Predicting a Suitable Rental Apartment in Manhattan (NY) Neighborhood

Coursera (Course 9) Capstone Project

The Battle of Neighbourhoods - Final Report - Week 1 & 2

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Contents -

1. Introduction:

Discussing and introducing the the business problem to the audience who would be interested in this project. 1.1 Background of the Problem I am a data scientist and helping a friend who is residing in Chennai, India. Currently, he lives within the walking distance to Chennai Downtown and Railway Station and hence he has access to good public transportation to work. Likewise, he enjoys many amenities in the neighborhood - such as international restaurants, cafes, food shops and entertainment.

He (my friend) has been offered a great opportunity to work in Manhattan, NY. He actually is very excited about it, but he is stressed a bit towards the process to secure a comparable place to live in Manhattan. Therefore, I have decided to help him by applying the skills I learned during the Coursera course to explore ways to help him in making sure that his decision is correct and rewarding. Of course, there are alternatives to achieve the answer using available several other tools, but it is worth and complimentary doing it with all the tools I laearned with Coursera.

1.2 Problem to be resolved: The problem here is to find a rental apartment unit in Manhattan NY that offers similar characteristics and benefits to my friend's current location (Chennai) and his current situation.

Hense - in order to set a basis for comparison, I want to find a rental unit subject to the following conditions:

- Apartment with min 2 bedrooms with monthly rent not to exceed US$7000/month
- Unit located within walking distance (<=1.0 mile, 1.6 km) from a subway metro station in Manhattan
- Area with amenities and venues similar to the ones described for current location (as described in section 2.1)

1.3 The intended Audience for this Project I believe this is a relevant project for any person or entity considering to move to a major city in US (Manhattan, New York), Europe, or Asia, since the approach and methodologies I am presenting here will be applicable in all cases. The use of FourSquare data and mapping techniques combined with data analysis will definitely help to resolve all the the questions. Also, this project will help in developing the Data Science skills.

2. Data:

Description of the data and its sources that will be used to solve the problem 2.1 Data for Present Situation (current residence place) Currently, my friend is living in the neighborhood of 'Valachery' in Chennai, India. I use Foursquare to identify the venues around the area of his residence which are then shown in the Chennai map shown in Methodology (section 3.0). It serves as a reference for comparison with the desired future location in Manhattan NY

2.2 Data required to solve the problem In order to make a good choice of a similar apartment in Manhattan NY, the following data is required: List/Information on neighborhoods form Manhattan with their Geodata (latitude and longitude. List/Information about the subway metro stations in Manhattan with geodata. Listed apartments for rent in Manhattan area with descriptions (number of beds, rent, location, address) Venues and amenities in the Manhattan neighborhoods (ex- top 10)

2.3 Data sources and data manipulation The list of Manhattan neighborhoods is worked out during LAb exercise during the course. A csv file was created which will be read in order to create a dataframe and its mapping. The csv file 'mh_neigh_data.csv' has the following below data structure.

The file will be directly read to the Jupiter Notebook for convenience and space savings. The clustering of neighborhoods and mapping will be shown however. An algorythm was used to determine the geodata from Nominatim . The actual algorythm coding may be shown in 'markdown' mode since it takes more time to run.

mh_neigh_data.tail():

	Borough	Neighborhood	Latitude	Longitude
35	Manhattan	Turtle Bay	40.752042	-73.967708
36	Manhattan	Tudor City	40.746917	-73.971219
37	Manhattan	Stuyvesant Town	40.731000	-73.974052
38	Manhattan	Flatiron	40.739673	-73.990947
39	Manhattan	Hudson Yards	40.756658	-74.000111

A list of Manhattan subway metro stops was compiled in Numbers (Apple excel) and it was complemented with wikipedia data (https://en.wikipedia.org/wiki/List_of_New_York_City_Subway_stations_in_Manhattan) and information from NY Transit authority and Google maps (https://www.google.com/maps/search/manhattan+subway+metro+stations/@40.7837297,-74.1033043,11z/data=!3m1!4b1) for a final consolidated list of subway stops names and their address. The geolocation was obtained via an algorythm using Nominatim. Details will be shown in the execution of methodolody in section 3.0. The subway csv file is 'MH_subway.csv' and the data structure is: mhsub.tail(): sub_station sub_address lat long

17 190 Street Subway Station Bennett Ave, New York, NY 10040, USA 40.858113 -73.932983

18 59 St-Lexington Av Station E 60th St, New York, NY 10065, USA 40.762259 -73.966271

19 57 Street Station New York, NY 10019, United States 40.764250 -73.954525

20 14 Street / 8 Av New York, NY 10014, United States 40.730862 -73.987156

21 MTA New York City 525 11th Ave, New York, NY 10018, USA 40.759809 -73.999282 A list of places for rent was collected by web-browsing real estate companies in Manhattan : http://www.rentmanhattan.com/index.cfm?page=search&state=results https://www.nestpick.com/search?city=new-york&page=1&order=relevance&district=manhattan&gclid=CjwKCAiAjNjgBRAgEiwAGLlf2hkP3A-cPxjZYkURqQEswQK2jKQEpv_MvKcrIhRWRzNkc_r-

fGi0lxoCA7cQAvD_BwE&type=apartment&display=list https://www.realtor.com/apartments/Manhattan_NY A csv file was compiled with the rental places that indicated: areas of Manhattan, address, number of beds, area and monthly rental price. The csv file 'nnnn.csv' had the following below structure. An algorythm was used to create all the geodata using Nominatim, as shown in section 3.0. The actual algorythm coding may be shown in 'markdown' mode becasues it takes time to run. With the use of geolocator = Nominatim(), it was possible to determine the latitude and longiude for the subway metro locations as well as for the geodata for each rental place listed. The loop algorythms used are shown in the execution of data in section 3.0 "Great_circle" function from geolocator was used to calculate distances between two points , as in the case to calculate average rent price for units around each subway station and at 1.6 km radius. Foursquare is used to find the avenues at Manhattan neighborhoods in general and a cluster is created to later be able to search for the venues depending of the location shown.

The data used as follows: Used Foursquare and geopy data to map top 10 venues for all Manhattan neighborhoods and clustered in groups (as per Course LAB) Use foursquare and geopy data to map the location of subway metro stations , separately and on top of the above clustered map in order to be able to identify the venues and ammenities near each metro station, or explore each subway location separately. Use Foursquare and geopy data to map the location of rental places, in some form, linked to the subway locations. create a map that depicts, for instance, the average rental price per square ft, around a radious of 1.0 mile (1.6 km) around each subway station - or a similar metrics. I will be able to quickly point to the popups to know the relative price per subway area. Addresses from rental locations will be converted to geodata(lat, long) using Geopy-distance and Nominatim. Data will be searched in open data sources if available, from real estate sites if open to reading, libraries or other government agencies such as Metro New York MTA, etc.

