The Battle of Neighborhoods – Final Capstone Project

Sadaqat Ali – September 2020

Introduction

New York City is one of the most ethenically diverse cities in the world. It started accepting immigrants in 19th century and have since bacame a melting pot of the diverse languages, people and cultures. In 2019, it was estimated to have a population of 8.3 million which live in 5 main boroughs namely Brooklyn, Bronx, Manhattan, Queens and Staten Island.

New York is a very busy city, both in terms of its population and tourists. As per the data of 2019, the populations of asians american is more than a million , which is about about 12 % of the population of New York city. Add to it the people from subcontinent i.e. India, Bangladesh and Pakistan, Srilanka and Nepal and you have a very large asian and south east asian population that has come to new york for studying, jobs and businesses.

Business Problem Description

An entrepreneur has recently moved to New Yorks and is looking to open a resturant. His initial market research reveals that there is good opportunity for a Thai food resturant as it equally popular among the european and north american tourists who crave exotic food and will pay hefty prices for a upbeat expensive resturant that provides good ambiance and asian population who loves aromatic and spicy food at afforable prices. New York is also very diverse in terms of earning and the entrepreneur is thus planning to open two thai resturants, an expensive version providing a fine dinning expereince to wealthy residents and tourists and an express version for middle class clients.

The business man thus hires a data scientist to suggest to him the location for two resturants, the upbeat expensive resturant in an locality which offers the opportunity for higher tips and better ratings driven by the social media usage of the rich and wealthy and a location for an express resturant offering thai food at afforable prices in a neighborhood which has low number of thai food restaurants.

Target Audience

A entrepreneur who wants to open a Thai Restaurant in Manhattan,New York.

Methodology

1.1 Data Sources

Geospatial data of the boroughs

New York population is distributed into 5 boroughs and 306 neighbourhoods. To explore the data, we need to get the access to the data containing the boroughs and their geospatial coordinates. I downloaded the data freely available from the website

https://cocl.us/new_york_dataset

in geojason format. This data will be transformed into Pandas data frame for easy data analysis and visualization.

Venue data for Thai restaurants, Ratings and Tips

Foursquare API would be used to get the information about venues with filtering applied to find the Thai restaurants. Graphical representation of number of boroughs vs number of Thai restaurants and neighbourhoods plotted against number of Thai restaurants would give us a fair idea about the distribution of the restaurants.

Foursquare data will also be used to retrieve the information about rating and amount of average tips that will help us to fulfil the requirement as stated in the problem description for the location of both upbeat and affordable restaurants.

The recommendation for the location of both restaurants will be plotted and viewed on the folium based maps within Jupyter notebook.

Various data analysis and plotting libraries and algorithms will be used during the course of the capstone project.

Pandas for data cleaning, analysis and statistical plots. Possible use of seaborn and plotly where deemed necessary for high quality graphics.

Numpy will be used to handle the data in vector format

Folium and geopy will help us plot the geospatial data on the maps with street layer in the background and the location of neighbourhood and resturants as a foreground layer

The top locations for the both the resutrants will be selected based on the client crietera.

Highest tips and ratings for upbeat resturant

Neighborhood with low number of resturants for affordable and express version of the resturant.

Setup the Environment

Preparing the environment for data analysis, visualizaiton and processing required importing the correct libraries needed for the job. Following important libraries were used

- Pandas – For data manipulation, cleanup and wrangling
- Numpy- For numeric processing
- Seaborn – for higher quality graphics
- Folium – For GIS mapping of the data
- Matplotlib – Lightweight plotting library

Resolution of the output Graphics

It was noted that by default the jupyter notebook produces fuzzy looking graphics, thus the following command was used improve the quality of the graphics output

%config InlineBackend.figure_format = 'svg'

