demonstrate how this project could be done using online tools, so that only data and browser access would be needed for students.

REQUIREMENTS: The "MAP" website allows the downloading of the Lovell's 1880-81 database in spreadsheet form. The GIS base map data associated with the Lovell's data is also available from the project, including buildings and lots identified by land use, and points representing individuals or firms identified by address. The requirements for this exercise were to identify the individuals working in the markets and link their work locations to their home addresses, then to map these links using lines to connect the points. Once this was accomplished, students were to use the mapping interface to explore the differences between markets in terms of the people working in them, their occupations, and their assumed journeys to work.

SEE APPENDIX 1: The context and steps involved for the Market Vendors study as envisaged was outlined by Prof. Sweeny in the document "Scenario for markets based on MAP's 1880 Lovells QGIS application" (Appendix 1 at the end of this document.)

Credits: Montréal, l'avenir du passé project, Robert Sweeny, Sherry Olson, Canadian Historical GIS Partnership Development project, GIS and Cartography Office Dept of Geography University of Toronto
Programming assistance: Jonathan Critchley <http://jonathancritchley.ca/> (Carto)

Approach: Unlike our other pilot projects, which focus on functionality of software for map design and presentation, this project is primarily about enabling the user to analyse and explore data interactively. Therefore rather than a breakdown of the code required to produce a final web-map, **this documentation will consist of the step by step process of using Carto's online tools to achieve the objectives of the exercise.** The decision was made to use latest tools from Carto <https://carto.com/>, including the new **Carto Builder** tools, as of date of production (mid-2017) as much as possible for completing this exercise.

Note: The **Carto online documentation is extensive and comprehensive**, therefore many details will be referenced to that documentation rather than explained in full here. See: <https://carto.com/docs/>

Functionality:

Mapping and GIS functionality: **Carto** (formerly CartoDB), is the online data-upload and basic webmap design interface. Carto requires users to sign up for an account, which is free within usage limits. <https://carto.com/pricing/> . It is worth noting that students can get access to a CARTO education account by signing via the GitHub Student Developer Pack: <https://education.github.com/pack> . They will access more space and the CARTO Engine features for two years free, which are not available with the standard free account. It appears that anyone with an education-tied email address is eligible.

Map Data: All data uploaded from shapefiles from MAP project to Carto datasets

Overlay Mapping data:

Lovell Directory points: lovellinmtl.shp - 34,650 features representing individuals or firms recorded in the Lovell's City Directory 1880-81 georeferenced by address. Attribute fields for points used herein:

ENTRY: Transcription of Entry in Directory: typically name of person or institution, firm (if applicable), description of occupation or business (if applicable)

LID: Lovell's Directory Entry Unique ID (person or firm)

LOVPTSID: Lovell's Directory Points Unique ID for Points - if more than one address is listed for a person (eg. work, home) the georeferenced points would have same LID, different LOVPTSID (Note: See below: "ISSUES WITH LOVPTSID FIELD AND REPLACEMENT WITH PTID")

ADDRESS: Street number and name, sometimes qualified as h or r (home, rear) or w (work)

ADDRESS2 (also 3 and 4): Supplemental addresses if applicable

FIRMORINST: Values coded as Person: 0; Firm or institution: 1

Lots: g80_lots.shp Lot polygons. The lots will be used to identify where markets were located.

Institutions: g80_inst.shp Contains building footprint polygons for various institutions in Montreal. The layer is used to identify the location of markets.

Background Mapping data: Shapefiles for Wards, Streets, Railways, Wharves, Beaches, River, Canal, Park

Base map: Customized Mapbox basemap. See APPENDIX 3: Adding customized basemap via Mapbox

Tabular data:

Lovell's City Directory Database 1880-81 (detailed): LOVELL80.DBF (DBase file)

Includes detailed parsing and codification of City Directory entries into multiple fields to facilitate analysis. Fields break down name into components, identify females, widows, building and locational information such as front or rear addresses, etc. Only field used in this analysis was OCCUPATION.

Notes re: Montréal, l'avenir du passé "MAP" project data

These data are available publicly through the Montréal, l'avenir du passé project website, through the Applications tab, at: http://www.mun.ca/mapm/app/app_frame.html . Download the **Goad 1880**

Windows application data. The detailed Lovell's City Directory 1880-81 data is available on the Database tab, at: http://www.mun.ca/mapm/data/data_frame.html

OVERVIEW OF WORKFLOW IN CARTO

Up until 2016 Carto used a module called **Carto Editor** and a styling library called **CartoCSS** for data management, map composition, editing and design. Although still using some of the basic building blocks of the previous versions, the most recent version of Carto features a new module called **Carto Builder** which encompasses all previous functionality. **Carto Builder** is "...a web-based drag and drop location intelligence tool for analysts and business users to discover and predict key insights from location data." Much more of Carto is menu-driven than previously, but users can still access command line or coding methods for accessing the nuts and bolts of analysis and design. For example, symbolization or "styling" of features can either be done via a graphic UI driven by menus and sliders, or in a text panel reading and writing CartoCSS. For examples see Figures 1a and 1b below on next page.

Figure 1a: Styling Lovell's point features layer using GUI Panel interface View

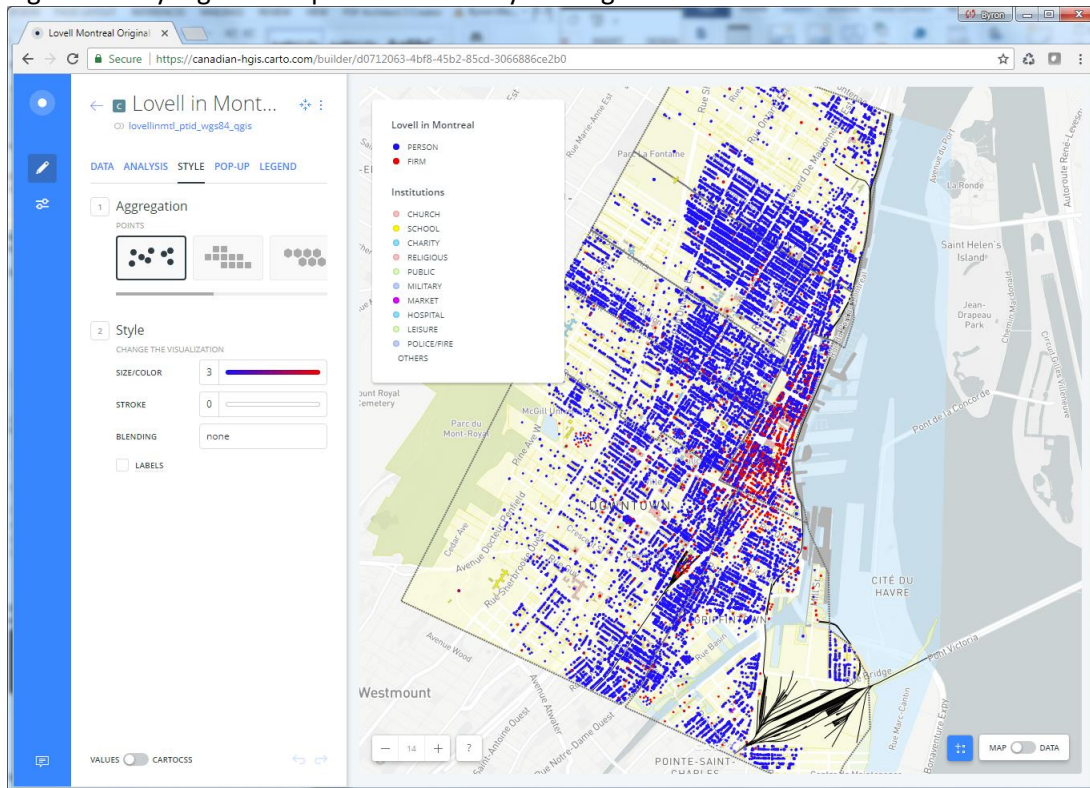
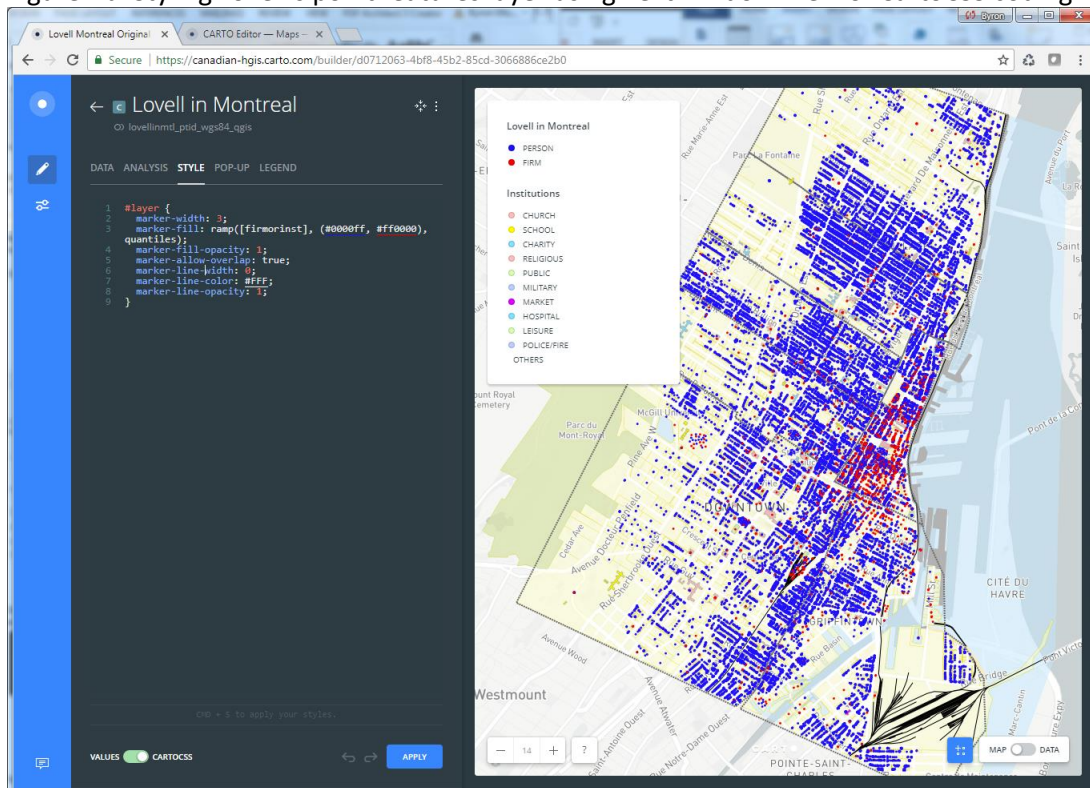


