From GPS and Google Maps to Spatial Computing

Cartography Module Programming Assignment
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INTRODUCTION

The Internet has revolutionized the practice and consumption of cartography. The goal of this assignment is to give you a sense of the state-of-the-art of Web cartography. It's going to be a relatively short assignment, and hopefully a fun one!

You'll be using the TileMill/MapBox stack for this assignment. MapBox is widely recognized as being on the forefront of web cartography, and TileMill has been an important part of its stack. Using the TileMill/MapBox stack, you can create all sorts of different maps and map-based applications. For instance, MapBox is used by Foursquare, Pinterest, National Geographic, Evernote, etc.

A couple of notes about MapBox and TileMill:

- MapBox is built on Mapnik, which is the same open-source map rendering library used by OpenStreetMap.
- MapBox is migrating away from TileMill to a new, very similar piece of software called MapBox Studio, which requires a MapBox account and supports vector tiles. Because MapBox Studio will use CartoCSS-based styling like TileMill, all or nearly all of what we learn in this assignment will be applicable in MapBox Studio if you choose to use it.

GETTING STARTED

Before doing anything, please view the video on this module's programming assignment.

You have two choices for completing this assignment in terms of platform:

(1) You can use the version of TileMill installed on the virtual machine you downloaded for the VGI assignment. This is the supported approach.
(2) You can download and install TileMill directly to your machine. We cannot support this approach in the forums. However, TileMill is relatively mature software and is available for all three major desktop operating systems[1].

Important: Enter all answers on the Coursera webpage for Module 7. All questions are weighted equally.

Task #1: Getting Used to TileMill and CartoCSS

[1] A few of us have had trouble getting TileMill running on OS X Yosemite (10.10). The solution is to go to the TileMill menu and choose "Update Preferences…". Tick "Install Development Builds" and hit "Check Now". This will allow you to install the latest development build, which solves this problem.

Open the "Open Streets, D.C." sample project in TileMill, which styles OpenStreetMap data in the Washington, D.C., U.S.A. area. You'll see that TileMill is based on something called "CartoCSS", which is a basic extension of regular CSS.

You can read more about CartoCSS here:
https://www.mapbox.com/tilemill/docs/manual/
(This page is particularly relevant
https://www.mapbox.com/tilemill/docs/crashcourse/styling/)

Find the line in the CartoCSS file "style.mss" that reads:

```
@park:#cea;
```

What happens when you change "#cea" to "#600013"?

Question 1a:

(a) A portion of parks that were previously green turned University of Minnesota maroon (hex value "#600013").
(b) Nothing
(c) All parks that were previously green turned University of Minnesota maroon (hex value "#600013").

Find the line that reads "`background-color: @land`". What happens when you change "`@land`" to "`#858383`"?

Question 1b:

(a) The land inside the boundary of Washington, D.C. stays the same color, but the background outside Washington, D.C. turns BLUE.
(b) The land inside the boundary of Washington, D.C. stays the same color, but the background outside Washington, D.C. turns GRAY.
(c) The land inside and outside the boundary of Washington, D.C. turns GREEN
(d) The land inside and outside the boundary of Washington, D.C. turns GRAY

Go to the file "highway.mss" and go to line 121, which reads:

```
[zoom=12] { line-width: 1.2 + 2; }
```

Change this line to:

```
[zoom=12] { line-width: 1.2 + 15; }
```

What happened?

Question 1c:

(a) All roads got a lot wider
(b) One type of road (the main roads) got a lot wider
(c) The rivers got wider

Zoom in one level using the "+" icon in the upper left corner of the map viewport. The zoom level should be 13. Now look at the roads. What do you see?

Question 1d:

(a) The roads that got wider stayed wide
(b) The roads that got wider got even wider with the zoom
(c) The roads that got wider got much narrower

Task #2: Make the ugliest possible reference map you can

Go back to the "Projects" pane by clicking the Projects icon on the lefthand side of the TileMill window. Open the "Road Trip" project. Zoom out to level 3.

Your instructions for this task are straightforward:

(1) Use the skills you developed in the first task to start an exploration of CartoCSS. Play around in the Road Trip project for a while, changing settings, trying new things, and seeing what happens.
(2) After you're done exploring, use your new knowledge of CartoCSS to make the ugliest possible version of the "Road Trip" map you can. Export the map as a PNG image and upload it to this discussion forum thread on Coursera.