1.2 Data Retrieval

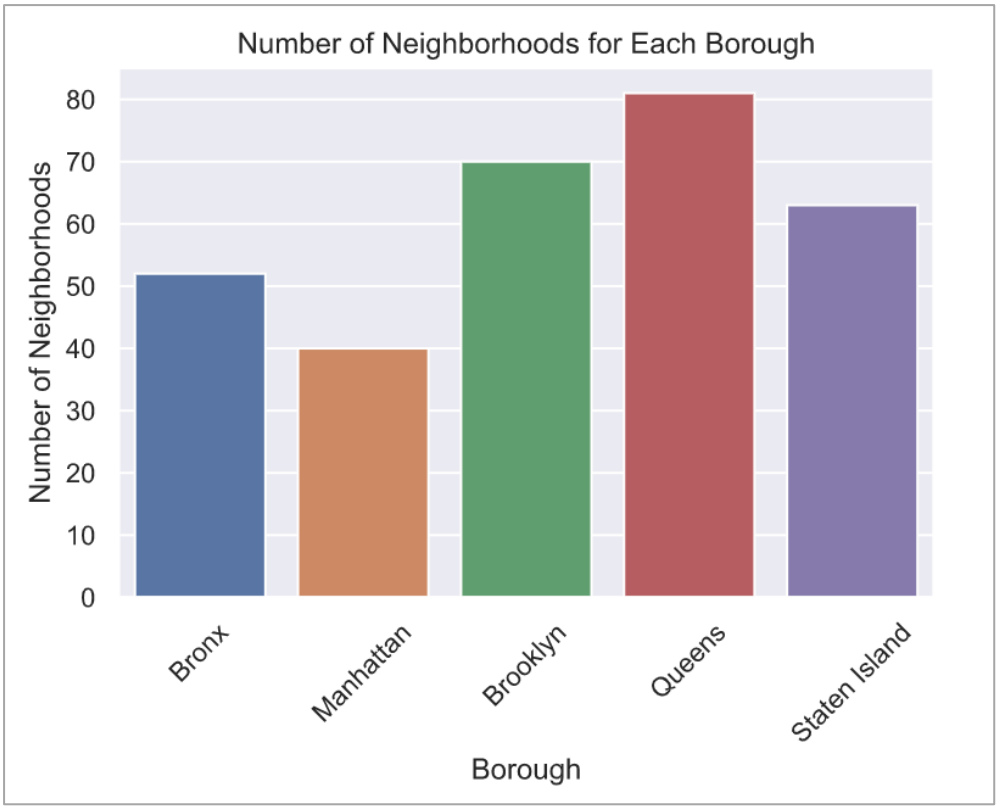
The data of the newyork buroughs and neighbourhoods was collected along with their GIS coordinates. 306 records were present in the data. The data is automatically downloaded to a file called “nyu_2451_34572-geojason.json”. The file was renamed to newyork.Jason for easy referral.

```
with open('newyork.json') as json_data:
    nydata = json.load(json_data)
nydata
```


```
{'type': 'FeatureCollection',
 'totalFeatures': 306,
 'features': [{'type': 'Feature',
   'id': 'nyu_2451_34572.1',
   'geometry': {'type': 'Point',
    'coordinates': [-73.84720052054902, 40.89470517661]},
   'geometry_name': 'geom',
   'properties': {'name': 'Wakefield',
    'stacked': 1,
    'annoline1': 'Wakefield',
    'annoline2': None,
    'annoline3': None,
    'annoangle': 0.0,
    'borough': 'Bronx',
    'bbox': [-73.84720052054902,
     40.89470517661,
     -73.84720052054902,
     40.89470517661]}},
```


1.2 Data Visualization

Plotting the bar graph of the burough, provides a visually easy to interpret the method of having a quick look of how neighborhood are distributed among boroughs



1.3 Data Transforamtion

Data was transformed from .json format to pandas dataframe called “neighborhoods”. The tranformation into pandas dataframe provides the opportunity to analyse, clean, and format the data into a analysis and visualization friendly format.

```
neighborhoods.head()
```

	Borough	Neighborhood	Latitude	Longitude
0	Bronx	Wakefield	40.894705	-73.847201
1	Bronx	Co-op City	40.874294	-73.829939
2	Bronx	Eastchester	40.887556	-73.827806
3	Bronx	Fieldston	40.895437	-73.905643
4	Bronx	Riverdale	40.890834	-73.912585

1.4 Retrieve Geospatial Data

Geopy package was used to retrieve the location dat for neighborhood and buroughs.