Figure 1b: Styling Lovell's point features layer using Text window View of CartoCSS coding



A useful quick reference guide is available at: <https://carto.com/learn/guides>. Helpful is "Getting started with Carto Builder" <https://carto.com/learn/guides/intro/getting-started-with-carto-builder>. To quote:

Builder contains many features that guide you through the process of creating a map and selecting how your data appears. Use the following task list as guide for some of the main CARTO Builder features:

- Change the [basemap](#).
- Add [map layers](#).
- Apply [custom styling](#) with the STYLE tab.
- Apply an [analysis workflow](#) to a selected map layer, in order to gain more insights about your data.
- Enable [pop-up information windows](#) to display when a viewer clicks, or hovers their mouse over, select data on your map.
- Enable map [legends](#) to display symbols and text that describe your map data.
- Add embedded widgets to your Map View and interact with your map on the fly, without modifying your actual data. For details, see [Exploring Data with Widgets](#).
- Control the visible features that appear on your published map with the [Map Options](#) (located from the Builder toolbar).
- Once you visualize and publish a map, you can get a link to share the map or embed it to a website or blog. For details, see [Publishing and Sharing Maps](#).

PRODUCTION NOTES

OVERLAY MAPPING DATA

Visualization of QGIS map layers

The MAP project data is downloaded as shape files, along with QGIS project documents which reference them. The Lovells data is visualized in the project document: Lovells 1880 directory.qgs. Opening in QGIS and examining at this project document is a good way to understand the various layers in the database and the attribute data attached to them. As a first step in the project it was decided to duplicate this QGIS map using Carto, to validate the uploading and visualization of data layers.

Projection of map data

The projection of the shape files provided by the MAP project is not identified within the shapefile (i.e. no .prj file is provided) however the QGIS document uses the Coordinate Reference system EPSG:2950, NAD83(CSRS) / MTM Zone 8 (a modified Transverse Mercator projection used commonly in Quebec. The coordinate data for the files are consistent with this projection as well. It was decided to re-project all shapefiles to the Web Mercator Auxiliary Sphere projection (EPSG:3857) to simplify upload. These layers were reprojected and given a suffix of "wmas" for ease of identification: eg: G80_lots_wmas.shp
See: <https://carto.com/learn/guides/intro/preparing-and-formatting-data>

Uploading of layers into Carto: Shapefiles, which comprise multiple component files, must be compressed to ".zip" files and uploaded to Carto as "Datasets". Carto uses PostgreSQL (PostGIS) as its back-end database. See: <https://carto.com/docs/carto-editor/datasets/>

ISSUES WITH LOVPTSID FIELD AND REPLACEMENT WITH PTID

The shapefile of all Lovell's Directory points used the field LOVPTSID as the unique ID field for each point location. However during our file processing we introduced some negative values for LOVPTSID which posed problems for the analysis in Carto. Therefore a new integer field was created named PTID and assigned the value of FID+1 to ensure positive unique IDs. This field is used in the exercise below.

ISSUES IMPORTING POINT LAYER INTO CARTO

The Lovell Directory points shapefile (34,650 features) that has been re-projected (using ArcGIS) to Web Mercator Auxiliary Sphere would not import to Carto normally. It attempted import for 24 hours and then timed out.

After consultation online with Carto Help personnel, there were a few steps that were taken to ensure that the file would import without issues:

- Reprojected to GCS_WGS_1984 (EPSG:4326) (Carto's default projection - see reference above)
- Re-exported the shapefile using QGIS
- Limited shapefile extent to the layer extent (QGIS Export Option) otherwise encountered issues later generating lines from points.

BASE MAP

Reference Base Map: Mapbox "Light" base map, was selected as the most useful option to provide a neutral base map as a geographic reference background for colour-based thematic mapping.

CREATING THE MAP TO SIMULATE QGIS PROJECT MAP LAYERS

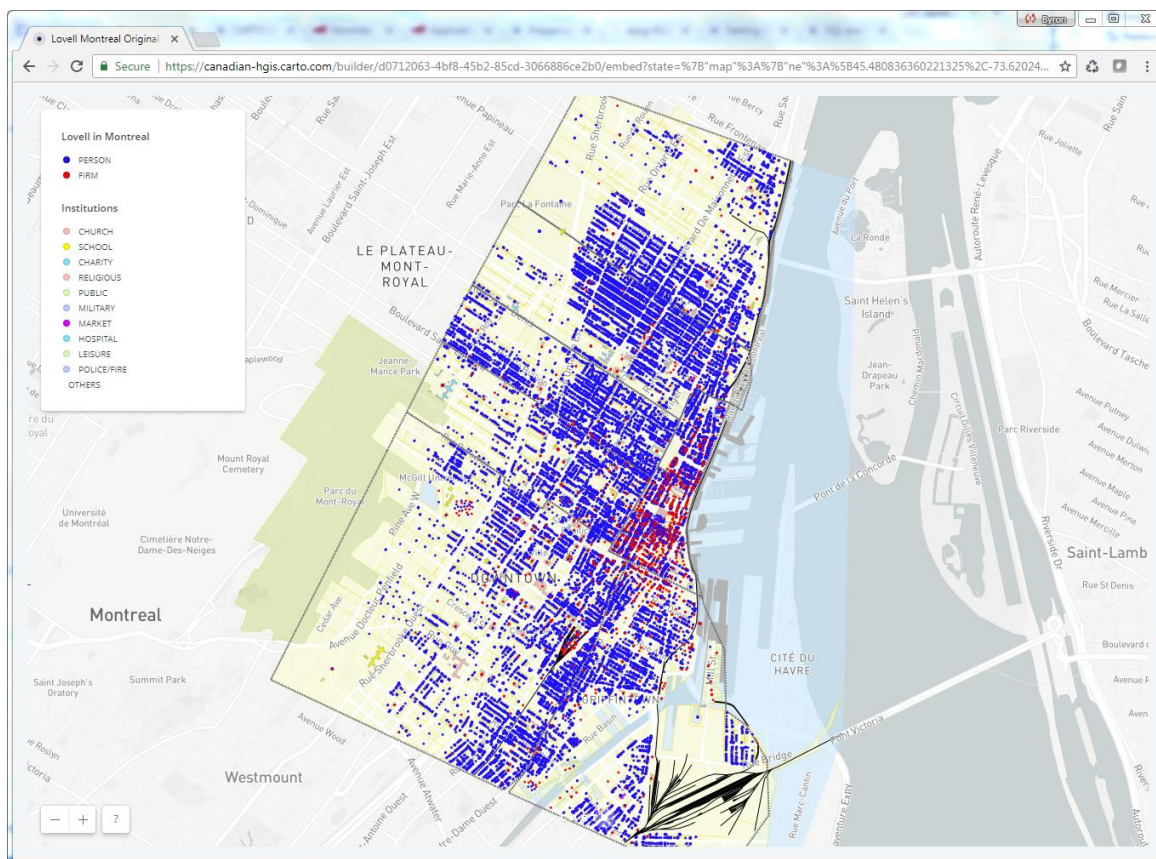
Once layers have been uploaded as datasets, proceed to the Maps section of the Carto Builder interface. Here create a new map. For description of symbolization tools see:

<https://carto.com/docs/carto-editor/maps>

<https://carto.com/learn/guides/intro/understanding-map-layers-in-builder>

To view the product of this process see resulting map of **All Layers – Mapbox Basemap** at:

<https://canadian-hgis.carto.com/builder/d0712063-4bf8-45b2-85cd-3066886ce2b0/embed>



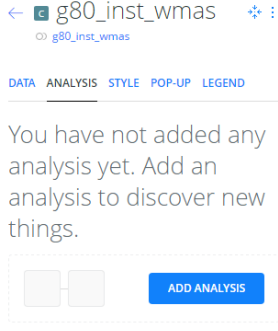
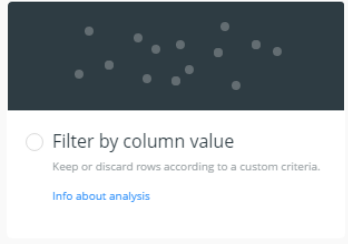
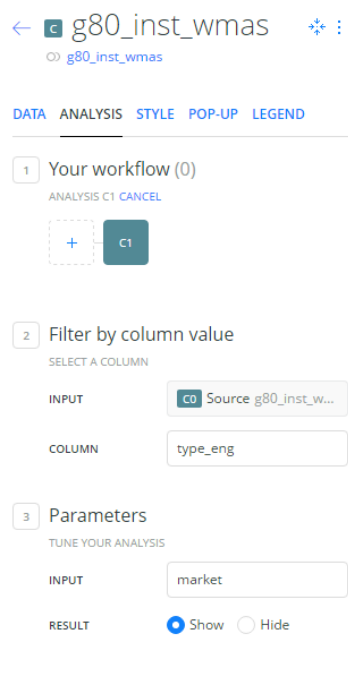
STEP-BY-STEP MARKET VENDOR ANALYSIS EXERCISE USING CARTO BUILDER

(Refer to Appendix 1 for Sweeny's Scenario for Markets Analysis)

1. **Create a New map**, using the datasets that have been created for Streets, Wards, Institutions, Lots and Lovell's City directory points, to use for the market vendor analysis.