The following maps were created to facilitate the analysis and the choice of the palace to live. Manhattan map of Neighborhoods manhattan subway metro locations Manhattan map of places for rent Manhattan map of clustered venues and neighborhoods Combined maps of Manhattan rent places with subway locations Combined maps of Manhattan rent places with subway locations and venues clusters

3. Methodology:

This section represents the main component of the report where the data is gathered, prepared for analysis. The tools described are used here and the Notebook cells indicates the execution of steps.

The analysis and the strategy: The strategy is based on mapping the above described data in section 2.0, in order to facilitate the choice of at least two candidate places for rent. The choice is made based on the demands imposed : location near a subway/train station, rental price and similar venues to Chennai, India. This visual approach and maps with popups labels allow quick identification of location, price and feature, thus making the selection very easy.

The processing of this DATA and its mapping will allow answering the key questions to make a decision:

What is the cost of available rental places that meet the demands?

What is the cost of rent around a mile radius from each subway metro station?

What is the area of Manhattan with best rental pricing that meets criteria established?

What is the distance from work place (Park Ave and 53 rd St) and the tentative future rental home? What are the venues of the two best places to live?

How the prices compare?

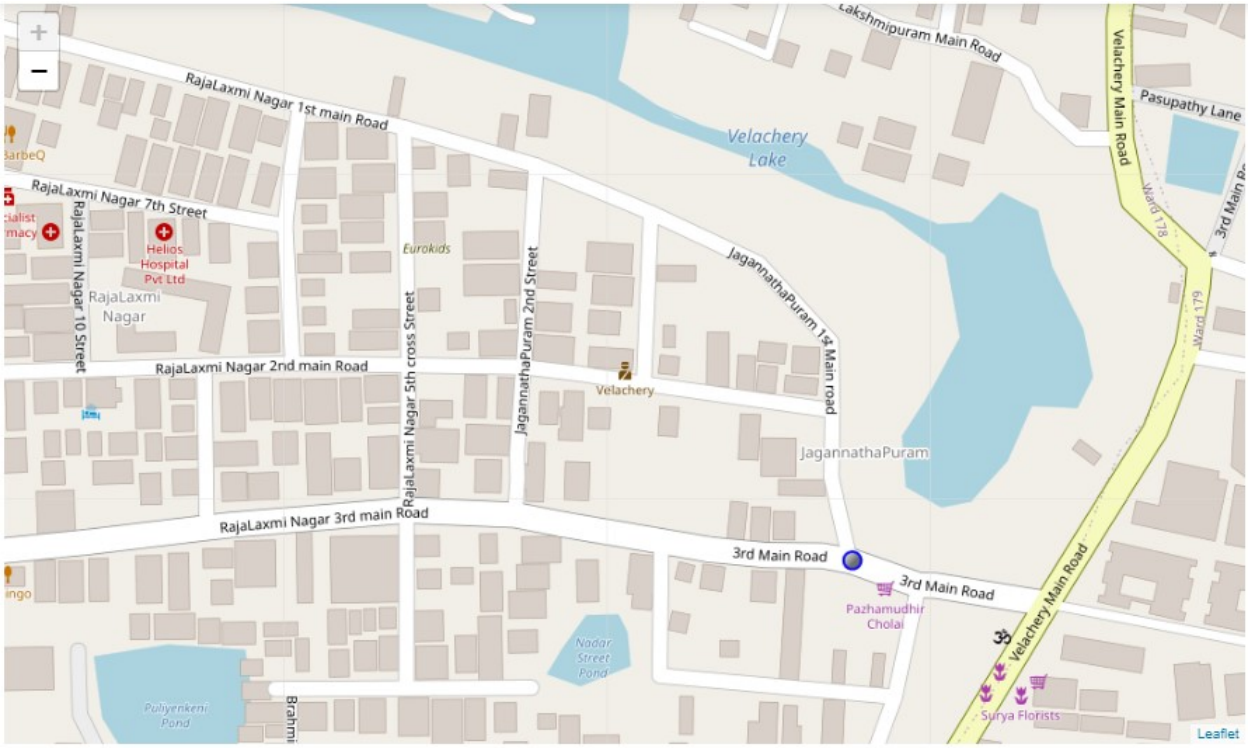
How venues distribute among Manhattan neighborhoods and around metro stations?

Are there tradeoffs between size and price and location?

Any other interesting statistical data findings of the real estate and overall data?

METHODOLOY EXECUTION - Mapping Data

Chennai Map - Current residence and venues in neighborhood for comparison to future Manhattan renting place



Venues near current residence place:

	name	categories	lat	lng
0	The Westin	Hotel	12.989379	80.220885
1	Andhi Kadai	Indian Restaurant	12.982532	80.224662
2	Subway	Sandwich Place	12.987449	80.218362
3	Subway - Velachery	Sandwich Place	12.987412	80.218464
4	Peaches	Vegetarian / Vegan Restaurant	12.985401	80.218026
5	Pizza Empire	Pizza Place	12.984231	80.217984
6	Mast Kalandar	Indian Restaurant	12.984715	80.217821
7	Coal Barbecue	BBQ Joint	12.986020	80.218074
8	Pazhamudhir Cholai	Market	12.984232	80.221835
9	Dhandeeshwaram	Bus Stop	12.982931	80.222244

MANHATTAN NEIGHBORHOODS - DATA AND MAPPING

Cluster neighborhood data was produced with Foursquare during course lab work.

```
# Read csv file with clustered neighborhoods with geodata
manhattan_data  = pd.read_csv('mh_neigh_data.csv')
manhattan_data.head()
```

	Borough	Neighborhood	Latitude	Longitude	Cluster Labels
0	Manhattan	Marble Hill	40.876551	-73.910660	2
1	Manhattan	Chinatown	40.715618	-73.994279	2
2	Manhattan	Washington Heights	40.851903	-73.936900	4
3	Manhattan	Inwood	40.867684	-73.921210	3
4	Manhattan	Hamilton Heights	40.823604	-73.949688	0

```
manhattan_data.tail()
```

	Borough	Neighborhood	Latitude	Longitude	Cluster Labels
35	Manhattan	Turtle Bay	40.752042	-73.967708	3
36	Manhattan	Tudor City	40.746917	-73.971219	3
37	Manhattan	Stuyvesant Town	40.731000	-73.974052	4
38	Manhattan	Flatiron	40.739673	-73.990947	3
39	Manhattan	Hudson Yards	40.756658	-74.000111	2