Get Geographical Coordinates of Newyork city

```
address = 'New York City, NY'

geolocator = Nominatim(user_agent="ny_explorer")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('The geograpical coordinate of New York City are {}, {}.'.format(latitude, longitude))
```

```
The geograpical coordinate of New York City are 40.7127281, -74.0060152.
```

1.5 Visualize Geospatial Data

Folium is a powerful and simple to use library that helps to visualize the geospatial data with ease. Lots of controls are provided with the library to fine tune the display. Folium was used to create a map showing locations of Newyork and its neighborhoods.

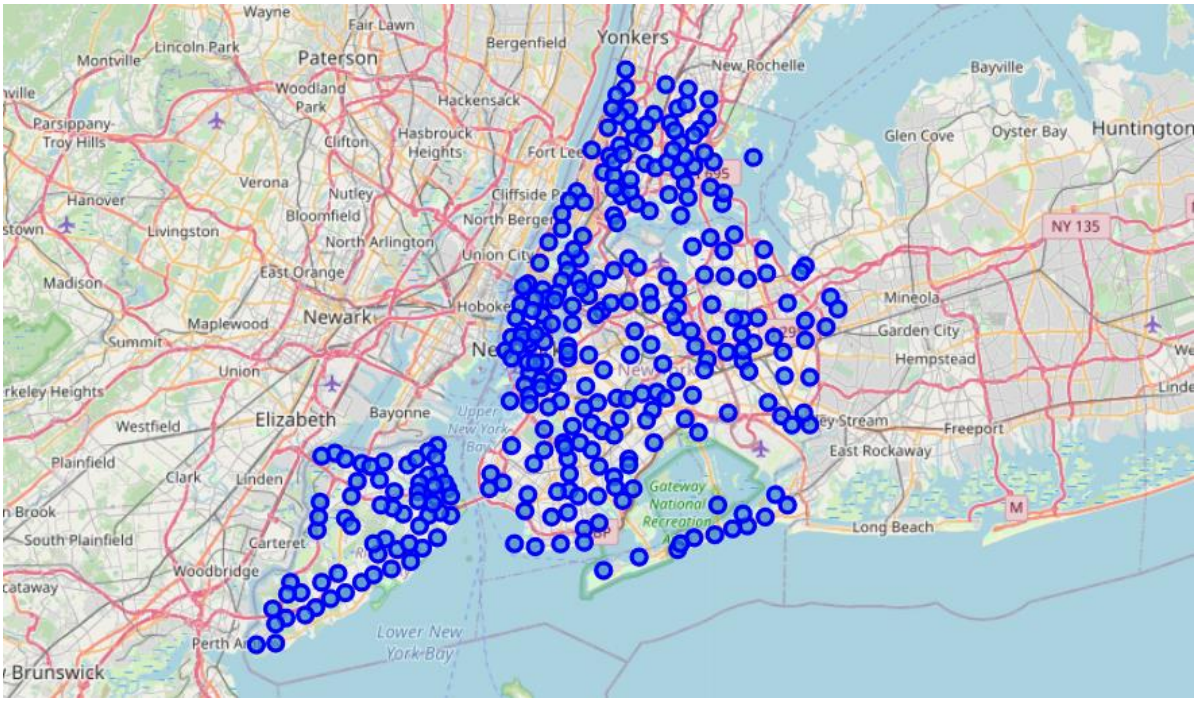
Create a map of New York with neighborhoods superimposed on top.

```
# create map of New York using latitude and longitude values
map_newyork = folium.Map(location=[latitude, longitude], zoom_start=10)

# add markers to map
for lat, lng, borough, neighborhood in zip(neighborhoods['Latitude'], neighborhoods['Longitude'], neighborhoods['Borough'], neigh
    label = '{}, {}'.format(neighborhood, borough)
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(map_newyork)

map_newyork
```