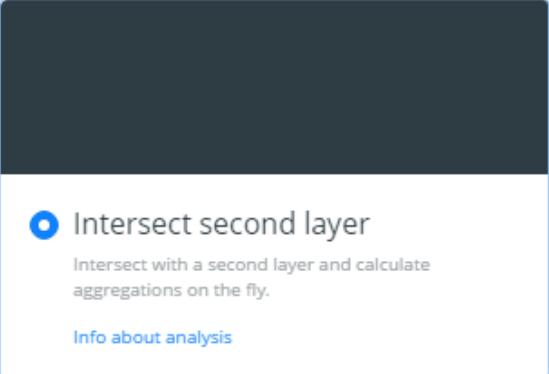
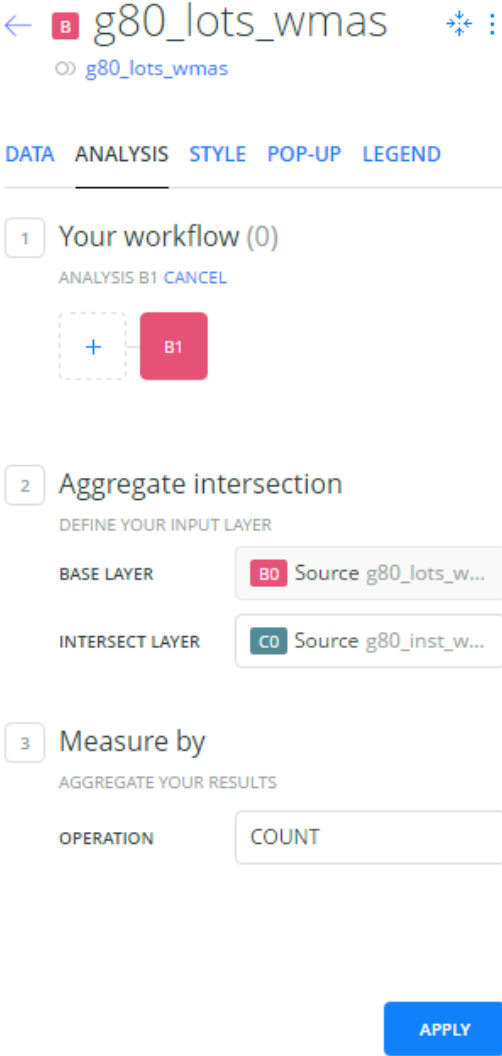
2. Selecting Market polygons from Institutions to create Markets Layer

From the Institutions layer we want to select only the Markets. As stated above, selection of features can be done one of two ways: applying a Filter via an interactive menu using the Carto Analysis tools; or using an SQL statement in a command line panel. As much as possible we will limit this documentation to illustrating the GUI menu based tools.

	<p>Click on the Institutions layer name once it has been brought into the map, to edit that layer. Then click on the Analysis tab.</p> <p>In Carto Builder, an "Analysis" is a processing operation such as filtering or intersecting, which effectively changes the view of your data set, without changing the original data. See: https://carto.com/learn/guides/analysis/analysis-tips-and-behavior/</p>
	<p>Click ADD ANALYSIS button. From the options available we want to select Filter by column Value Analysis and then the ADD ANALYSIS button.</p>
	<p>The layer has an attribute 'type_eng' that provides a "type" for each institution feature.</p> <p>Filter column 'type_eng', using Parameter input 'market'. Select the Result 'Show' as this will query the layer and only show the features in the layer that have attribute 'type_eng' = 'market'.</p> <p>Applying this analysis modifies your data layer so that only the selected features are considered included in the map layer.</p> <p>[Note: An alternative way to accomplish this is to, switch from the ANALYSIS tab to the DATA tab. At the bottom there is a switch that is set to VALUES by default, click on it to switch to SQL. Type in the SQL statement SELECT * FROM g80_inst_wmas WHERE type_eng LIKE 'market' Click on APPLY. This will select all the markets.]</p>

3. Select lots/properties that intersect with institutions/market features

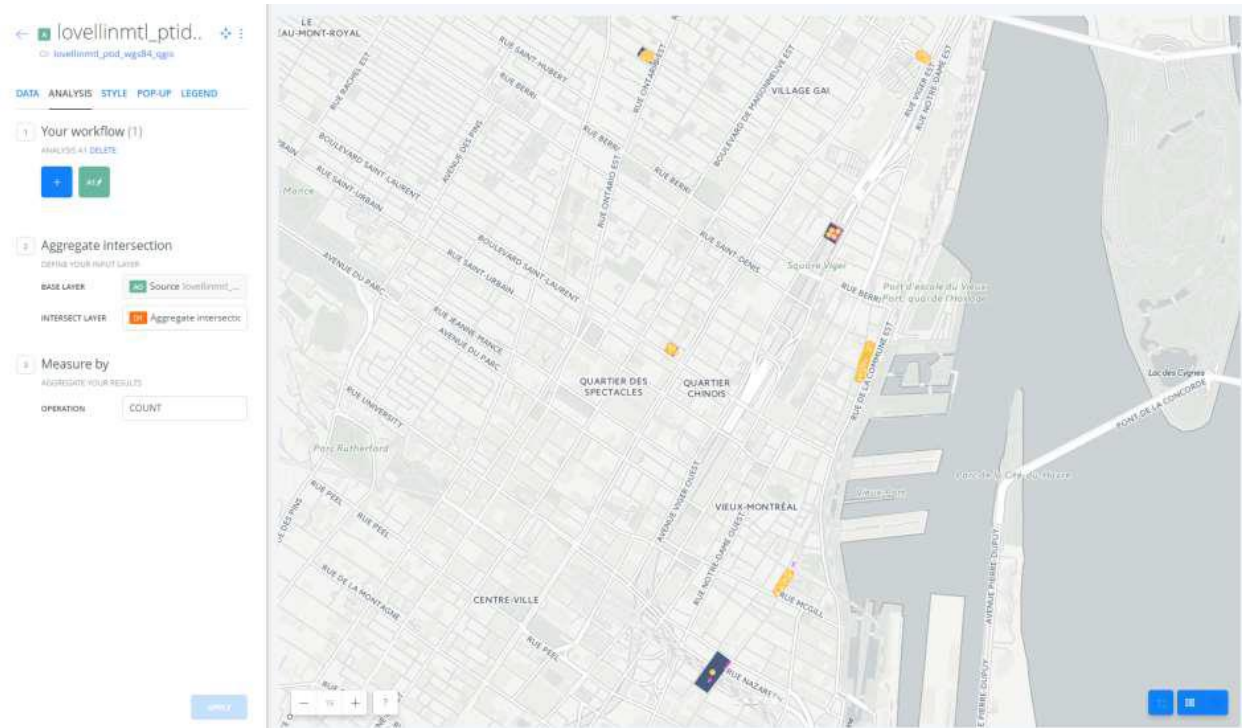
As explained in Appendix 1, we need to identify the lots that contain market buildings, so that we can use them to select people or businesses working in the markets. You can use the filtered institutions/market layer to identify the lots with which these selected features intersect.

	<p>Select the Lots layer, click to ADD ANALYSIS and select the Intersect second layer analysis, then click the ADD ANALYSIS button</p>
	<p>In the panel that results, the Lots layer is included as the BASE LAYER. Select the Institutions layer that was filtered to identify Markets as the INTERSECT LAYER under Aggregate intersection. Leave the Measure by OPERATION as the default COUNT. (If you select 'COUNT' all columns are selected.) When you hit apply you will see the map update and only the lots that intersect with the Market layer remain.</p>

4. Select market point locations - i.e. points that intersect with the market lots and export as new dataset

In the same way we filtered the lots layer using the Intersect Second layer Analysis, we can filter the points layer to identify Lovell Directory points that intersect with market lots.

Select the points layer, click to ADD ANALYSIS and select the Intersect second layer analysis. Select the filtered Lots layer as the INTERSECT LAYER under Aggregate intersection. Leave the Measure by OPERATION as the default COUNT. If you select 'COUNT' all columns are selected. When you hit apply you will see the map update and only the points that intersect with the Market layer remain.



A total of 489 market points are selected. If viewing the attribute table for selected features you have to hit the right button several times until you get to the last page/view.



We need to save this layer output of the analysis as a new dataset. This is because we have to do some editing on it. One cannot run SQL on or edit a layer if it is part of an analysis, it must be exported as an independent data set first. Select the point layer and click the button to the right hand side of the layer name to expose a layer options menu. Select Export data. Then select the preferred file format. This can be as a CSV file or a shape file, for example. We exported it as a CSV file, re-imported it as a new dataset, called lovellinmtl_ptid_wgs84_qgis_markets, which we renamed Market Points.

5. Clean up dataset of market points to isolate "work" locations by deleting points with duplicate LID values representing any "home" location

There are some points in the selected features resulting from the intersect analysis that have duplicate values for the LID attribute, i.e. represent the same individual. This would occur, for example, when a

person lives and works in the same building in a market, or works in one market and lives in a lot which contains another market. We only want to include in the "Work" dataset the points that acted as market work locations, not residential/home locations. This requires identifying points with duplicate LID values, then comparing the records to determine which one is which, and deleting the home location.