Question 2a:

☐Under the Coursera honor code, I have uploaded my map to the appropriate discussion forum (and it is an *ugly* map ☺).

Important: Although this is optional, we highly recommend registering for MapBox and posting this map (or any other map you make in this assignment) to your MapBox account. This will give you an idea of how to share the maps you make using TileMill with the world! This page has instructions for how to do so.

If you do, tweet the link to @spatialcompmooc!

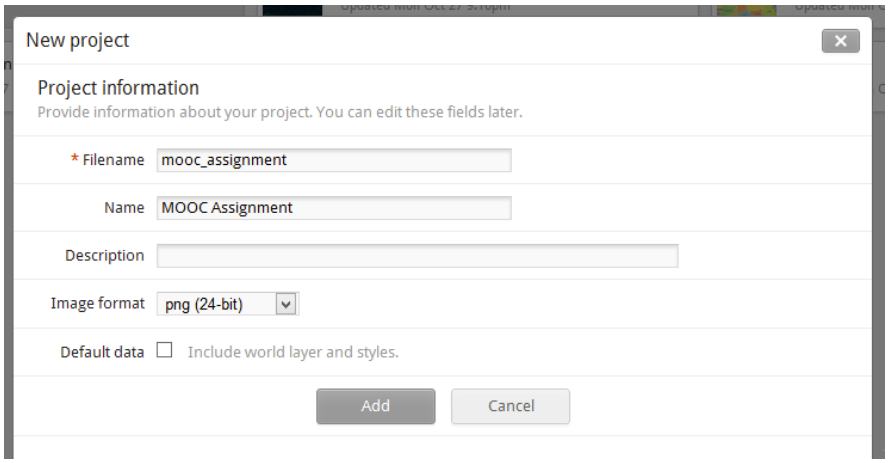
Task #3: Use TileMill to make a thematic map

In this task, we're going to import a *shapefile* into TileMill and use the data in this shapefile to make a quantitative choropleth map using a color scheme from ColorBrewer.

The shapefile is a standard (if old) spatial data format that includes both vector geometries and attribute values (Wikipedia has a decent article on the shapefile format).

To get started on this task, follow the following steps:

(1) Start a new project in TileMill, filling in the following values in the "New Project" window:

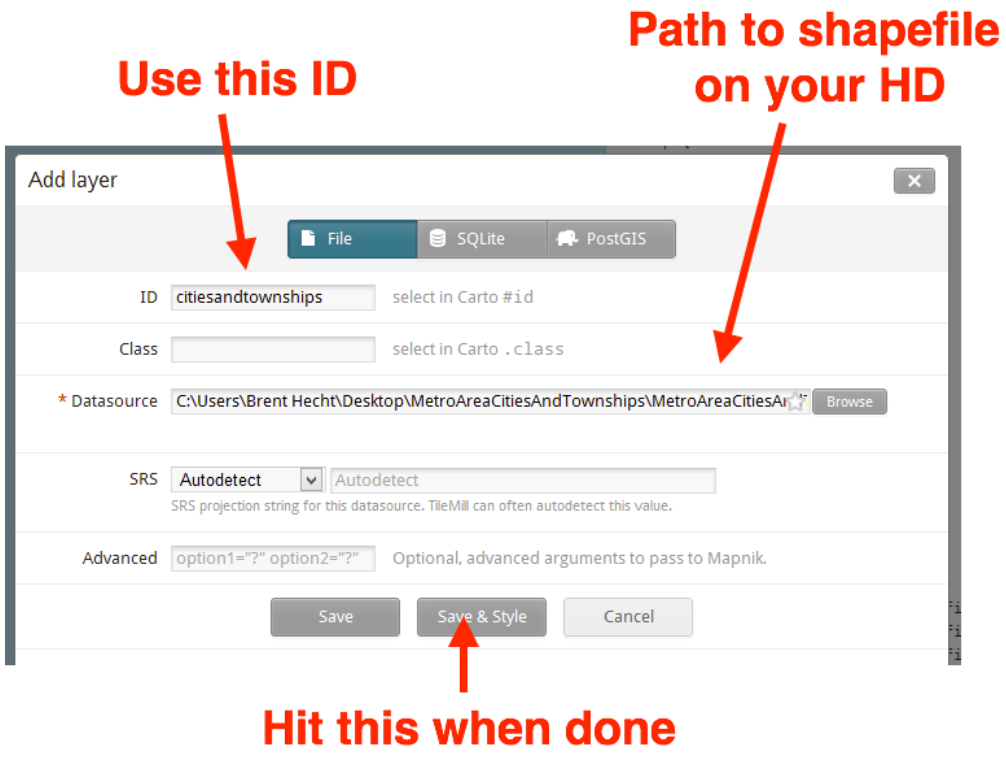


Be sure to uncheck "Include world layer and styles".