Below is the data at the regional scale for all the neighborhoods of Newyork



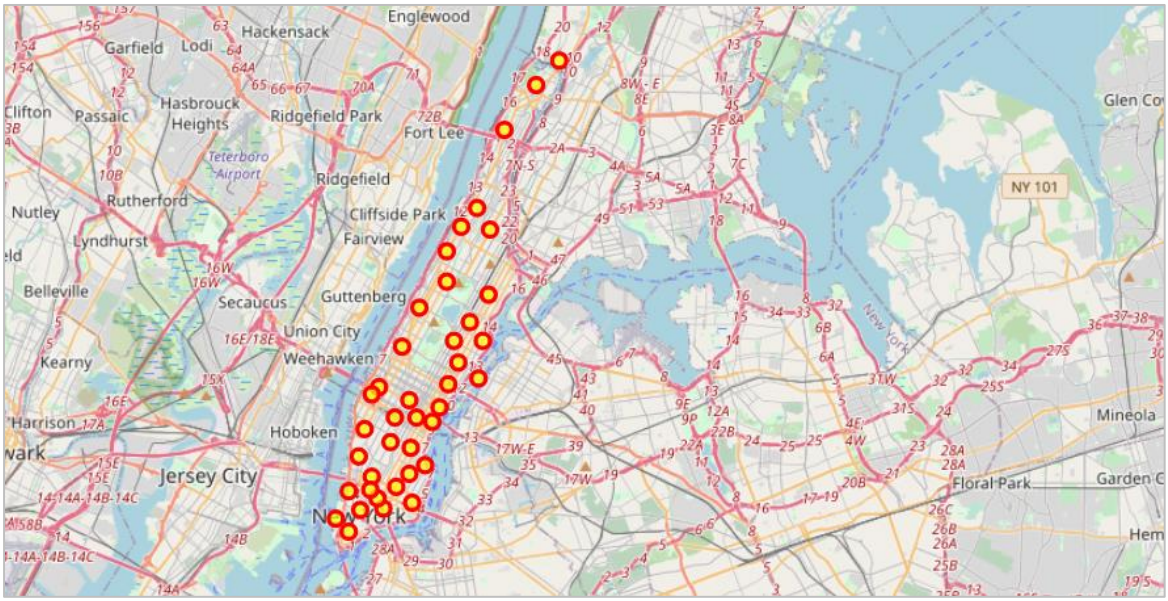
Data both at regional (all newyork neighborhoods and buroughs) and at the local scale (focusing on Manhattan) was visualized. Below is the display of neighborhoods of Manhattan.

As we did with all of New York City, let's visualizat Manhattan and its Neighborhoods

```
# create map of Manhattan using latitude and longitude values
map_manhattan = folium.Map(location=[latitude, longitude], zoom_start=11)

# add markers to map
for lat, lng, label in zip(manhattan_data['Latitude'], manhattan_data['Longitude'], manhattan_data['Neighborhood']):
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='red',
        fill=True,
        fill_color='#ffff00',
        fill_opacity=0.7,
        parse_html=False).add_to(map_manhattan)

map_manhattan
```