There are a variety of methods available to accomplish this process. For example, it can be done outside of Carto using Excel on the CSV file or QGIS on the shapefile. We did this within Carto using SQL statements and editing tools. We exported the Market points dataset as a CSV file, re-imported it as a new dataset and used SQL within Carto. In the Datasets View, click on the dataset name to view it as a table. Then switch the toggle at the bottom of the window to open an SQL command window.

lovellinmtl_ptid_wgs84_qgis_markets :
PUBLIC Updated 6 months ago

+ ADD ROW + ADD COLUMN EXPORT

lid	firmorinst	lovptsid	ptid	worhome	xtr_info	address	entry
458	0	458	442	work		Bonsecours market	Archambault Léon, con...
741	0	741	711	work		15 St Antoine market	Averon Mrs Mary
805	0	805	774	work		Bonsecours market	Baignet Mrs D. wid Oliv...
951	0	951	918	work		stall 4 St James market	Barbier Pierre, butcher
1001	0	1001	968	work		St Ann's market	Barnes Mrs Catherine ...
1171	0	1171	1135	work		stall 13 St Ann's market	Bauden John, butcher
1222	0	1222	1184	work		stand 32 Bonsecours ...	Bacinet Jean D., trader
1313	0	1313	1268	work		1 St Lawrence market	Beauchamo Mrs Julie w...
1318	0	1318	1272	work		stall 26 Bonsecours m...	Beauchamo Mrs Julie w...

1. SELECT * FROM lovellinmtl_ptid_wgs84_qgis_markets

SQL + 4 to apply your query. CTRL + Space to autocomplete

METADATA SQL PREVIEW APPLY CREATE MAP

Replace the SQL statement with the following:

```
SELECT lid, COUNT(*)
FROM lovellinmtl_wgs84_qgis_markets
GROUP BY lid
HAVING COUNT(*) > 1
```

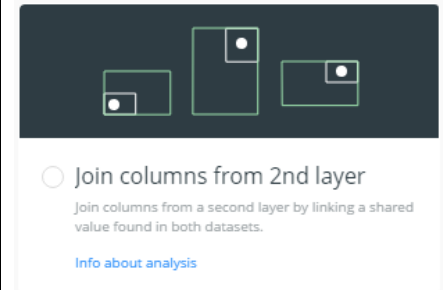
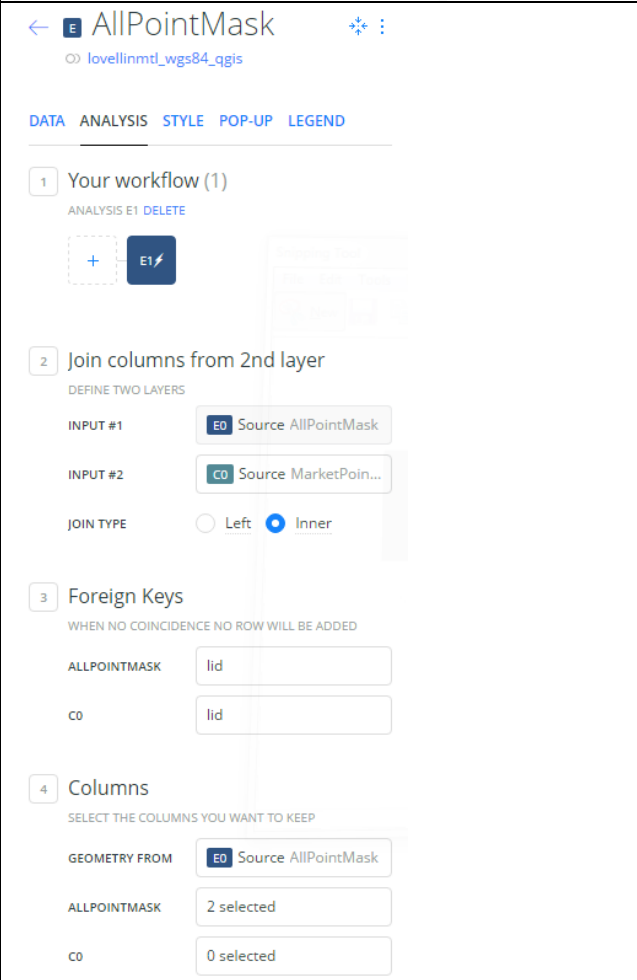
When you Apply the SQL statement it filters and groups all 9 LID values that are duplicates.

Using this information, the Market points layer needs to be reduced by 9 points, removing the duplicate locations that are not markets/work locations. One way to try help identify if a point is a market location or a home location is through the other attributes. If the Address attribute includes text like "stall" it suggests it is a market work location. Or "h" or "r" may be part of the Address, indicating "home" or "residence." Two features that have lid = 31081 have the following address values: 61 Centre; h 40 Montmorenci. The feature with the address = "h 40 Montmorenci" would be deleted.

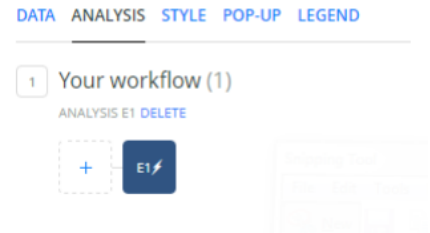
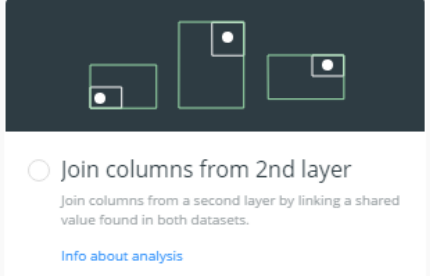
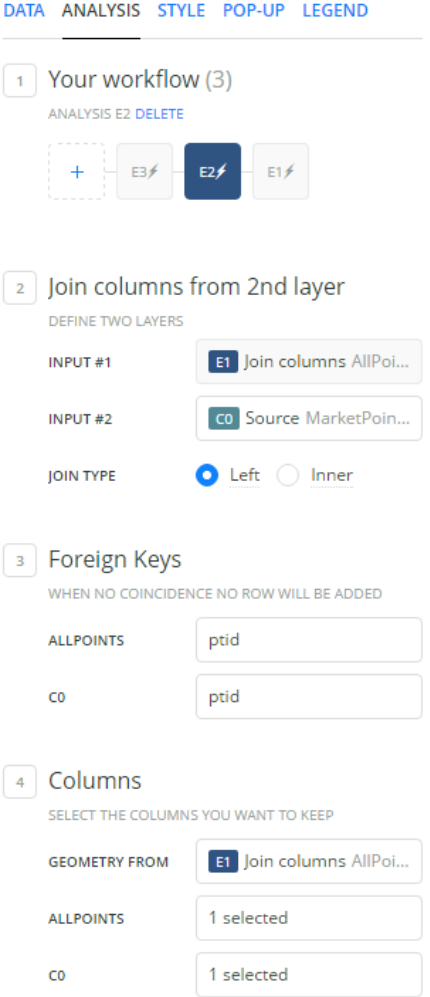
After the 9 duplicate points are deleted, the result is a dataset that contains the locations of the 480 work locations inside the market. We created a new text field in the table "WORKORHOME" and assigned all features in dataset the value "work". Save this as a new dataset, or if working outside of Carto, bring the edited table with only market locations back into Carto as a new dataset. We called it: lovellinmtl_ptid_wgs84_qgis_markets

6. Create a clean new dataset of all "work" and "home" locations

To identify and add the points that represent the homes of people that correspond to the work locations we have established, we want to find points with the same LID as those work locations. We will use the Analysis tool "Join Columns from 2nd layer" to link the original point layer that contains all features with the market work location layer that we just created, using LID as the common or join field.

	<p>INPUT #1 Dataset the analysis will be applied to is the layer containing all the Lovell points Lovellinmtl_ptid_wgs84_qgis.</p>
	<p>INPUT #2 is the Market point layer: lovellinmtl_ptid_wgs84_qgis_markets Bring that layer into your map.</p> <p>JOIN TYPE is "Inner", which returns ONLY the results from INPUT #1 that INTERSECT with INPUT #2</p> <p>The Foreign Keys (Join Field) are LID in both tables. We want to identify all point features that have a corresponding LID to the Market point features.</p> <p>Select the desired Columns (attributes) from each of the layers that you want to appear in the result layer. Make sure to select PTID, the Unique Identifier for all points in the full dataset, and WORKORHOME to identify those which are work locations.</p> <p>End result is a layer with 892 points, a subset of all points containing those that have an LID matching the market work points. This includes all Market work and home points.</p>

The next step is to assign the value of the WORKORHOME field to these 892 points. We did this by joining it to the Market Work points layer we previously created, to assign those with value "work." By default, the remaining null values will be "home" locations.

	<p>Add a second Analysis on the 892 point dataset which is the result of the first Analysis by clicking on the ANALYSIS tab and then clicking the + button next to the icon for the first analysis</p>
	<p>We again use the "Join columns from 2nd layer" analysis. INPUT #1 is the result of the previous Join Analysis, the 892 points layer. We want to join it again to the market work points layer, to identify which points were categorized as "work" in the WORKORHOME field.</p>
	<p>The join is on the PTID field unique identifier for points. This time we use a JOIN TYPE "Left", which returns all rows from the INPUT #1 table where there are matches between the two layer PTIDs. When there is a match the WORKORHOME value is assigned as "work", where there are no matches then the field is left "NULL".</p> <p>Columns option select WORKORHOME attribute from the Market layer.</p> <p>The end result is a 892 point file with 480 points identified as "work" in the WORKORHOME field.</p>

7. Create a clean new dataset of all "home" locations

Select the 892 points layer, and click Export data. Chose the desired Data format. In this case we exported as a CSV file. In the exported table:

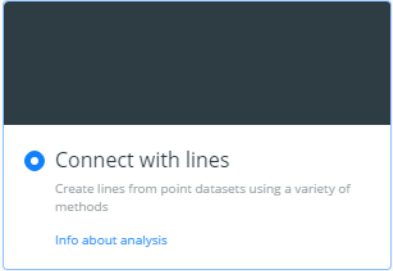
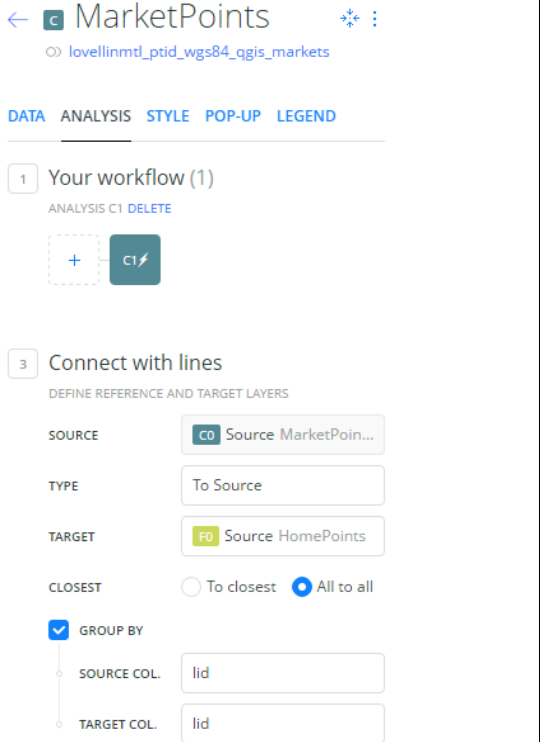
- Sorted on the WORKORHOME field
- Selected all 480 features with the value "work" and deleted them
- Updated the remaining empty fields with the value "home"
- Column name was exported as "right_workorhome", so renamed it to "WORKORHOME" for consistency

This results in a new layer that contains the 412 market home locations.

