**Research Journal**

My attempt to solve this assignment went as follows:

I decided that I would attempt to include every motor vehicle bridge within the Pittsburgh city limit. This includes on and off ramps and bridges not over water. My first google searches for bridges in Pittsburgh were relatively fruitless. I eventually stumbled upon this site:

<https://bridgehunter.com/category/city/pittsburgh-pennsylvania/exhibit>.

I was able to pull information from the page source that I put into an ipython notebook. Then I cleaned the data until I had a table of 45 motor vehicle bridges. The notebook can be viewed here:

<https://github.com/juwanno/Bridges/blob/master/Untitled.ipynb>.

All of the files referred to in this journal can be found at:

<https://github.com/juwanno/Bridges>.

I realized that 45 bridges was far below the amount that I was looking for so I abandoned this data. I continued my search and found these two websites: <https://skeetidot.cartodb.com/tables/pittsburgh_bridges/public/map>

<http://pghgis.pittsburghpa.opendata.arcgis.com/datasets/60b25e95c256460592304758b59de19c_0>.

I downloaded the datasets and began the process of merging them while removing duplicates, demolished bridges, and bridges that did not service motor vehicles. The first link gave me the data for the two CartoDB\_Bridges files while the second provided the information for the Pittsburgh\_Bridges\_GIS files. I then combined these into the Pittsburgh\_CartoDB\_Bridges\_Merge file. This data produced around 140 bridges. I worked mostly with Microsoft Excel.

At the same time, I discovered the National Bridge Inventory and downloaded the dataset for every bridge in the United States:

<https://www.fhwa.dot.gov/bridge/nbi/ascii.cfm?year=2015>.

I was able to look up the FIPS codes for Pittsburgh and pull out the bridges I was interested in. I also used the National\_Bridge\_Inventory\_Manual to determine which bridges were for motor vehicles as well as to determine how the latitudes and longitudes were represented. I then converted these to decimal degrees for use in my mapping tool. This produced around 300 bridges, and included every on/off ramp. I also used Excel for this step.

I used ArcGIS to map out all of my data. The map can be viewed here:

<http://arcg.is/22ekzIa>.

I first mapped the National Bridge Inventory data. Unfortunately, many of the data points were outside of the city limits. I removed these points from my edited file. The remaining coordinates were not accurate enough to properly locate the bridges on the map. They were given down to the hundredth of a second, so I assume the error occurred at the time they created/recorded the coordinates. This led to this data set becoming relatively useless for mapping. I then decided to use the data merged from the CartoDB and Pittsburgh Bridges data. These seemed to be much more accurate when I mapped them out, though not always perfect. Unfortunately, I lost about half the number of bridges from before, but the data was usable. The provided map contains multiple layers representing each of these steps labeled by which file I used to create them.

Now that I had my data, I had to decide how to map it/determine the best route. Google Maps and Google Earth did not seem to be efficient options at first. I searched for a Google Maps traveling salesman problem solution and came upon this site:

<http://gebweb.net/optimap/>.

It allowed me to enter around 50 locations at a time and determine the optimal route between a set starting and ending point. This website is able to return a reordered list of coordinates, an estimated time of travel, and a list of turn by turn directions. I decided make groups of 50 bridges resulting in 3 legs. I tested making the groups go north to south versus east to west.

The times were close for the two groupings but the east to west groups, where the paths tending to go north/south, ended up being quicker. I have included screenshots of all three legs of the faster group as well as turn by turn directions. Additionally, a csv file of the coordinates in their final order has also been attached. Leg 1 consisted of 50 bridges and was 45.3 miles long with an estimated travel time of 2 hours and 20 minutes. Leg 2 consisted of 49 bridges and was 41.2 miles long with an estimated travel time of 1 hour and 55 minutes. Leg 3 consisted of 39 bridges and was 35.0 miles long with an estimated travel time of 1 hour and 40 minutes. In the end, I got a final answer of about 5 hours and 55 minutes and crossed 138 bridges while traveling 121.5 miles.