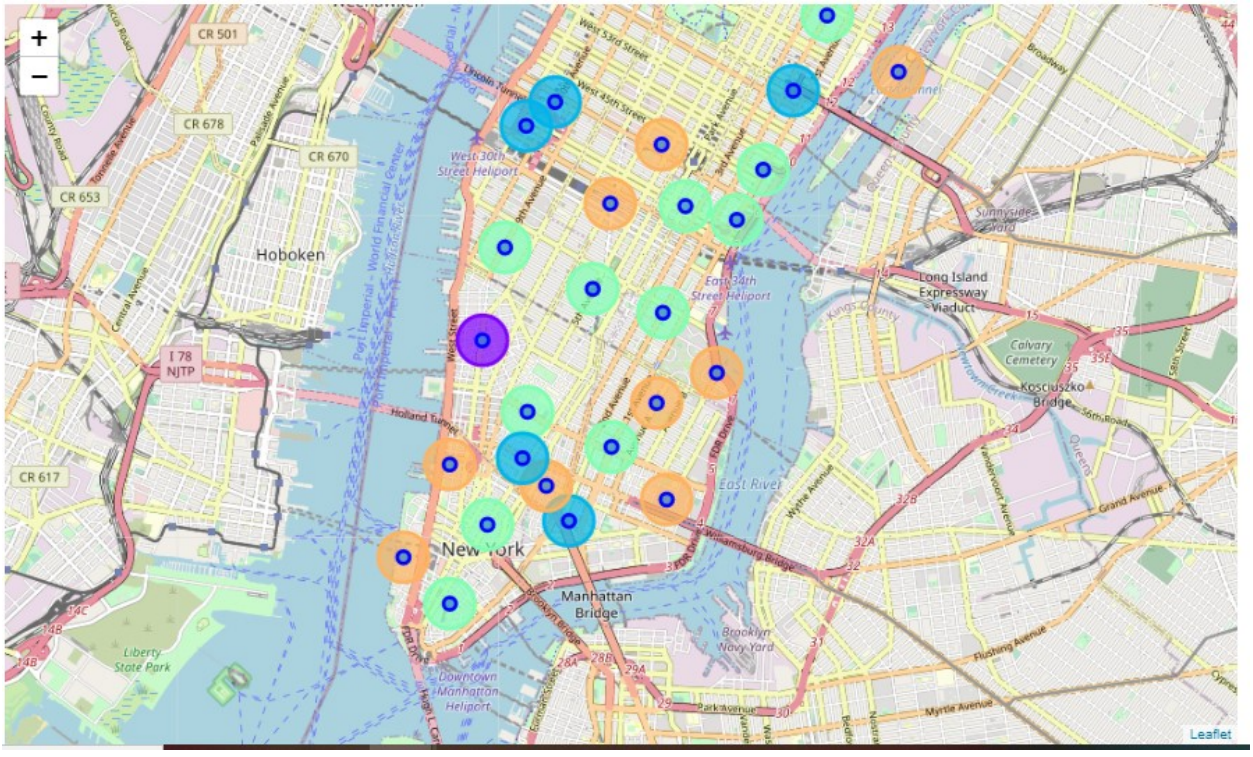
Manhattan Borough neighborhoods - top 10 clustered venues

```
manhattan_merged = pd.read_csv('manhattan_merged.csv', encoding='cp1252')
manhattan_merged.head()
```

	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	9th Com V
0	Manhattan	Marble Hill	40.876551	-73.910660	2	Coffee Shop	Discount Store	Yoga Studio	Steakhouse	Supplement Shop	Tennis Stadium	Shoe Store	Gym	
1	Manhattan	Chinatown	40.715618	-73.994279	2	Chinese Restaurant	Cocktail Bar	Dim Sum Restaurant	American Restaurant	Vietnamese Restaurant	Salon / Barbershop	Noodle House	Bakery	B Tea
2	Manhattan	Washington Heights	40.851903	-73.936900	4	Café	Bakery	Mobile Phone Shop	Pizza Place	Sandwich Place	Park	Gym	Latin American Restaurant	Resta
3	Manhattan	Inwood	40.867684	-73.921210	3	Mexican Restaurant	Lounge	Pizza Place	Café	Wine Bar	Bakery	American Restaurant	Park	Fi Y
4	Manhattan	Hamilton Heights	40.823604	-73.949688	0	Mexican Restaurant	Coffee Shop	Café	Deli / Bodega	Pizza Place	Liquor Store	Indian Restaurant	Sushi Restaurant	San

Map of Manhattan neighborhoods with top 10 clustered venues

popups allows to identify each neighborhood and the cluster of venues around it in order to proceed to examine in more detail in the next cell



Examine a particular Cluster - print venues

After examining several cluster data, I concluded that cluster # 2 resembles closer to the Chennai place, therefore providing guidance as to where to look for the future apartment . Assign a value to 'kk' to explore a given cluster.

	Neighborhood	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	9th Most Common Venue	10th Most Common Venue
0	Marble Hill	Coffee Shop	Discount Store	Yoga Studio	Steakhouse	Supplement Shop	Tennis Stadium	Shoe Store	Gym	Bank	Seafood Restaurant
1	Chinatown	Chinese Restaurant	Cocktail Bar	Dim Sum Restaurant	American Restaurant	Vietnamese Restaurant	Salon / Barbershop	Noodle House	Bakery	Bubble Tea Shop	Ice Cream Shop
6	Central Harlem	African Restaurant	Seafood Restaurant	French Restaurant	American Restaurant	Cosmetics Shop	Chinese Restaurant	Event Space	Liquor Store	Beer Bar	Gym / Fitness Center
9	Yorkville	Coffee Shop	Gym	Bar	Italian Restaurant	Sushi Restaurant	Pizza Place	Mexican Restaurant	Deli / Bodega	Japanese Restaurant	Pub
14	Clinton	Theater	Italian Restaurant	Coffee Shop	American Restaurant	Gym / Fitness Center	Hotel	Wine Shop	Spa	Gym	Indie Theater
23	Soho	Clothing Store	Boutique	Women's Store	Shoe Store	Men's Store	Furniture / Home Store	Italian Restaurant	Mediterranean Restaurant	Art Gallery	Design Studio
26	Morningside Heights	Coffee Shop	American Restaurant	Park	Bookstore	Pizza Place	Sandwich Place	Burger Joint	Café	Deli / Bodega	Tennis Court
34	Sutton Place	Gym / Fitness Center	Italian Restaurant	Furniture / Home Store	Indian Restaurant	Dessert Shop	American Restaurant	Bakery	Juice Bar	Boutique	Sushi Restaurant
39	Hudson Yards	Coffee Shop	Italian Restaurant	Hotel	Theater	American Restaurant	Café	Gym / Fitness Center	Thai Restaurant	Restaurant	Gym

Map of Manhattan places for rent

Several Manhattan real estate webs were web scrapped to collect rental data, as mentioned in section 2.0. The result was summarized in a .csv file for direct reading, in order to consolidate the process. The initial data for 144 apartment did not have the latitude and longitude data (NaN) but the information was established in the following cell using an algorithm and Nominatim.