Upload the new 412 home locations point file to Carto and bring it into the map with the 480 Market work location points.

8. Create lines between corresponding market "home" and "work" locations

We use the "Connect with Lines" Analysis to create lines between corresponding points.

	<p>With the Market points selected go to the ANALYSIS tab and click ADD ANALYSIS, then "Connect with lines" analysis.</p>
	<p>The TYPE used is "To Source". Connect two point columns, in two different tables, based on an optional matching condition, and apply it to both the target and the source tables.</p> <p>The TARGET is the 480 Home points layer.</p> <p>CLOSESTS option is set to All to all as there are multiple Home points to join lines from the Market points.</p> <p>Enabling GROUP BY allows the selection of a common attribute matching condition, in this case we want to use LID values to draw lines between Market points with the same LID values as Home points.</p>

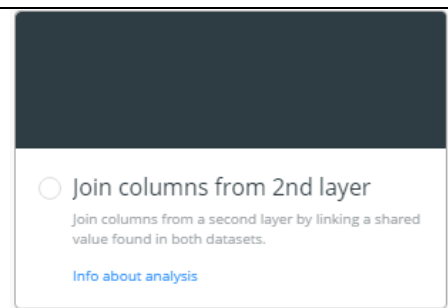
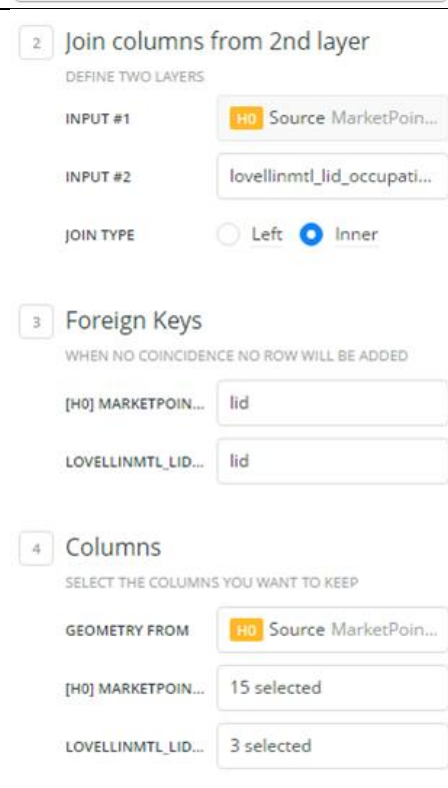
The analysis does remove the points from the map from which you are generating the lines, so the result of this analysis is to create lines between Home and Work Points but remove the Work points. You can simply re-add the market points the the map and style them so they overlay on top of the line layer.

The line layer can be exported as a shapefile and will appear as independent line features. This is not necessary for our purposes as the Analysis result can be used in Carto for drawing and styling lines.

9. Joining Occupation data to points and lines

See below "Appendix 2: Occupational classification" for method of assigning 10 occupational classes. These classes were assigned to the Market work points shapefile of 480 points. For our purposes we need a table that contains unique LIDs and associated occupation. We exported the shapefile attribute table as a .CSV file and called it lovellinmtl_lid_occupations.csv.

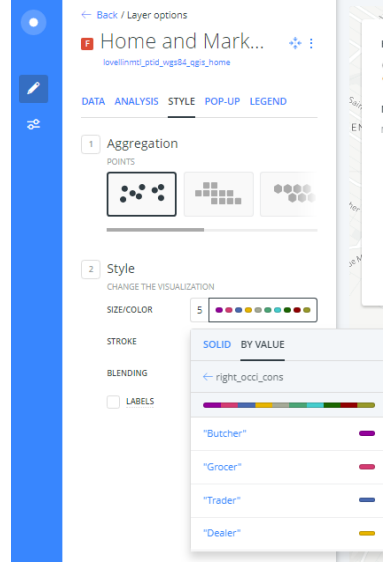
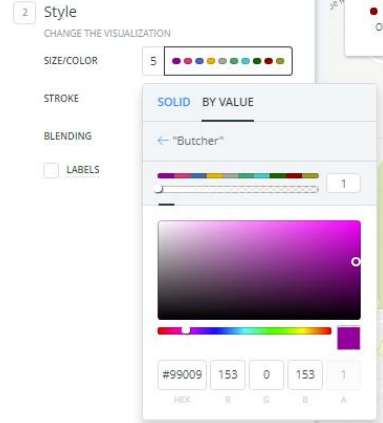
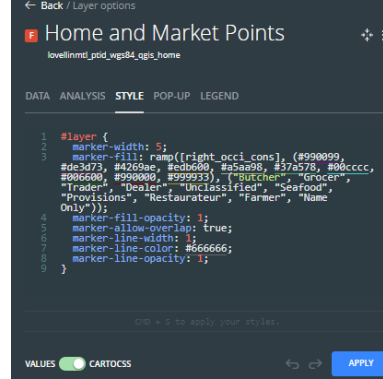
Import the CSV file with unique LID values and associated occupations to Carto. Once it is loaded as a data set, you do not have to add the table to the map in order to use it as part of a Join Analysis.

	<p>To join the Occupation field to the Market points ADD the market layer to a map, click on the ANALYSIS tab and ADD ANALYSIS BUTTON. The select Join columns from 2nd layer analysis.</p>
	<p>Click on the INPUT #2 input and scroll down the list until you find the table that was imported containing the occupation values you want to join. In this example the table is "lovellinmtl_lid_occupations"</p> <p>Leave JOIN TYPE as default "Inner" option.</p> <p>Foreign keys (Join Item) is 'LID' in both tables.</p> <p>Under "Columns" retain all the fields from the Market Points Source data. From the joined Target data file make sure to select the occupation class column OCCI_CONS.</p>

This Analysis results in the Market work points layer of 480 points with occupation classes assigned. Do the same analysis for the Market home points layer, and the Connect to Lines layer, so that all three layers have occupations coded by LID value.

10. Symbolize Market home points, work points and lines by Occupation Category

To symbolize the points and lines by Occupation category, edit each layer in turn, and use the Style interface to "Change the visualization."

	<p>For example, when editing the home points layer, click on the Style tab and then click on the set of color blocks specifying SIZE/COLOR. This will bring up a menu allowing you to specify that colour is to be assigned "BY VALUE". Select the Occupation Category field "right_occ_cons" as the values to use for symbolization.</p>
	<p>The Style interface will assign colours by default. To customize these as you wish, click on each colour in the colour bar, and then specify the colour you wish to use.</p> <p>You can make a record of the colours specified (by HEX code for example) and then replicate the process for each symbol layer.</p>
	<p>Unfortunately it does not seem to be possible to save a Style, i.e. a list of item values and corresponding symbols, using the graphic user interface. An alternative way this can be done is by specifying one layer interactively, and then toggling the editing view from VALUES to CARTOCSS at the bottom of the editing panel. You can then copy-paste the CartoCSS text into each of the other layers' style specification.</p>

11. Use Carto Widget "Category" to allow data exploration

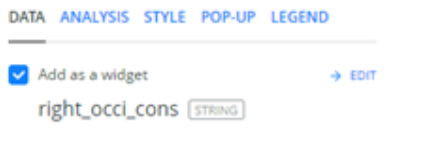

Widgets in Carto are User Interface tools which are added in a panel on the right hand side of the map to allow the viewer to visualize and explore data displayed on the map. See:

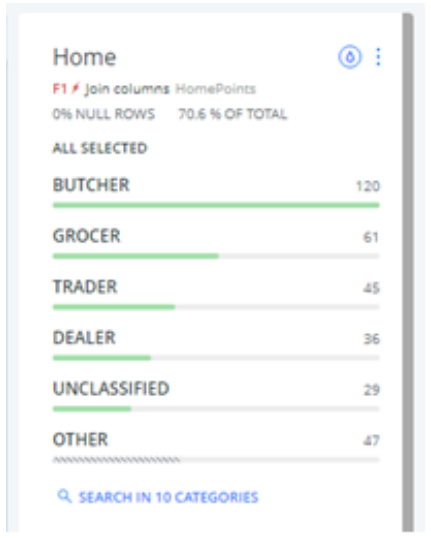
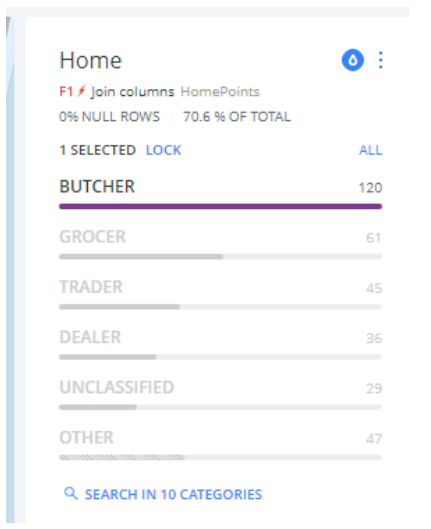
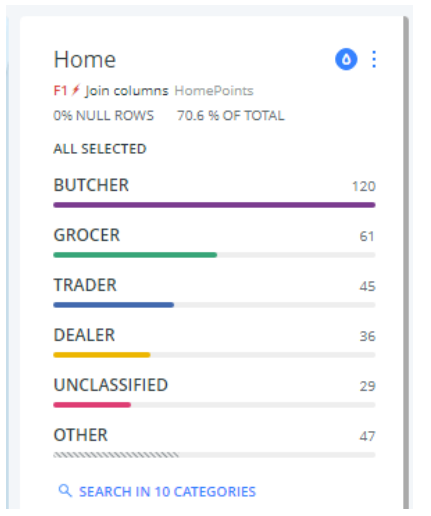
<https://carto.com/learn/guides/widgets/exploring-widgets>

<https://carto.com/learn/guides/widgets/viewing-analysis-results-with-widgets>

There are widgets of different types. (Category, Histogram, Formula, Time-Series.) The "Category" widget can create layer toggles allowing the user to filter data by a field's nominal attribute values "categories" and turn categorical data within layers on and off. The user can also use them to assign a default "auto-style" to a layer based on attribute values.

There are two ways to add a widget. On the top of the map panel, you can click on the Widgets tab and be led through the process. Alternatively, you can select a map Layer, click on the DATA Tab and then click the checkbox next to the attribute you want to use in the widget. In this example we are adding the same Category-type widget to each of our layers (HomePoints, WorkPoints, Connected lines) using the OCCI_CONS occupation field (occupation categories.) When you have clicked on a layer name in the left layer panel and gone to the DATA tab you will see the option to add widgets, and options to edit them based on fields and their contents in your dataset.

	<p>So for example, we select our HomePoints layer data tab and Add as a widget the joined Occupation field we added through the Join Columns analysis "right_occ_cons".</p>
	<p>Type will be "Category", Aggregate by "right_occ_cons", Operation will be set at "Count." The contents of the widget (such as the number of features of each category shown on the map) auto-update based on what is in the map view.</p>

 <p>Home</p> <p>F1 Join columns: HomePoints</p> <p>0% NULL ROWS 70.6 % OF TOTAL</p> <p>ALL SELECTED</p> <table border="1"> <tbody> <tr><td>BUTCHER</td><td>120</td></tr> <tr><td>GROCER</td><td>61</td></tr> <tr><td>TRADER</td><td>45</td></tr> <tr><td>DEALER</td><td>36</td></tr> <tr><td>UNCLASSIFIED</td><td>29</td></tr> <tr><td>OTHER</td><td>47</td></tr> </tbody> </table> <p>SEARCH IN 10 CATEGORIES</p>	BUTCHER	120	GROCER	61	TRADER	45	DEALER	36	UNCLASSIFIED	29	OTHER	47	<p>The STRING widget for right_occurrences will list all of the occupation categories in the widget, and the widget will appear in the panel to the right of the map. If you have not assigned custom colours the widget will use uniform colours by default for each occupation category (green here.) If you have assigned custom colours on the map (as we have) this will not override that style.</p>
BUTCHER	120												
GROCER	61												
TRADER	45												
DEALER	36												
UNCLASSIFIED	29												
OTHER	47												
 <p>Home</p> <p>F1 Join columns: HomePoints</p> <p>0% NULL ROWS 70.6 % OF TOTAL</p> <p>1 SELECTED LOCK ALL</p> <table border="1"> <tbody> <tr><td>BUTCHER</td><td>120</td></tr> <tr><td>GROCER</td><td>61</td></tr> <tr><td>TRADER</td><td>45</td></tr> <tr><td>DEALER</td><td>36</td></tr> <tr><td>UNCLASSIFIED</td><td>29</td></tr> <tr><td>OTHER</td><td>47</td></tr> </tbody> </table> <p>SEARCH IN 10 CATEGORIES</p>	BUTCHER	120	GROCER	61	TRADER	45	DEALER	36	UNCLASSIFIED	29	OTHER	47	<p>The viewer can click on an attribute value, in this example “BUTCHER” to only display points (or lines) that are associated with the occupation Butcher in the map. This can be done on all three layers (Home, Markets, Lines) to view the data related to butchers on the map, in isolation.</p> <p>See figure below on next page that illustrates this.</p>
BUTCHER	120												
GROCER	61												
TRADER	45												
DEALER	36												
UNCLASSIFIED	29												
OTHER	47												
 <p>Home</p> <p>F1 Join columns: HomePoints</p> <p>0% NULL ROWS 70.6 % OF TOTAL</p> <p>ALL SELECTED</p> <table border="1"> <tbody> <tr><td>BUTCHER</td><td>120</td></tr> <tr><td>GROCER</td><td>61</td></tr> <tr><td>TRADER</td><td>45</td></tr> <tr><td>DEALER</td><td>36</td></tr> <tr><td>UNCLASSIFIED</td><td>29</td></tr> <tr><td>OTHER</td><td>47</td></tr> </tbody> </table> <p>SEARCH IN 10 CATEGORIES</p>	BUTCHER	120	GROCER	61	TRADER	45	DEALER	36	UNCLASSIFIED	29	OTHER	47	<p>You the designer, or you the viewer, can click on the small teardrop button in the top right to auto style a layer, which will apply a colour coding by aggregated values. This can be very useful for basic data exploration, but does not carry over from one layer to another, so different colours may be assigned to the same occupation on different layers (home, work, lines.) Since we have assigned custom standardized occupation colours we do not want overridden, we would not recommend this to viewers in our current use-case.</p>
BUTCHER	120												
GROCER	61												
TRADER	45												
DEALER	36												
UNCLASSIFIED	29												
OTHER	47												

The widget names can be set under the WIDGETS tab.

