Coursera Capstone Project

The Battle of Neighborhoods - Final Report (Week 1 and 2)

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Upload Libraries Required

In [2]:

```
import numpy as np # library to handle data in a vectorized manner
import time
import pandas as pd # library for data analsysis
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)

import json # library to handle JSON files
import requests # library to handle requests
from pandas.io.json import json_normalize # tranform JSON file into a pandas dataframe

!conda install -c conda-forge geopy --yes # uncomment this line if you haven't complete
d the Foursquare API lab
from geopy.geocoders import Nominatim # convert an address into latitude and longitude
 values

!conda install -c conda-forge folium=0.5.0 --yes # uncomment this line if you haven't c
ompleted the Foursquare API lab
import folium # map rendering library
import folium # map rendering library
from folium import plugins

# Matplotlib and associated plotting modules
import matplotlib.cm as cm
import matplotlib.colors as colors

import seaborn as sns

# import k-means from clustering stage
from sklearn.cluster import KMeans

print('Libraries imported.')
```

```
Solving environment: done


==> WARNING: A newer version of conda exists. <==
  current version: 4.5.11
  latest version: 4.7.12

Please update conda by running

    $ conda update -n base -c defaults conda



## Package Plan ##

  environment location: /home/jupyterlab/conda/envs/python

  added / updated specs:
    - geopy


The following packages will be downloaded:

    package                    |            build
    ---------------------------|-----------------
    scikit-learn-0.20.1        |   py36h22eb022_0         5.7 MB
    liblapack-3.8.0            |      11_openblas          10 KB  conda-fo
rge
    scipy-1.3.2                |   py36h921218d_0        18.0 MB  conda-fo
rge
    geographiclib-1.50         |             py_0          34 KB  conda-fo
rge
    libopenblas-0.3.6          |       h5a2b251_2         7.7 MB
    liblapacke-3.8.0           |      11_openblas          10 KB  conda-fo
rge
    numpy-1.17.3               |   py36h95a1406_0         5.2 MB  conda-fo
rge
    libcblas-3.8.0             |      11_openblas          10 KB  conda-fo
rge
    libblas-3.8.0              |      11_openblas          10 KB  conda-fo
rge
    geopy-1.20.0               |             py_0          57 KB  conda-fo
rge
    blas-2.11                  |         openblas          10 KB  conda-fo
rge
    ------------------------------------------------------------
                                          Total:        36.8 MB

The following NEW packages will be INSTALLED:

    geographiclib: 1.50-py_0                              conda-forge
    geopy:         1.20.0-py_0                            conda-forge
    libblas:       3.8.0-11_openblas                      conda-forge
    libcblas:      3.8.0-11_openblas                      conda-forge
    liblapack:     3.8.0-11_openblas                      conda-forge
    liblapacke:    3.8.0-11_openblas                      conda-forge
    libopenblas:   0.3.6-h5a2b251_2

The following packages will be UPDATED:

    blas:          1.1-openblas                           conda-forge -->
```

```
2.11-openblas         conda-forge
    numpy:         1.16.2-py36_blas_openblash1522bff_0    conda-forge [bla
s_openblas] --> 1.17.3-py36h95a1406_0 conda-forge
    scipy:         1.2.1-py36_blas_openblash1522bff_0     conda-forge [bla
s_openblas] --> 1.3.2-py36h921218d_0  conda-forge

The following packages will be DOWNGRADED:

    scikit-learn:  0.20.1-py36_blas_openblashebff5e3_1200 conda-forge [bla
s_openblas] --> 0.20.1-py36h22eb022_0


Downloading and Extracting Packages
scikit-learn-0.20.1  | 5.7 MB    | ##################################### |
100%
liblapack-3.8.0      | 10 KB     | ##################################### |
100%
scipy-1.3.2          | 18.0 MB   | ##################################### |
100%
geographiclib-1.50   | 34 KB     | ##################################### |
100%
libopenblas-0.3.6    | 7.7 MB    | ##################################### |
100%
liblapacke-3.8.0     | 10 KB     | ##################################### |
100%
numpy-1.17.3         | 5.2 MB    | ##################################### |
100%
libcblas-3.8.0       | 10 KB     | ##################################### |
100%
libblas-3.8.0        | 10 KB     | ##################################### |
100%
geopy-1.20.0         | 57 KB     | ##################################### |
100%
blas-2.11            | 10 KB     | ##################################### |
100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
Solving environment: done


==> WARNING: A newer version of conda exists. <==
  current version: 4.5.11
  latest version: 4.7.12

Please update conda by running

    $ conda update -n base -c defaults conda



# All requested packages already installed.

Libraries imported.
```

Coursera Capstone - REPORT

Content

Introduction Section :

1.1 Discussion of the "backgroung situation" leading to the problem at hand:

1.2 Problem to be resolved

1.3 Audience for this project.

Data Section:

2.1 Data of Current Situation (current residence place)

2.2 Data required to resolve the problem

2.3 Data sources and data manipulation

Methodology section :

3.1 Process steps and strategy to resolve the problem

3.2 Data Science Methods, machine learing, mapping tools and exploratory data analysis.

Results section

Discussion of the results and how they help to take a decision.