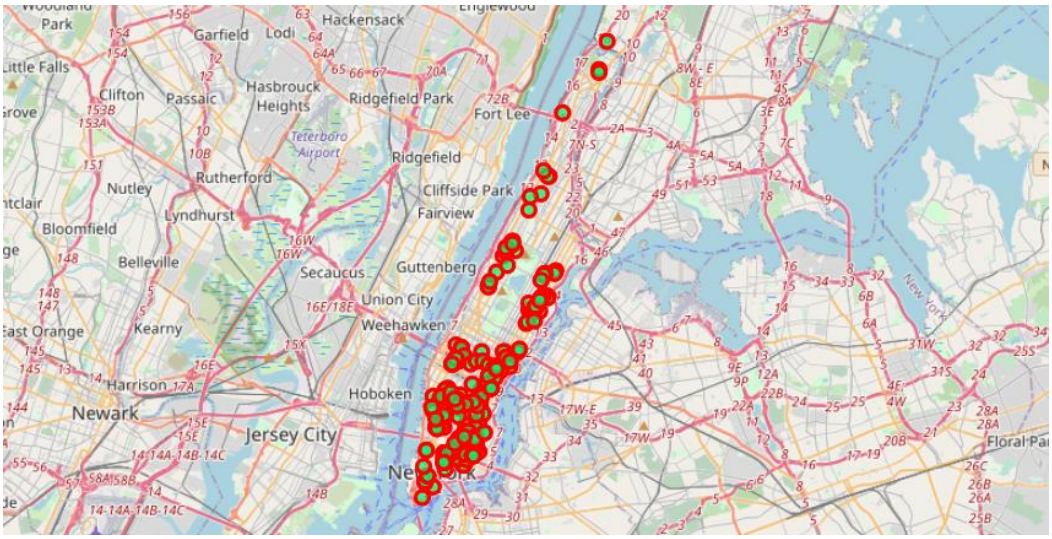


1.6 Neighborhood Exploration

Data exploration of the neighborhood of the nearby venues of Manhattan was done and data was filtered based on Thai restaurants and data was plotted on the map for the neighborhoods with thai restaurants

```
manhattan_neigh_loc.head()
```

	Neighborhood	Id	Name	Latitude	Longitude	Category
0	Marble Hill	4a739e29f964a520f5dc1fe3	Siam Square	40.878796	-73.916701	Thai Restaurant
1	Chinatown	5bbea2ad9411f2002c2c8562	Noree Thai Bazaar	40.717900	-73.992966	Thai Restaurant
2	Chinatown	5cc4e9d0c876c8002c3010cb	Wayla	40.718291	-73.992584	Thai Restaurant
3	Chinatown	598b97d559fe5c1d37565107	Jia	40.715454	-73.990036	Thai Restaurant
4	Chinatown	57e0890e498ed6d471c6fe92	Thailicious NYC	40.716310	-73.999944	Thai Restaurant



1.7 Data Preparation for Machine Learning

Machine learning cannot be applied to the categorical data; thus the data needs to be transformed into numerical data using different technique. One such technique is called One Hot Encoding which helped convert the venues occurrence to frequency and how many venues were in each neighborhood

```
# one hot encoding
manhattan_onehot = pd.get_dummies(manhattan_venues[['Venue Category']], prefix="", prefix_sep="")

# add neighborhood column back to dataframe
manhattan_onehot['Neighborhood'] = manhattan_venues['Neighborhood']

# move neighborhood column to the first column
fixed_columns = [manhattan_onehot.columns[-1]] + list(manhattan_onehot.columns[:-1])
manhattan_onehot = manhattan_onehot[fixed_columns]

manhattan_onehot.head()
```

	Neighborhood	Accessories Store	Adult Boutique	Afghan Restaurant	African Restaurant	American Restaurant	Antique Shop	Arepa Restaurant	Argentinian Restaurant	Art Gallery	...	Video Store	Vietnamese Restaurant	Volleyball Court
0	Marble Hill	0	0	0	0	0	0	0	0	0	...	0	0	0
1	Marble Hill	0	0	0	0	0	0	0	0	0	...	0	0	0
2	Marble Hill	0	0	0	0	0	0	0	0	0	...	0	0	0
3	Marble Hill	0	0	0	0	0	0	0	0	0	...	0	0	0
4	Marble Hill	0	0	0	0	0	0	0	0	0	...	0	0	0