LAYERS (8/8)WIDGETS

ADD

Lines

G2MarketPointOccupation

Markets

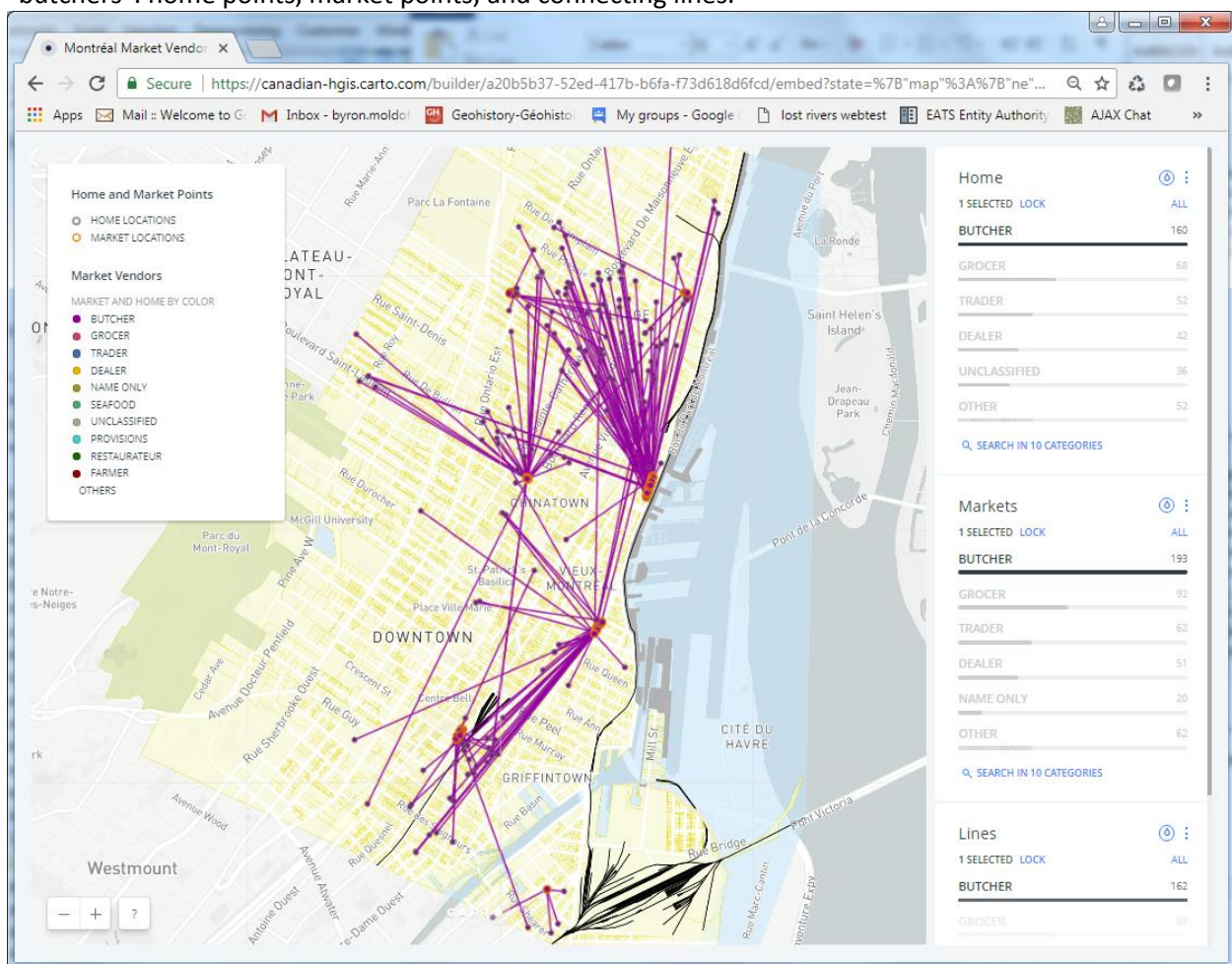
H1MarketPoints

Home

F1HomePoints

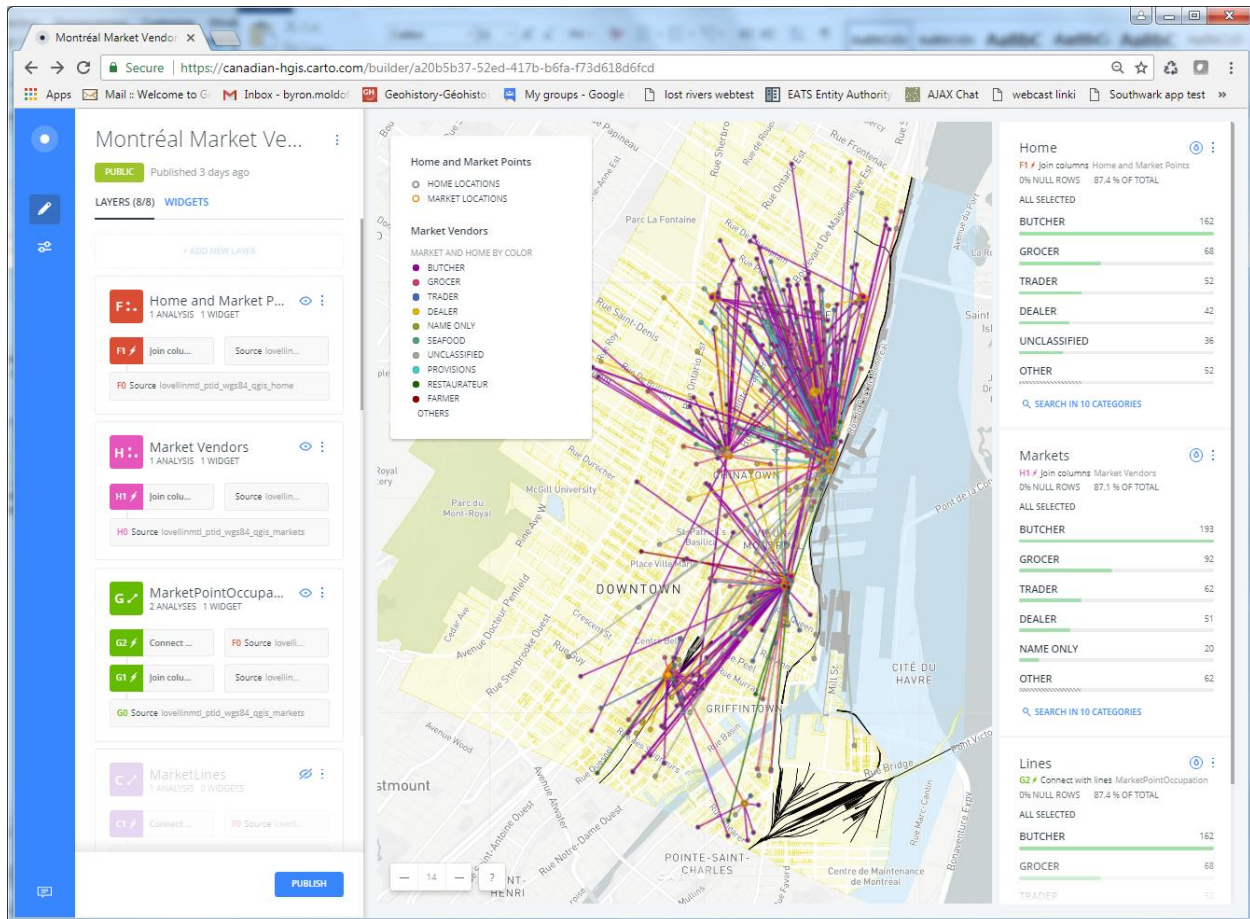
The list will contain all of the widgets you have added. You can click on the name of the widget to open widget options. The text at the top of the screen will be the text that appears above a widget. You can double click on it and change it in the same way you change a layer name. Hit enter to submit the change.

Viewer's browser view with widgets selected to show data isolated for vendors of occupation category "butchers": home points, market points, and connecting lines.



12. Publish map to make it public and share it online

We have now completed the map which can be used to explore the work and home locations of market vendors and the relationship between these, by occupation. The editing view in Carto Builder looks like the image below. For users it will appear the same, but without the left hand editing panel. Users or students can turn off and on symbols and colour coding at will, using the widgets on the right. We should edit the Map metadata to include an appropriate name, public description and tags as well.



Clicking PUBLISH will give you access to a link URL to send to users, or an embedded URL to include in a blog or website. For our Montréal Market Vendors ca 1880 web-map this link is:

<https://canadian-hgis.carto.com/builder/a20b5b37-52ed-417b-b6fa-f73d618d6fcd/embed>

APPENDIX 1

Scenario for markets based on MAP's 1880 Lovells QGIS application

Prof. Robert Sweeny, Memorial University of Newfoundland

As is still the case in many parts of the world, people in 19th century Montreal bought most of their food at markets. There were both neighbourhood markets and a large central market in the heart of the city. From west to east St Gabriel, St Antoine, St Anne, St Laurent, St James and Papineau wards each had their own market, while Marché Bonsecours on St Paul Street served as the main market. In addition there was a wholesale cattle market adjacent to the newly constructed Canadian Pacific railway line in the east end of the city centre, on Craig street, and a hay and horse market to the west, near the Grand Trunk Railway station on Chaboillez Square.

In the Lovell's city directory it was frequent for people who leased stalls in the retail markets to also list their home address. These addresses are an indication of how local the ward markets were. In this exercise we will be comparing this residential information with other variables to assess the character of these differing markets.

Understandably, markets were located near where people lived. The simplest way to see where they were is to select the institutions layer and query for the word market in the name field. The syntax of your query should look like this:

"Nom_name" ilike '%market%'

Using the operator ilike makes the query case insensitive, and by bracketing 'market' with %s searches for this word anywhere in the field. Please note the differing types of quotation marks used. QGIS uses doubles for fields, but singles for search items.

This will highlight 23 buildings. Use the information cursor to click on a highlighted building, and then zoom in to see the immediate area. Note how many entries from the Lovell's directory are located either on the building or its lot. Repeat this zooming in and out for each of the markets. All but the wholesale markets for cattle, horses and hay have numerous entries on their lot.

In constructing this HGIS, Lovell's entries were placed on lots, rather than in specific buildings, so although we correctly located each market by querying on its name this was not the best way to proceed. As you have just seen, for some markets the points representing people or businesses, while lying within the lot, were sometimes not positioned over the top of an actual building. Thus, if we used this method to select people working at the market we would miss quite a few.

The solution is to select the lots where institutions called markets were located. This is easy to do and the first step we have already accomplished – we have selected the buildings. Now we do a spatial query, available from the Vector tab's pull down menu. Select the lots layer and then the institutions layer, agreeing to restrict this selection to those lots containing all or part of one of the 23 buildings selected (use "intersect", not "contain"). Nine lots will be selected and the results of the query will appear in a window on the screen. Use the "zoom to item" feature to see each of lots in the list. You will note that the St Anne's market consists of two adjacent lots.

Now we repeat this procedure, but this time to select point entries which "people" these lots. A spatial query for entries within these nine lots identifies 490 separate points. To see who these people are, click on the database icon from the top menu and then click on move selection to the top (the icon with the little up arrow). Now we are ready to view our people working in these markets, but it would make sense to look at those working in the same market together, so click on title of the Map_link column and the entries will be re-ordered by lot number. MAP uses the same ward-based numbering system in all its 1880s applications, so we have now effectively spatially organized our people starting with the Bonsecours Market in the East ward. As you scroll down the highlighted table you will see differing markets appear, but you will not see most of the entries, so adjust the column widths, so that the address and entry fields are visible. Note how frequently a second address, and very occasionally a third, appears. Most of these are preceded by the letter h, which means this is their home address.

Each address given in the alphabetical listing of Lovell's within the city limits was given a point, so people with multiple addresses have multiple points. They have same id number (LID) but more than one point id (LOVPTSID). What we are going to do is create lines out of the points for each these multiple entries.

[... Here Sweeny included a section on how to generate lines from a set of points paired up by matching on a a common field in QGIS. Not necessary here as the methodology for our web-mapping sites is completely different.]

If you look at the entries for each of the markets, most are dominated by various types of butchers stalls. This is understandable as most meats are not seasonal in the way that fruit and vegetables are and these stalls were rented for the entire year. But also many of the people selling at these markets were farming families who sold their produce out of the back of their carts and they would not have had need to rent a stall.

Markets were not the only place to buy food. Green grocers were ubiquitous, with more than a thousand listed in Lovell's. Many of the employees of the butchers owning the stalls in the markets gave butcher as their occupation and their residence, but not who they worked for, is provided by the Lovell's alphabetical listing. More than 340 fruit and vegetable dealers and 230 bakers are also listed. There is no sure way of knowing, save for the 65 milkmen, if the address given by most of these people active in the food industry was where they worked or not. In most cases, it was probably their home. If the address is on a major commercial street it is, however, probably a good indicator of their workplace, as few earned enough to pay the high rents these streets commanded.

APPENDIX 2: Occupational classification

OCCUPATION as described in the Lovell's City Directory file was transcribed verbatim, and so needed to be classified and coded for any systematic occupational analysis. Prof. Sherry Olson of the "MAP" project had developed an occupational coding scheme for the census database of the project, so it was decided to adapt that coding for Lovell's. Prof. Olson established 247 occupational classes using 3-letter codes from ACC for Accountant to WOO for Wood dealer. These were based on occupational descriptions in the City of Montréal Tax Rolls in the late 19th century. Part of her explanatory correspondence runs:

"Often ambiguous, as you know, are complex titles like 'hardware dealer' or 'hardware merchant' -- for assignment to merchant, dealer, or trader, On the whole, in Montreal, the merchants are the big fish and the traders are the small fry, dealers are a mixed bag. We devised our coding system from the taxroll data, but Lovell's is more specific than the taxroll about such commercial occupations."