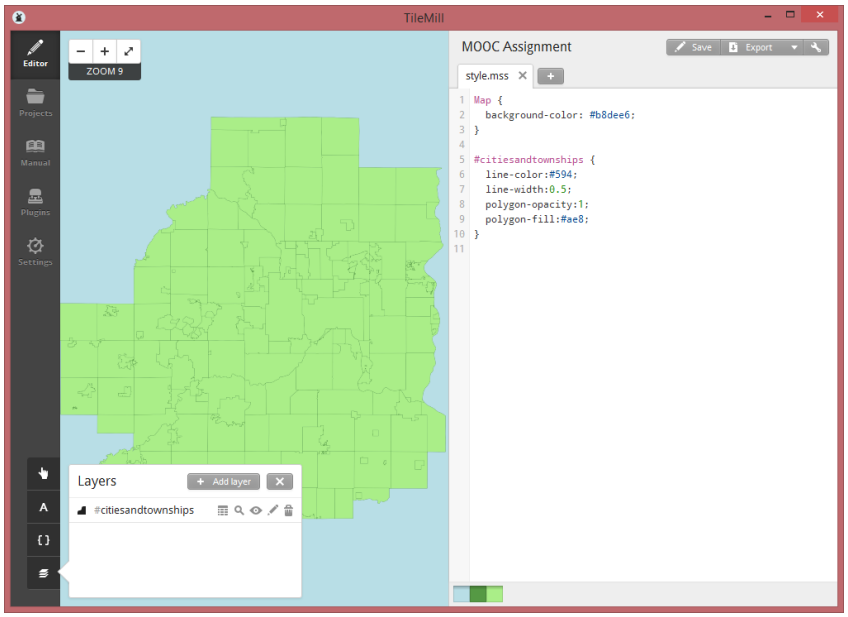
(2) Download this shapefile of cities and townships (city-like entities) in the broader Minneapolis/Saint Paul region. The shapefile contains both the geometries for the cities and townships, as well as a large number of demographic attributes from the United States census.

(3) Unzip the shapefile you downloaded and add it to your TileMill project using the instructions on this page. Begin with Step #4 to save time and avoid confusion.

Obviously, do not use their parameters in the "New Layer" window. Instead, use these:



Your TileMill window should now look something like this:



Right now, we're not communicating the distribution of any spatial attribute, so we're looking at a reference map, not a thematic map. Fortunately, CartoCSS supports *conditional formatting*, meaning we can color each enumeration unit (cities and townships) according to the value of some attribute. We'll use the `POV100RAT` attribute,

which is included in the shapefile. It describes the ratio of people in each city or township whose income is less than or equal to the poverty rate.

To make a thematic choropleth map of "POV100RAT", delete the text under #citiesandtownships and replace it with the text below. We pre-made the class breaks, for which I used a natural breaks algorithm[2].

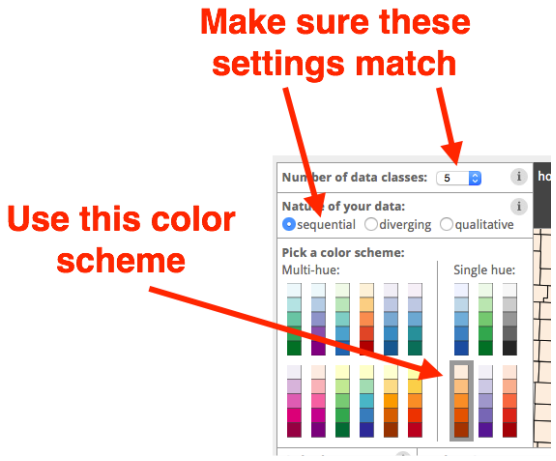
```
#citiesandtownships {
      line-color:#000;
      line-width:0.5;
      polygon-opacity:1;

      [_POV100RAT >= 0.000] {polygon-fill:#e41a1c;}
      [_POV100RAT >= 0.052] {polygon-fill:#377eb8;}
      [_POV100RAT >= 0.105] {polygon-fill:#4daf4a;}
      [_POV100RAT >= 0.183] {polygon-fill:#984ea3;}
      [_POV100RAT >= 0.298] {polygon-fill:#ff7f00;}
}
```

What is wrong with this map?