1.8 KMean Clustering

Kmeans clustering is an unsupervised machine learning algorithms that groups together a set of objects in a way that objects in the same cluster are more similar to each other than to objects in other clusters. Kmeans clustering was used to cluster the neighborhoods that has similar averages for Thai restaurants in that particular neighborhood

	Neighborhood	Accessories Store	Adult Boutique	Afghan Restaurant	African Restaurant	American Restaurant	Antique Shop	Arepa Restaurant	Argentinian Restaurant	Art Gallery	...	Video Store	Vietnamese Restaurant	Volleyball Court
0	Battery Park City	0.0	0.0	0.0	0.000000	0.000000	0.0	0.00	0.000000	0.000000	...	0.0	0.000000	0.0
1	Carnegie Hill	0.0	0.0	0.0	0.000000	0.000000	0.0	0.00	0.011236	0.000000	...	0.0	0.011236	0.0
2	Central Harlem	0.0	0.0	0.0	0.068182	0.045455	0.0	0.00	0.000000	0.022727	...	0.0	0.000000	0.0
3	Chelsea	0.0	0.0	0.0	0.000000	0.040000	0.0	0.01	0.000000	0.040000	...	0.0	0.000000	0.0
4	Chinatown	0.0	0.0	0.0	0.000000	0.030000	0.0	0.00	0.000000	0.000000	...	0.0	0.030000	0.0

1.9 Integrating dataframe with venues and clusters

A new merged dataframe that includes the cluster as well as the top 10 venues for each neighborhood.

	Borough	Neighborhood	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue
0	Manhattan	Marble Hill	40.876551	-73.910660	1	Coffee Shop	Gym	Discount Store	Sandwich Place	Yoga Studio	Ice Cream Shop	Deli / Bodega	Pharmacy
1	Manhattan	Chinatown	40.715618	-73.994279	1	Chinese Restaurant	Bakery	Cocktail Bar	Dessert Shop	American Restaurant	Optical Shop	Vietnamese Restaurant	Noodle House
2	Manhattan	Washington Heights	40.851903	-73.936900	3	Café	Bakery	Deli / Bodega	Chinese Restaurant	Mobile Phone Shop	Grocery Store	Spanish Restaurant	Supplement Shop
3	Manhattan	Inwood	40.867684	-73.921210	3	Mexican Restaurant	Restaurant	Café	Lounge	Spanish Restaurant	Bakery	Park	Pizza Place
4	Manhattan	Hamilton Heights	40.823604	-73.949688	3	Pizza Place	Café	Coffee Shop	Mexican Restaurant	Yoga Studio	Sushi Restaurant	Caribbean Restaurant	School

1.10 Visualizing the Cluster

The resulting clusters were then visualized as bar plot using seaborn library to show average number of Thai resturants in each cluster within Manhattan. We can see that most of the Thai restaurants are in cluster 0. Interpreting the plot, we can see that the most optimum cluster to open the thai restaurant are cluster number 2 or number 4. As per initial requirement, the entrepreneur needed to invest safely in an area with less competition.

Results

- Datascience methodology proved effective in recommending areas for opening a Thai Resturant with high probability of good return on investment.
- The exercise showed how data can be scraped from a website and used in python environment for data analysis, visualization and applying machine learning
- Data visualization provided excellent methods of graphically representing the data and using seaborn library and geospatial data was effectively visualized using the folium library.
- Kmeans provided good clustering algorithm for helping to recommend a location for thai Resturant that makes business sense.

Discussion

- There is room for the improvement as other features such as restaurant ratings, areas with best tips and user likes from foursquare would provide more data and better clustering based on multi-attribute analysis and clustering.
- The exercise showcased the power of datascience methodology and practice as recommender system and in visualization and data wrangling domains

Conslusion

- The exercise provided good opportunity to help recommend a best place / places for opening a restaurant in Manhattan, Newyork. This methodology can be applied to variety of similar problems requiring clustering and recommendations using unsupervised machine learning.
- We were able to predict the best location to start Thai resturant while ensuring the high rate of return and safe investment.