Time constraints made it necessary to limit the coding for our pilot project to the selected records required for the Market Vendors analysis, rather than to code all records. Therefore it was only done after the "Select points that intersect with Market Lots" step explained above, so that we had 480 occupations to code. This was done by a preliminary analysis of the Lovell's City Directory OCCUPATION field for the selected records, and then assembling a set of search terms to look for in that field, for example "butcher" and "meat" were used to assign the occupation of "BUTCHER".

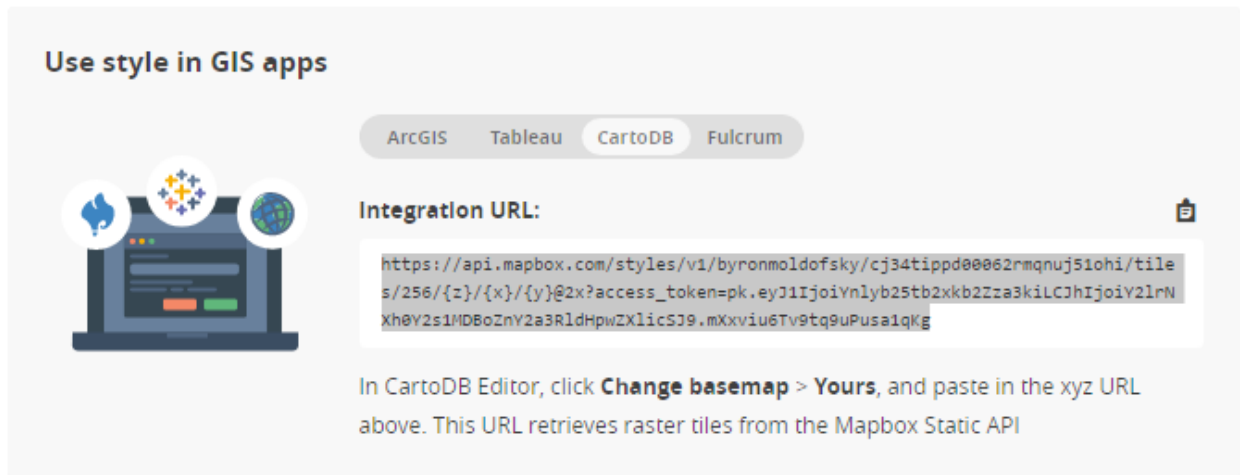
We ended up with 34 occupational classifications and codes. This would be too many to effectively map using colour coded symbols. Also some codes were not true occupations (such as "Widow") or occurred in insignificant numbers (such as "Fireman"), or were placeholders indicating no substantive information was provided about occupation (such as "Name only".) Therefore the occupational classes were reclassified into 10 consolidated groups, for the purposes of mapping, and these were assigned to the points in the Market Vendors shapefile. The original occupation classes and the consolidated groups are listed in the table below.

Detailed Group	Consolidated Group	Detailed Group	Consolidated Group
butcher	BUTCHER	provisions	PROVISIONS
grocer	GROCER	bartender	RESTAURATEUR
seafood	SEAFOOD	refreshments	RESTAURATEUR
trader	TRADER	restaurateur	RESTAURATEUR
armory	DEALER	farmer	FARMER
basketmaker	DEALER	florist	FARMER
butter dealer	DEALER	gardener	FARMER
clerk	DEALER	address name only	NAME ONLY
clothier	DEALER	market name only	NAME ONLY
confectioner	DEALER	name only	NAME ONLY
dealer	DEALER	person name only	NAME ONLY
fancy goods	DEALER	caretaker	UNCLASSIFIED
glassworker	DEALER	fireman	UNCLASSIFIED
jeweler	DEALER	lead and color	UNCLASSIFIED
merchant	DEALER	painter	UNCLASSIFIED
storekeeper	DEALER	telegrapher	UNCLASSIFIED
		widow	UNCLASSIFIED

APPENDIX 3: Adding customized basemap via Mapbox

Carto provides a variety of basemaps from different providers to use as background for data layers, including their own (<https://carto.com/location-data-services/basemaps/>), Stamen Maps (<http://maps.stamen.com>) and Here (<https://developer.here.com/>.) They also allow users to provide their own customized basemap from their own server or a variety of other providers. This may become particularly useful, or even necessary, if the map you are designing contains a large number of layers. Carto's free or public account has a limit of 8 layers allowed in any map. If more than 8 are needed as part of background or reference information, but there is no need for users to interact with them, a custom style that contains these additional layers can be created and used as the basemap.

It was decided to test this option by generating a Mapbox base map containing the Montréal 1880 buildings and parks, and to use this as a custom basemap in Carto. We will not go through the process of creating the basemap in Mapbox. Once you have styled and published the style in Mapbox Studio click on Share, develop & use. On the page that opens scroll down to Use Style in GIS apps and click on the CartoDB tab:



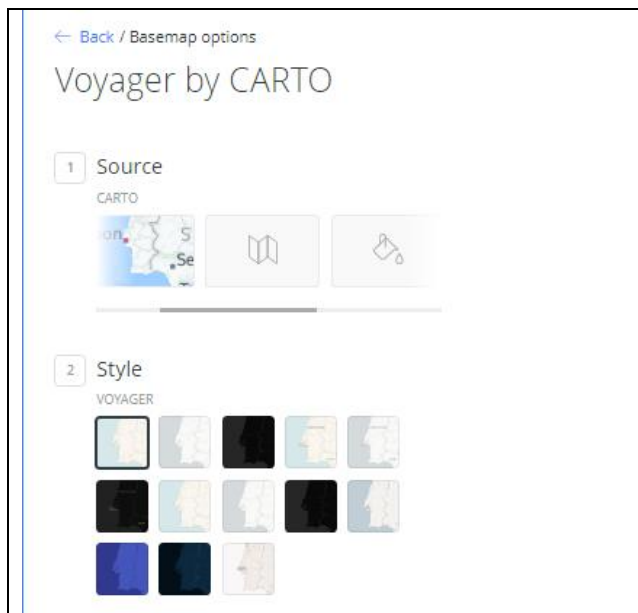
Use style in GIS apps

ArcGIS Tableau **CartoDB** Fulcrum

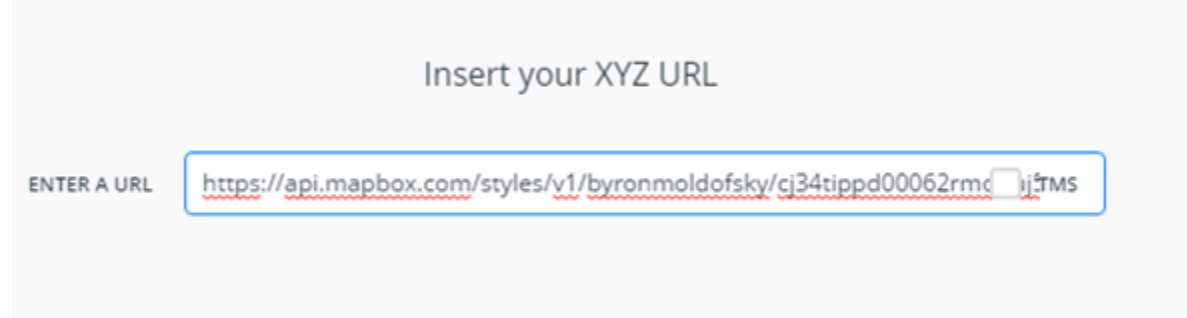
Integration URL:

```
https://api.mapbox.com/styles/v1/byronmoldofsky/cj34tippd00062rmqnuj51ohi/tiles/256/{z}/{x}/{y}@2x?access_token=pk.eyJ1Ijoibnlyb25tb2xkb2Zia3kiLCJhIjoib2l2LnR5b2s1MDBoZnY2a3RldHpwZXlic5J9.mXxviu6Tv9tq9uPusa1qKq
```

In CartoDB Editor, click **Change basemap > Yours**, and paste in the xyz URL above. This URL retrieves raster tiles from the Mapbox Static API

 <p>← Back / Basemap options</p> <p>Voyager by CARTO</p> <p>1 Source</p> <p>CARTO</p> <p>2 Style</p> <p>VOYAGER</p>	<p>Copy the style code and go to the map on Carto to which you want to apply the Mapbox base layer. At the bottom of the Layers panel you will see a Basemap layer. Click on it to access Basemap options. It will show the Default Basemap added to every Carto map, which is called Voyager.</p> <p>Slide the Source selection over to the CUSTOM icon (looks like a folded map). Other options (NASA, TILEJSON, MAPBOX) are available. You do not want to select Mapbox from this list - that is for old versions of tiles produced with earlier versions of Mapbox/Tilemill.</p>
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Click CUSTOM and under Style click on the + icon. Paste the code that you copied from Mapbox into the Insert your XYZ URL field. See below.



The screenshot shows a light gray rectangular box with the title "Insert your XYZ URL" centered at the top. Below the title, on the left, is the text "ENTER A URL". To the right of this text is a text input field with a blue border. Inside the input field, the URL "https://api.mapbox.com/styles/v1/byronmoldofsky/cj34tippd00062rmd" is pasted, followed by a small square icon with a red 'x' and the text "TMS". The URL is underlined with a red dashed line.

When you press the ADD BASEMAP button the Mapbox style will be used and you will not longer be using the Carto Voyager basemap (or whichever you had selected.)

NOTE: Using this basemap in Carto will count towards Mapbox's usage limit, for its free account (i.e. 50,000 views a month).