G1 Progress Report 2

**Summary**

In June of 2020, I spent most of my time working on creating the *PostgreSQL* database using updated data from the AFDC website, using the *PostGIS* extension to create a reduced station network, and generating the OD matrix via the *Esri REST API* for *Python*. Here is a summary of the three steps I have taken:

* The new data of 2020 for the hydrogen stations and compressed natural gas stations are in csv format, and it is imported into the database named “afv” on my computer. The *Postgres* database are created and managed using both command-line tools and interfaces such as *pgAdmin* and *Postgres App*.
* The reduced network is constricted by the *ST\_distance* and *ST\_Dwithin* functions in the *PostGIS* extension. The former function returns the straight-line geodetic distance (not the actual driving distance), and the latter selects all pairs of nodes within 400 miles of the geodetic distance.
* The *Esri API* has many ways to access in *Python*, and I have to use *SAML* login to be able to use the ASU students’ *Esri* credits. Although there are other methods such as anonymous login and *Esri* build-in user login, they only provide limited credits which are not sufficient for this project.

**Technical Issues and Solutions**

The csv files from AFDC website have many fields that are unnecessary for my project, such as the *telephone numbers* and the *open date*. I cleaned the data by deleting the excessive fields in the *Excel* before importing the csv files to the database. The *id, zip, station name, lat*, and *lon* fields are preserved. The data type of the *id* is *serial*, which are automatic increment integers. The *lat* and *lon* fields should be set to *double precision,* while the rest ones should be *varchar* (character varying). I used to set the *zip* filed to *int*, but then I realized some zones in North America has letters in their zip codes. Thus, the *varchar* data type is more suitable for the *zip* field.

Then I created a table that contains *geometry* objects that are transferred from the *lat* and *lon*. However, the distances that are returned from the *ST\_distance* function are extremely small, such as 0.000001, because the function returns the value in the unit of the degree of the *lat* and *lon* if the input arguments are *geometries*. By using *geography* objects instead, it will return distance in meters. One can either transfer the objects to *geography* objects using the command:

st\_distance(h2stations.geom::geography)

Or create the *geography* objects when importing the csv data:

ALTER TABLE h2stations ADD COLUMN geog geography(POINT,4326);

UPDATE h2stations SET geog = ST\_GeogFromText('SRID=4326;POINT(' || lon || ' ' || lat || ')');

To make all pairs of stations within 400 miles in the database, one can select the *id* from one table and left join it with the copy of the table, then exclude the pairs that have the same *id* and the reversed-id pair. For example, we do not need the pair when id1 = id2 because it means they are the same stations, and we only need one of the pairs: (id1 = 1, id2 = 2), or (id1 = 2, id2 = 1). This could be achieved by one of the two commands:

CREATE TABLE h2pairsDistinct AS

SELECT DISTINCT ON (h2pairs.st\_distance) id1, id2 FROM h2pairs WHERE id1 != id2;

Or alternatively:

SELECT h2stations.id id1, h2stationsCopy.id id2, st\_distance(h2stations.geog, h2stationsCopy.geog) FROM h2stations, h2stationsCopy WHERE st\_dwithin(h2stations.geog, h2stationsCopy.geog, 643738) and h2stations.id < h2stationscopy.id;

Then, one can left join the *lat* and *lon* to the table of the station pairs (<400 miles) to create a table that can be used for *Esri API*. The command is here:

CREATE TABLE leftjoin1 AS SELECT h2pairsdistinct.id1, h2pairsdistinct.id2, h2stations.lat, h2stations.lon FROM h2pairsdistinct LEFT JOIN h2stations ON h2stations.id = h2pairsdistinct.id1;

Once the table is prepared, import the table in the database to your local csv files. Then, one can use the *Esri API* for *Python* and the *Pandas* data frame to generate the reduced station network. Per the *Esri* documentation, the use limits for a regular user is 1,000 point and 3600 seconds. I successfully generated 10 pairs in 21.2 seconds, 100 pairs in 66.5 seconds, and 1,000 pairs in 728.2 seconds. However, it seems that I reach the limits of a regular user very soon, then I have to use the *SAML* login as an ASU student user who has 1,000 assigned credits. The *Python* script examples can be found via this link:

<https://developers.arcgis.com/python/guide/part5-generate-od-cost-matrix/>

**Conclusion**

To conclude the report, here are four crucial takeaways for working with the *Postgres* database and the *Esri* APIs:

* One can create a database dump using the *pg\_dump* application for database backup. The database can be backed up in the *SQL* format and can be restored by *pg\_restore* command. However, when using other people’s database dump to restore the data, one should inquire from them the data dump format. Sometimes, the cluster dump files are created by the *pg\_dumpall*, and the *SQL* queries may contain the same name as the local database’s. The queries may mess up the local data if the data-restore commands are not run carefully.
* For general *Esri* *API* users, Small data can be managed by build-in username and passwords. If you need more powerful tools, the *SAML* login is good for records that are more than 1000 rows. The staff from the ASU Geospatial Hub are very helpful for giving me detailed instructions.
* The *Jupyter Notebook* is a dynamic tool for scratching and testing your *Python* code. I use *Anaconda* to load the *Jupyter Notebook*, which avoids many issues when launching it in the Mac os *Terminal*.
* In *PostGIS*, *geometry* arguments return the distance in the unit of degree, while *geography* arguments return the distance in the unit of meter, if the coordinate system is set to WGS 84, SRID = 4326. *Geography* arguments are more suitable for this project because the value it returns is more readable and fits the geodetic curve.