Question 3a:

(a) Nothing, it's a perfect quantitative choropleth map
(b) It uses variation in hue to communicate the distribution of a quantitative spatial attribute (i.e., it uses a color scheme intended for qualitative variables).
(c) It uses the color red inappropriately

Go to ColorBrewer.org and select the below color scheme:



[2] TileMill does not currently support data classification algorithms. This can be done in a GIS, as described in an earlier version of this assignment.

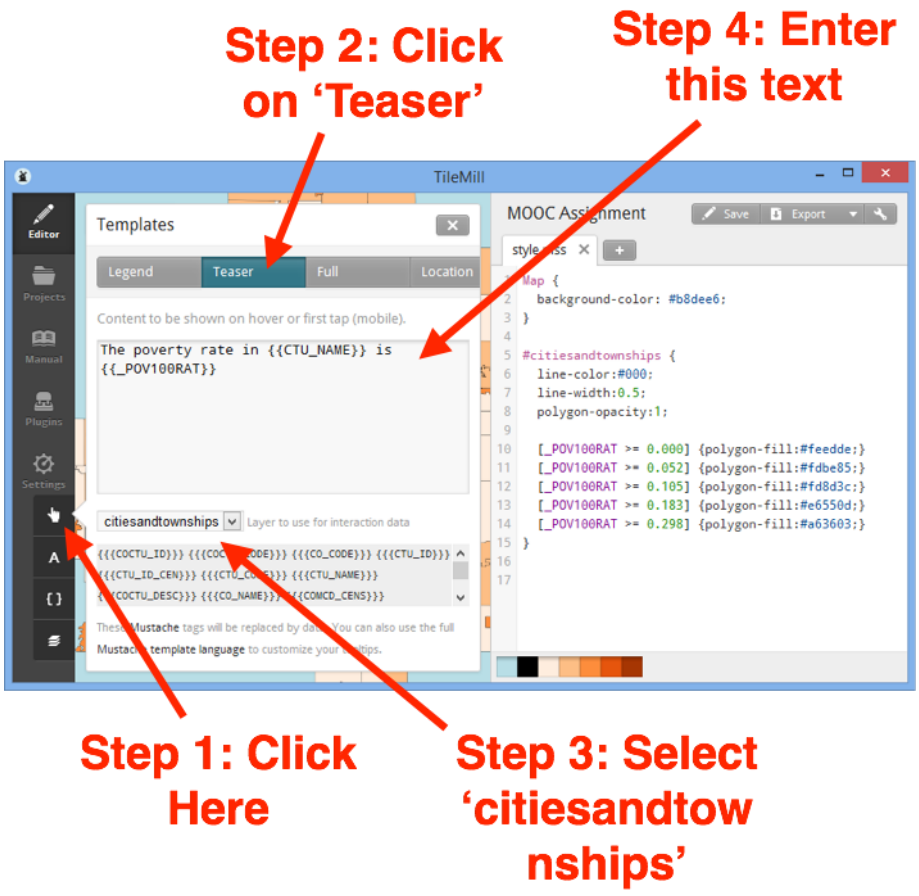
Replace the hex values currently used in the CartoCSS conditional formatting above with the hex values from this color scheme.

What trends exist in this map of poverty?

Question 3b:

(a) The center of the metropolitan area has minimal poverty, whereas the outskirts have lots of poverty.
(b) The outskirts have less poverty than the center of the metropolitan area.
(c) Poverty seems to be randomly distributed.

Lastly, click the "Hand" icon, select "Teaser", and follow the rest of the steps below.



In Step 4, the text you want to enter is:

```
The poverty rate in {{CTU_NAME}} is {{_POV100RAT}}
```

Now, click out of the "Templates" window, hit "Save" (or save the project another way), and mouse around.

Find “Ravenna Twp.” (Ravenna Township), which is the furthest East township (furthest to the right). What is the proportion of people whose income is under the poverty line in Ravenna Township?

Question 3c:

(a) 0.12
(b) 0.51
(c) 0.001
(d) 0.042
(e) 0.92

That’s it for our quick exploration of web cartography with TileMill and MapBox. Consider uploading your map to MapBox as indicated above. Hopefully this will jumpstart your explorations of web mapping!