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
0	West 105th Street	Upper West Side	2.94	5	3400	10000	NaN	NaN
1	East 97th Street	Upper East Side	3.57	3	2100	7500	NaN	NaN
2	West 105th Street	Upper West Side	1.89	4	2800	5300	NaN	NaN
3	CARMINE ST.	West Village	3.03	2	1650	5000	NaN	NaN
4	171 W 23RD ST.	Chelsea	3.45	2	1450	5000	NaN	NaN

```
mh_rent.tail()
```

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
139	200 East 72nd Street	Rental in Lenox Hill	5.15	3	1700	8750	NaN	NaN
140	50 Murray Street	No fee rental in Tribeca	7.11	2	1223	8700	NaN	NaN
141	300 East 56th Street	No fee rental in Midtown East	3.87	3	2100	8118	NaN	NaN
142	1930 Broadway	No fee rental in Central Park West	5.06	2	1600	8095	NaN	NaN
143	33 West 9th Street	Rental in Greenwich Village	6.67	2	1500	10000	NaN	NaN

Obtain geodata (lat, long) for each rental place in Manhattan with Nominatim

Data was stored in a .csv file for simplification of the report and saving code processing time.

This coding was 'markdown' below for the report and its execution concerns.

####Therefore, the csv saved will be just read directly in the following cell. for n in range(len(mh_rent)): address= mh_rent['Address'][n] address=(mh_rent['Address'][n]+ ' , '+' Manhattan NY ') geolocator = Nominatim() location = geolocator.geocode(address) latitude = location.latitude longitude = location.longitude mh_rent['Lat'][n]=latitude mh_rent['Long'][n]=longitude

#print(n,latitude,longitude) time.sleep(2)

print('Geodata completed')

save dataframe to csv file

mh_rent.to_csv('MH_rent_latlong.csv',index=False) mh_rent.shape

```
mh_rent=pd.read_csv('MH_rent_latlong.csv')
mh_rent.head()
```

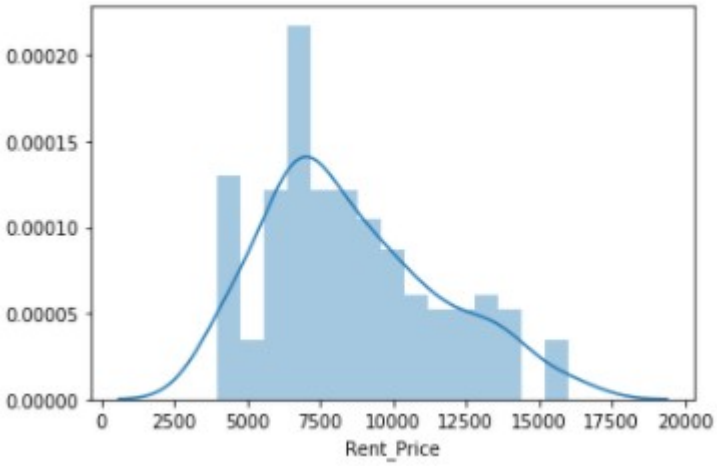
	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
0	West 105th Street	Upper West Side	2.94	5	3400	10000	40.799771	-73.966213
1	East 97th Street	Upper East Side	3.57	3	2100	7500	40.788585	-73.955277
2	West 105th Street	Upper West Side	1.89	4	2800	5300	40.799771	-73.966213
3	CARMINE ST.	West Village	3.03	2	1650	5000	40.730523	-74.001873
4	171 W 23RD ST.	Chelsea	3.45	2	1450	5000	40.744118	-73.995299

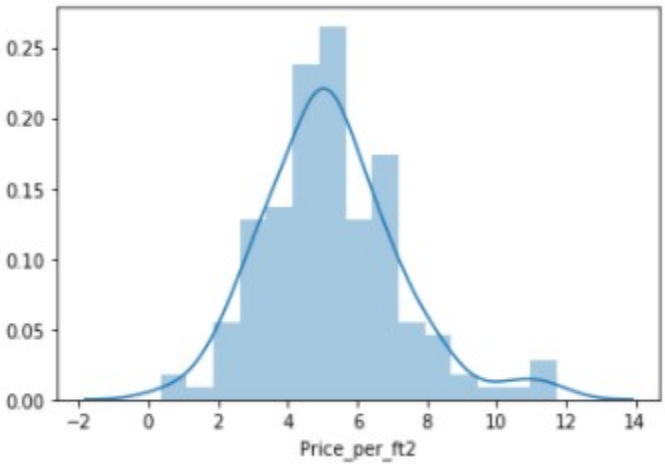
```
mh_rent.tail()
```

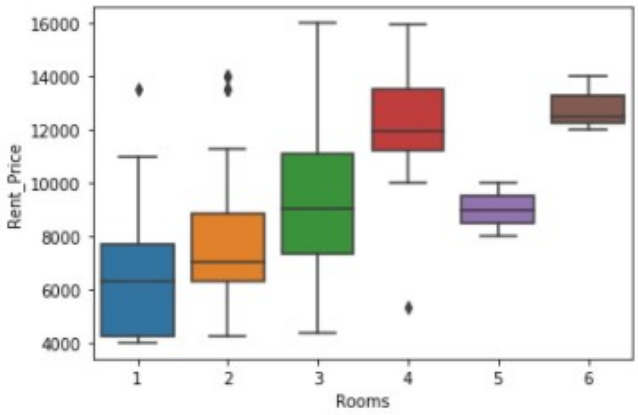
	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
139	200 East 72nd Street	Rental in Lenox Hill	5.15	3	1700	8750	40.769465	-73.960339
140	50 Murray Street	No fee rental in Tribeca	7.11	2	1223	8700	40.714051	-74.009608
141	300 East 56th Street	No fee rental in Midtown East	3.87	3	2100	8118	40.758216	-73.965190
142	1930 Broadway	No fee rental in Central Park West	5.06	2	1600	8095	40.772474	-73.981901
143	33 West 9th Street	Rental in Greenwich Village	6.67	2	1500	10000	40.733691	-73.997323

Manhattan apartment rent price statistics

A US 7000 Dollar per month rent is actually around the mean value - which has similar amenities to Chennai apartment rent! This sounds good.

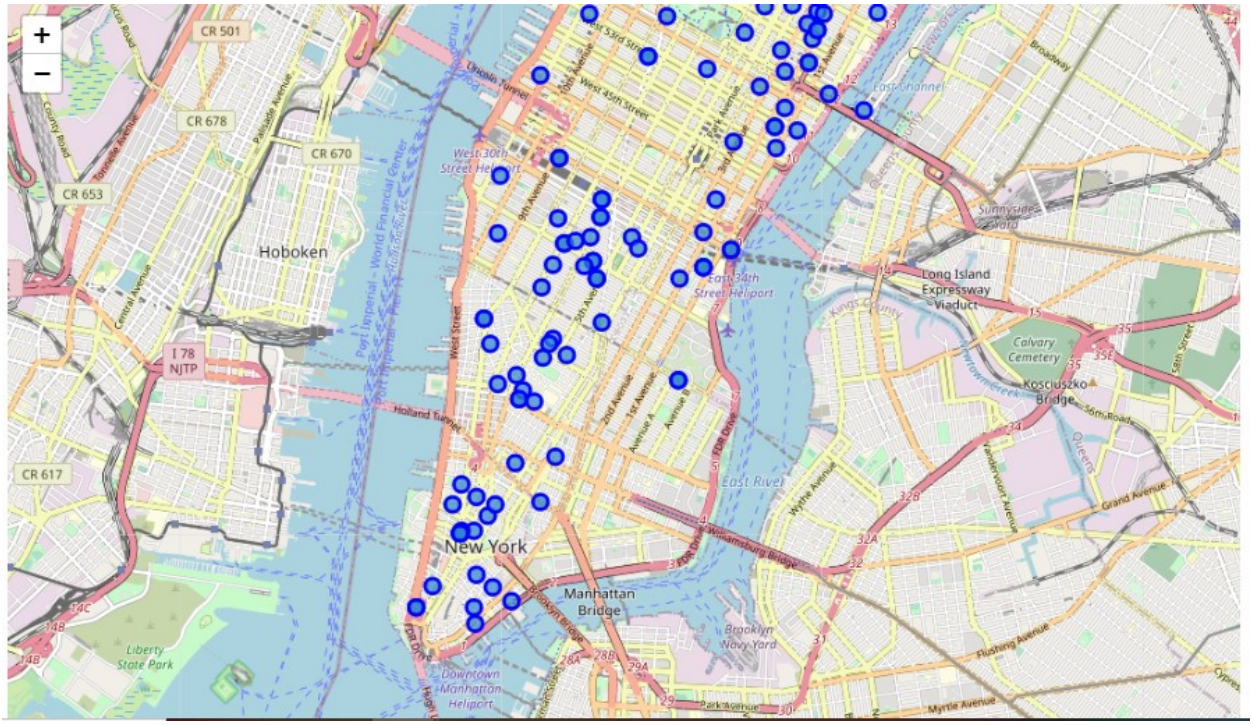






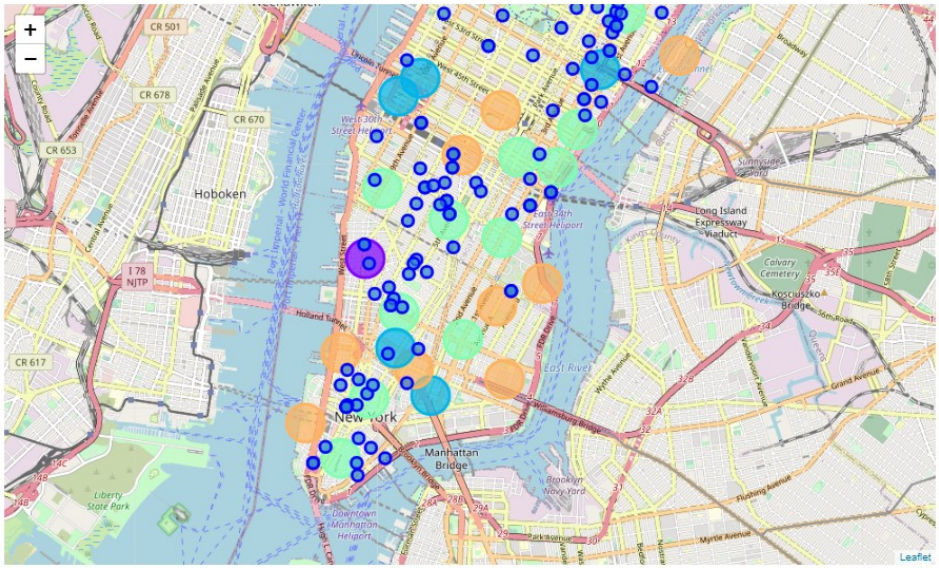
Map of Manhattan apartments for rent

The popups indicates the address and the monthly price for rent by making it convenient to select the target apartment with the price condition stipulated (max US7000)



Map of Manhattan showing the places for rent and the cluster of venues

Now, one can point to a rental place for price and address location information while knowing the cluster venues around it. This is very useful way to explore rental possibilities



Now, one can explore a particular rental place and its venues in detail

In the map shown above, examination of apartments with rental place below 7000/month is straightforward while knowing the venues around it.

We could find an apartment with a right price and in a right location with desirable venues.

The next step is to see if it is located near a subway metro station/railway station, in the following cells -

	Neighborhood	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	9th Most Common Venue	10th Most Common Venue
3	Inwood	Mexican Restaurant	Lounge	Pizza Place	Café	Wine Bar	Bakery	American Restaurant	Park	Frozen Yogurt Shop	Spanish Restaurant
5	Manhattanville	Deli / Bodega	Italian Restaurant	Seafood Restaurant	Mexican Restaurant	Sushi Restaurant	Beer Garden	Coffee Shop	Falafel Restaurant	Bike Trail	Other Nightlife
10	Lenox Hill	Sushi Restaurant	Italian Restaurant	Coffee Shop	Gym / Fitness Center	Pizza Place	Burger Joint	Deli / Bodega	Gym	Sporting Goods Shop	Thai Restaurant
12	Upper West Side	Italian Restaurant	Bar	Bakery	Vegetarian / Vegan Restaurant	Indian Restaurant	Coffee Shop	Cosmetics Shop	Wine Bar	Mexican Restaurant	Sushi Restaurant
16	Murray Hill	Sandwich Place	Hotel	Japanese Restaurant	Gym / Fitness Center	Coffee Shop	Salon / Barbershop	Burger Joint	French Restaurant	Bar	Italian Restaurant
17	Chelsea	Coffee Shop	Italian Restaurant	Ice Cream Shop	Bakery	Nightclub	Theater	Art Gallery	Seafood Restaurant	American Restaurant	Hotel
18	Greenwich Village	Italian Restaurant	Sushi Restaurant	French Restaurant	Clothing Store	Chinese Restaurant	Café	Indian Restaurant	Bakery	Seafood Restaurant	Electronics Store
27	Gramercy	Italian Restaurant	Restaurant	Thrift / Vintage Store	Cocktail Bar	Bagel Shop	Coffee Shop	Pizza Place	Mexican Restaurant	Grocery Store	Wine Shop
29	Financial District	Coffee Shop	Hotel	Gym	Wine Shop	Steakhouse	Bar	Italian Restaurant	Pizza Place	Park	Gym / Fitness Center
31	Noho	Italian Restaurant	French Restaurant	Cocktail Bar	Gift Shop	Bookstore	Grocery Store	Mexican Restaurant	Hotel	Sushi Restaurant	Coffee Shop
32	Civic Center	Gym / Fitness Center	Bakery	Italian Restaurant	Cocktail Bar	French Restaurant	Sandwich Place	Coffee Shop	Gym	Yoga Studio	Park
35	Turtle Bay	Italian Restaurant	Coffee Shop	Steakhouse	Wine Bar	Sushi Restaurant	Hotel	Noodle House	Indian Restaurant	Japanese Restaurant	French Restaurant
36	Tudor City	Café	Park	Pizza Place	Mexican Restaurant	Greek Restaurant	Sushi Restaurant	Hotel	Deli / Bodega	Diner	Dog Run
38	Flatiron	Italian Restaurant	American Restaurant	Gym	Gym / Fitness Center	Yoga Studio	Vegetarian / Vegan Restaurant	Bakery	Clothing Store	Cosmetics Shop	Cycle Studio

Mapping Manhattan Subway locations

Manhattan subway metro locations (address) was obtained from web scrapping sites such as Wikipedia, Google and NY Metro Transit. For simplification, a csv file was produced from the 'numbers' (Apple excel) so that the reading of this file is the starting point here.

The geodata will be obtained via Nominatim using the algorithm below.

	sub_station	sub_address
0	Dyckman Street Subway Station	170 Nagle Ave, New York, NY 10034, USA
1	57 Street Subway Station	New York, NY 10106, USA
2	Broad St	New York, NY 10005, USA
3	175 Street Station	807 W 177th St, New York, NY 10033, USA
4	5 Av and 53 St	New York, NY 10022, USA

	sub_station	sub_address
0	Dyckman Street Subway Station	170 Nagle Ave, New York, NY 10034, USA
1	57 Street Subway Station	New York, NY 10106, USA
2	Broad St	New York, NY 10005, USA
3	175 Street Station	807 W 177th St, New York, NY 10033, USA
4	5 Av and 53 St	New York, NY 10022, USA

Add colums labeled 'lat' and 'long' to be filled with geodata

```
#  Add columns 'lat'  and 'long' to mh dataframe - with random temporary numbers to get started
sLength = len(mh['sub_station'])
lat = pd.Series(np.random.randn(sLength))
long=pd.Series(np.random.randn(sLength))
mh = mh.assign(lat=lat.values)
mh = mh.assign(long=long.values)
```

Algorithm to find latitude and longitude for each subway metro station and add them to data frame

This coding has been 'Markdown' just to simplify the file report, and the csv file will be read in cell below.

for n in range(len(mh)): address= mh['sub_address'][n] geolocator = Nominatim() location = geolocator.geocode(address) latitude = location.latitude longitude = location.longitude mh['lat'][n]=latitude mh['long'][n]=longitude

#print(n,latitude,longitude) time.sleep(2)

print('Geodata completed')

save dataframe to csv file

mh.to_csv('MH_subway.csv',index=False) mh.shape

Read csv file that produced the subway stations list with geodata

	sub_station	sub_address	lat	long
0	Dyckman Street Subway Station	170 Nagle Ave, New York, NY 10034, USA	40.861857	-73.924509
1	57 Street Subway Station	New York, NY 10106, USA	40.764250	-73.954525
2	Broad St	New York, NY 10005, USA	40.730862	-73.987156
3	175 Street Station	807 W 177th St, New York, NY 10033, USA	40.847991	-73.939785
4	5 Av and 53 St	New York, NY 10022, USA	40.764250	-73.954525

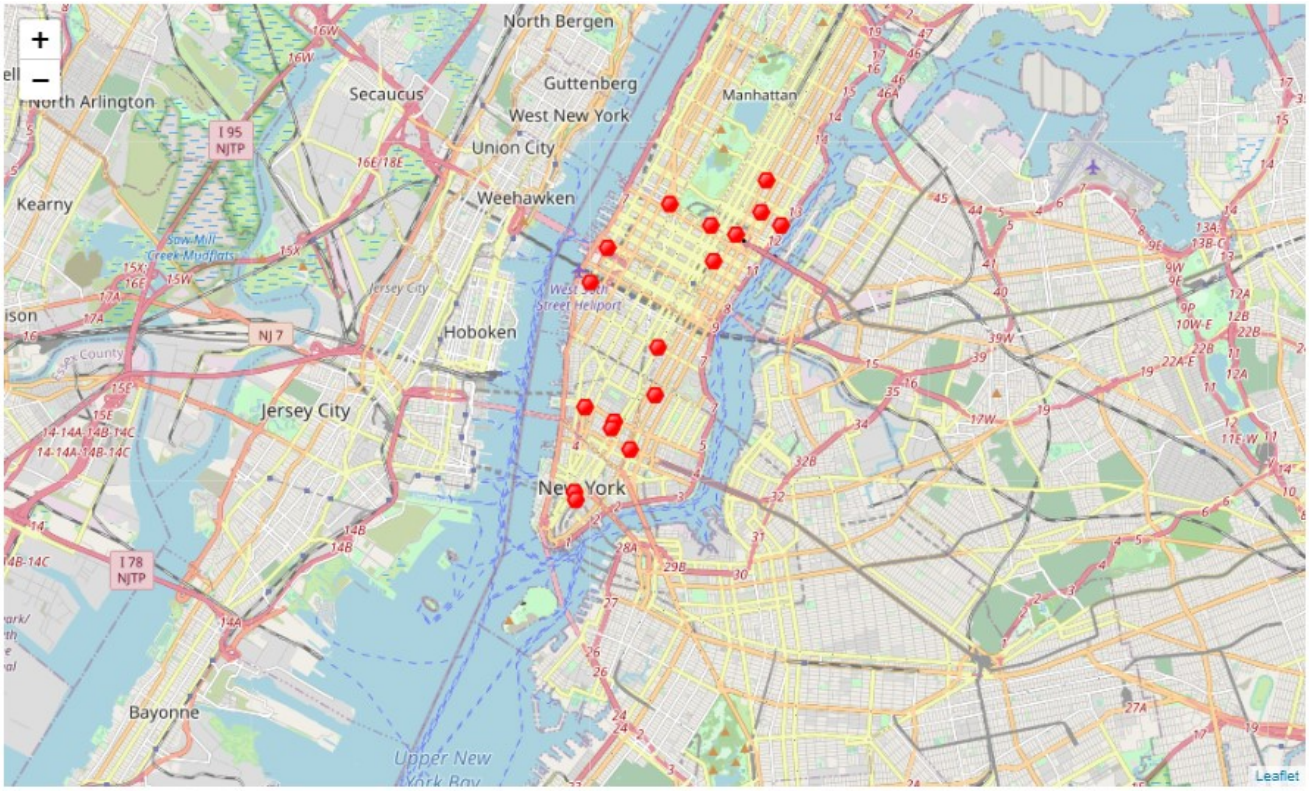
```
# removing duplicate rows and creating a new set mhsub1
mhsub1=mh.drop_duplicates(subset=['lat','long'], keep="last").reset_index(drop=True)
mhsub1.shape
```

```
(22, 4)
```

```
mhsub1.tail()
```

	sub_station	sub_address	lat	long
17	190 Street Subway Station	Bennett Ave, New York, NY 10040, USA	40.858113	-73.932983
18	59 St-Lexington Av Station	E 60th St, New York, NY 10065, USA	40.762259	-73.966271
19	57 Street Station	New York, NY 10019, United States	40.764250	-73.954525
20	14 Street / 8 Av	New York, NY 10014, United States	40.730862	-73.987156
21	MTA New York City	525 11th Ave, New York, NY 10018, USA	40.759809	-73.999282

Manhattan map that shows the location of subway stations



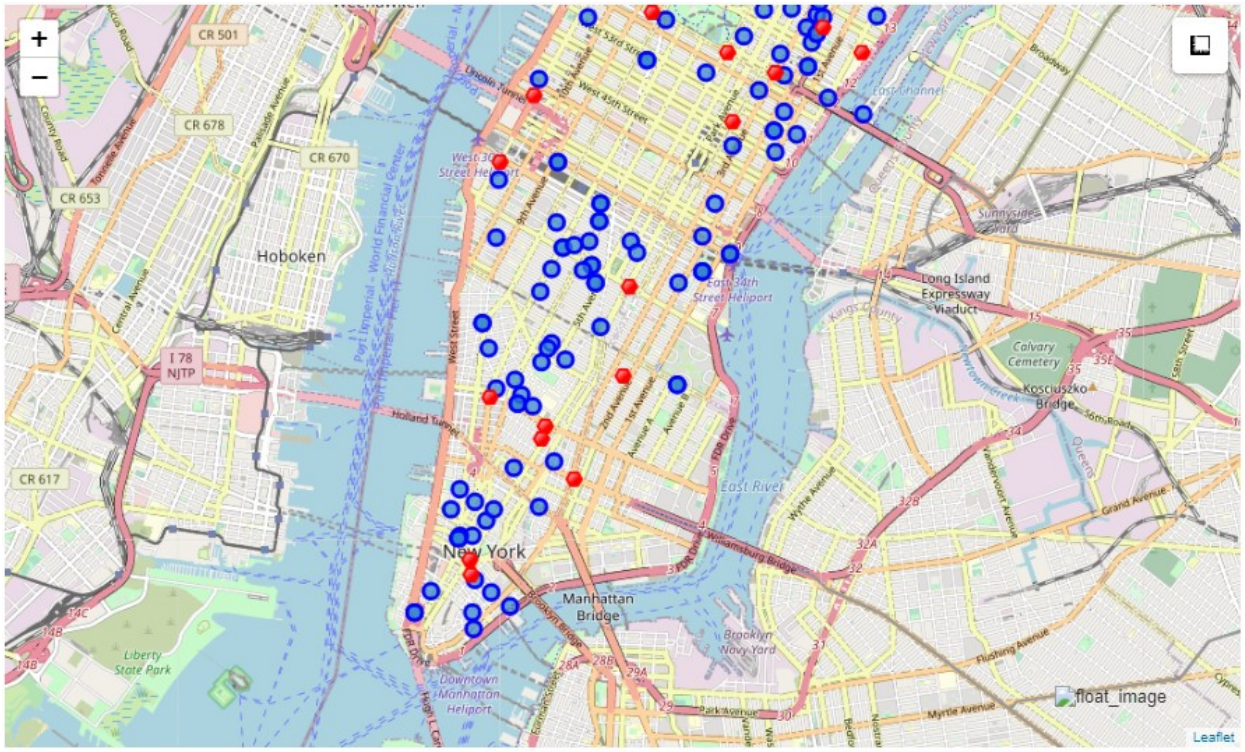
Map of Manhattan showing places for rent and the subway locations nearby

Now, we can visualize the desired rental places and their nearest subway stations. Popups display rental address and monthly rental price and the subway station name.

Notice that the icon in the top-right corner is a "ruler" that allows to measure the distance from a rental place to any specific subway station

```
mh_rent.head()
```

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
0	West 105th Street	Upper West Side	2.94	5	3400	10000	40.799771	-73.966213
1	East 97th Street	Upper East Side	3.57	3	2100	7500	40.788585	-73.955277
2	West 105th Street	Upper West Side	1.89	4	2800	5300	40.799771	-73.966213
3	CARMINE ST.	West Village	3.03	2	1650	5000	40.730523	-74.001873
4	171 W 23RD ST.	Chelsea	3.45	2	1450	5000	40.744118	-73.995299



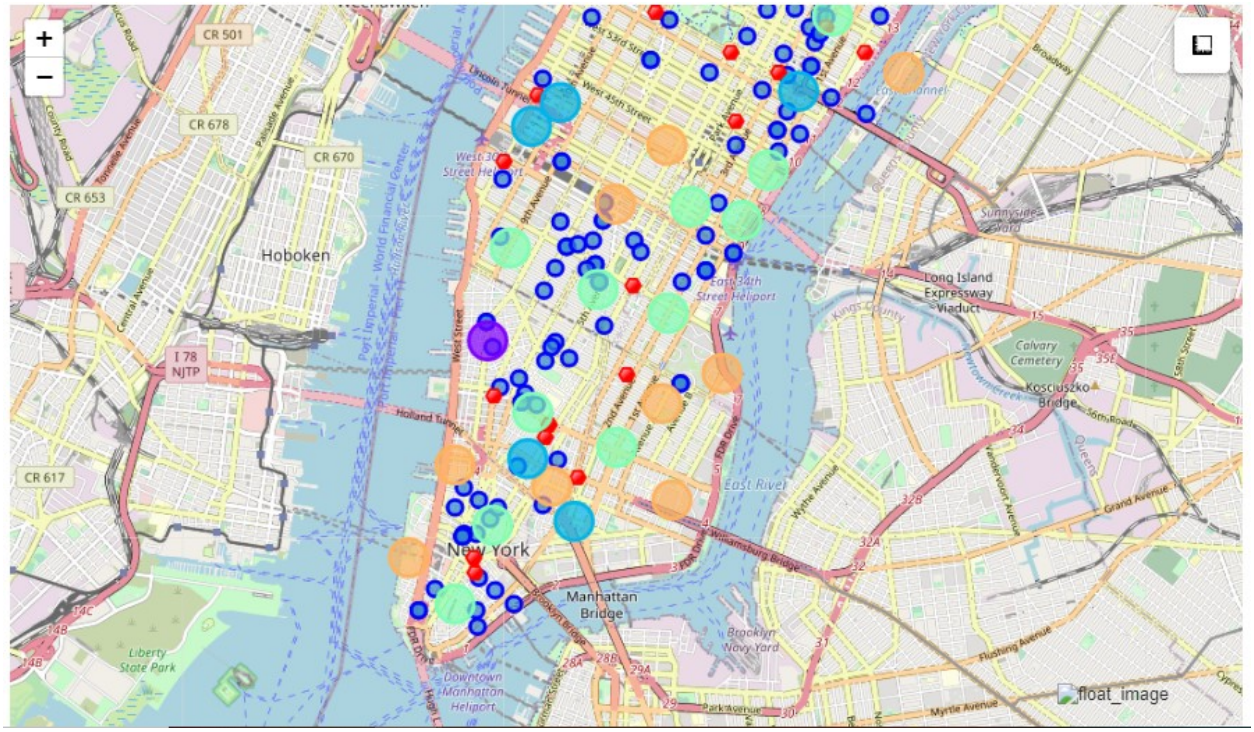
4.0 Results

Consolidating all the results into a single map

I would like to consolidate all the required inforamtion to make the apartment selection in one single map

Map of Manhattan with rental places, subway locations and cluster of venues

**** Red dots are Subway stations, Blue dots are apartments available for rent, Bubbles are the clusters of venues



Solving the Problem - Select the apartment for rent

The above consolidate map was used to explore options.

After examining the above map, I have chosen two locations that meet all the requirements for my friend - which will be further assessed to make a choice.

- Apartment 1: 305 East 63rd Street in the Sutton Place Neighborhood and near 'subway 59th Street' station, Cluster # 2 Monthly rent : 7500 Dollars

- Apartment 2: 19 Dutch Street in the Financial District Neighborhood and near 'Fulton Street Subway' station, Cluster # 3 Monthly rent : 6935 Dollars

Venues for Apartment 1 - Cluster 2

	Neighborhood	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	9th Most Common Venue	10th Most Common Venue
0	Marble Hill	Coffee Shop	Discount Store	Yoga Studio	Steakhouse	Supplement Shop	Tennis Stadium	Shoe Store	Gym	Bank	Seafood Restaurant
1	Chinatown	Chinese Restaurant	Cocktail Bar	Dim Sum Restaurant	American Restaurant	Vietnamese Restaurant	Salon / Barbershop	Noodle House	Bakery	Bubble Tea Shop	Ice Cream Shop
6	Central Harlem	African Restaurant	Seafood Restaurant	French Restaurant	American Restaurant	Cosmetics Shop	Chinese Restaurant	Event Space	Liquor Store	Beer Bar	Gym / Fitness Center
9	Yorkville	Coffee Shop	Gym	Bar	Italian Restaurant	Sushi Restaurant	Pizza Place	Mexican Restaurant	Deli / Bodega	Japanese Restaurant	Pub
14	Clinton	Theater	Italian Restaurant	Coffee Shop	American Restaurant	Gym / Fitness Center	Hotel	Wine Shop	Spa	Gym	Indie Theater
23	Soho	Clothing Store	Boutique	Women's Store	Shoe Store	Men's Store	Furniture / Home Store	Italian Restaurant	Mediterranean Restaurant	Art Gallery	Design Studio
26	Morningside Heights	Coffee Shop	American Restaurant	Park	Bookstore	Pizza Place	Sandwich Place	Burger Joint	Café	Deli / Bodega	Tennis Court
34	Sutton Place	Gym / Fitness Center	Italian Restaurant	Furniture / Home Store	Indian Restaurant	Dessert Shop	American Restaurant	Bakery	Juice Bar	Boutique	Sushi Restaurant
39	Hudson Yards	Coffee Shop	Italian Restaurant	Hotel	Theater	American Restaurant	Café	Gym / Fitness Center	Thai Restaurant	Restaurant	Gym

Venues for Apartment 2 - Cluster 3

	Neighborhood	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	9th Most Common Venue	10th Most Common Venue
3	Inwood	Mexican Restaurant	Lounge	Pizza Place	Café	Wine Bar	Bakery	American Restaurant	Park	Frozen Yogurt Shop	Spanish Restaurant
5	Manhattanville	Deli / Bodega	Italian Restaurant	Seafood Restaurant	Mexican Restaurant	Sushi Restaurant	Beer Garden	Coffee Shop	Falafel Restaurant	Bike Trail	Other Nightlife
10	Lenox Hill	Sushi Restaurant	Italian Restaurant	Coffee Shop	Gym / Fitness Center	Pizza Place	Burger Joint	Deli / Bodega	Gym	Sporting Goods Shop	Thai Restaurant
12	Upper West Side	Italian Restaurant	Bar	Bakery	Vegetarian / Vegan Restaurant	Indian Restaurant	Coffee Shop	Cosmetics Shop	Wine Bar	Mexican Restaurant	Sushi Restaurant
16	Murray Hill	Sandwich Place	Hotel	Japanese Restaurant	Gym / Fitness Center	Coffee Shop	Salon / Barbershop	Burger Joint	French Restaurant	Bar	Italian Restaurant
17	Chelsea	Coffee Shop	Italian Restaurant	Ice Cream Shop	Bakery	Nightclub	Theater	Art Gallery	Seafood Restaurant	American Restaurant	Hotel
18	Greenwich Village	Italian Restaurant	Sushi Restaurant	French Restaurant	Clothing Store	Chinese Restaurant	Café	Indian Restaurant	Bakery	Seafood Restaurant	Electronics Store
27	Gramercy	Italian Restaurant	Restaurant	Thrift / Vintage Store	Cocktail Bar	Bagel Shop	Coffee Shop	Pizza Place	Mexican Restaurant	Grocery Store	Wine Shop
29	Financial District	Coffee Shop	Hotel	Gym	Wine Shop	Steakhouse	Bar	Italian Restaurant	Pizza Place	Park	Gym / Fitness Center
31	Noho	Italian Restaurant	French Restaurant	Cocktail Bar	Gift Shop	Bookstore	Grocery Store	Mexican Restaurant	Hotel	Sushi Restaurant	Coffee Shop
32	Civic Center	Gym / Fitness Center	Bakery	Italian Restaurant	Cocktail Bar	French Restaurant	Sandwich Place	Coffee Shop	Gym	Yoga Studio	Park
35	Turtle Bay	Italian Restaurant	Coffee Shop	Steakhouse	Wine Bar	Sushi Restaurant	Hotel	Noodle House	Indian Restaurant	Japanese Restaurant	French Restaurant
36	Tudor City	Café	Park	Pizza Place	Mexican Restaurant	Greek Restaurant	Sushi Restaurant	Hotel	Deli / Bodega	Diner	Dog Run
38	Flatiron	Italian Restaurant	American Restaurant	Gym	Gym / Fitness Center	Yoga Studio	Vegetarian / Vegan	Bakery	Clothing Store	Cosmetics Shop	Cycle Studio

5.0 Discussion

Apartment Selection

Using the "one map" above, I was able to explore all the possibilities, since the popups provides the information needed to make a right decision.

Apartment 1 rent costs US7500 slightly above the US7000 budget. Apt 1 is located 400 meters away from subway station at 59th Street and it is 600 meters away from work place (Park Ave and 53rd). I can walk to work place and use subway for other places around. Venues for this apt are as of Cluster 2 and it is located in a fine district in the East side of Manhattan.

Apartment 2 rent cost is US6935, just under the US7000 budget. Apt 2 is located 60 meters away from subway station at Fulton Street, but I will have to ride the subway daily to work , possibly 40-60 min ride. Venues for this apt are as of Cluster 3.¶

6.0 Conclusion

Based on current residence - Velachery, Chennai venues, I feel that Cluster 2 type of venues is a closer resemblance to my current place. That means that APARTMENT 1 is a better choice since the extra monthly rent is worth the conveniences (expecially reduces the subway journey to work place) it provides.

I built a model here that is very useful to predict a possible rental place for newly coming people to Manhattan neighborhood.

This model is also useful for other people who want to set up new business ventures in any new places like Manhattan or some other countries.

I just wanted to speak a little bit about how this course work has been - I am very impressed with the content, lab work and overall organization of the Coursera IBM Data Science Certification Course. Also, I feel this Capstone project helped me to find a great opportunity to practice and apply the Data Science skills I learned.