Discussion section

Elaboration and discussion on any observations and/or recommendations for improvement.

Conclusion section

Decision taken and Report Conclusion

1. Introduction Section :

Discussion of the business problem and the audience who would be interested in this project.

1.1 Scenario and Background

I am working as Global IT Infrastructure Manager and currently residing in Harrow, London, United Kingdom. I currently live within walking distance to "Harrow Metro station" therefore I have access to good public transportation to work. Likewise, I enjoy many ammenities in the neighborhood , such as international cousine restaurants, cafes, food shops, malls and entertainment again in a walking distance. I have been offered a great opportunity to work in Manhattan, NY. Although, I am very excited about it, I am a bit stress toward the process to secure a comparable place to live in Manhattan. Therefore, I decided to apply the learned skills during the Coursera course to explore ways to make sure my decision is factual and rewarding. Of course, there are alternatives to achieve the answer using available Google and Social media tools, but it rewarding doing it myself with learned tools.

1.2 Problem to be resolved:

The challenge to resolve is being able to find a rental apartment unit in Manhattan NY that offers similar characteristics and benefits to my current situation. Therefore, in order to set a basis for comparison, I want to find a renta unit subject to the following conditions:

Apartment with min 2 bedrooms with monthly rent not to exceed US$5000/month Unit located within walking distance (<=1.0 mile, 1.6 km) from a subway metro station in Manhattan Area with ammenities and venues similar to the ones described for current location (See item 2.1)

1.3 Interested Audience

This is a relevant project for a person or entity considering moving to a major city in Europe, US or Asia, since the approach and methodologies used here are applicable in all cases. The use of FourSquare data and mapping techniques combined with data analysis will help resolve the key questions arisen. Lastly, this project is a good practical case toward the development of Data Science skills.

2. Data Section :

Description of the data and its sources that will be used to solve the problem.

2.1 Data of Current Situation

I Currently reside in the neighborhood of 'Harrow-On-The-Hill' in London UK. I use Foursquare to identify the venues around the area of residence which are then shown in the London map shown in methodology and execution in section 3.0 . It serves as a reference for comparison with the desired future location in Manhattan NY

2.2 Data Required to resolve 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 (latitud and longitud. List/Information about the subway metro stations in Manhattan with geodata. Listed apartments for rent in Manhattan area with descriptions (how many beds, price, location, address) Venues and ammenities in the Manhattan neighborhoods (e.g. top 10) 2.3 sources and manipulation The list of Manhattan neighborhoods is worked out during LAb exercise during the course. We will follow the same exercise to create the Manhattan dataframe out of NewYork neighborhood dataframe. The clustering of neighborhoods and mapping will be shown however. An algorithm was used to determine the geodata from Nominatim.NY Neighborhood has a total of 5 boroughs and 306 neighborhoods. In order to segement the neighborhoods and explore them, we will essentially need a dataset that contains the 5 boroughs and the neighborhoods that exist in each borough as well as the the latitude and logitude coordinates of each neighborhood. Luckily, this dataset exists for free on the web. Feel free to try to find this dataset on your own, but here is the link to the dataset: https://geo.nyu.edu/catalog/nyu_2451_34572 (https://geo.nyu.edu/catalog/nyu_2451_34572)

In [4]:

```
!wget -q -O 'newyork_data.json' https://cocl.us/new_york_dataset
print('Data downloaded!')
```

```
Data downloaded!
```

Load and explore the data

Next, let's load the data.

In [5]:

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

In [6]:

```
## Quick look at the data
newyork_data
```

Out[6]:


```
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```

```
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```
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   'coordinates': [-73.82667757138641, 40.79060155670148]},
  'geometry_name': 'geom',
  'properties': {'name': 'Malba',
   'stacked': 1,
   'annoline1': 'Malba',
   'annoline2': None,
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Queens',
   'bbox': [-73.82667757138641,
    40.79060155670148,
    -73.82667757138641,
    40.79060155670148]}},
 {'type': 'Feature',
  'id': 'nyu_2451_34572.296',
  'geometry': {'type': 'Point',
   'coordinates': [-73.890345709872, 40.6819989345173]},
  'geometry_name': 'geom',
  'properties': {'name': 'Highland Park',
   'stacked': 2,
   'annoline1': 'Highland',
   'annoline2': 'Park',
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Brooklyn',
   'bbox': [-73.890345709872,
    40.6819989345173,
    -73.890345709872,
    40.6819989345173]}},
 {'type': 'Feature',
  'id': 'nyu_2451_34572.297',
  'geometry': {'type': 'Point',
   'coordinates': [-73.94841515328893, 40.60937770113766]},
  'geometry_name': 'geom',
  'properties': {'name': 'Madison',
   'stacked': 1,
   'annoline1': 'Madison',
   'annoline2': None,
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Brooklyn',
   'bbox': [-73.94841515328893,
    40.60937770113766,
    -73.94841515328893,
    40.60937770113766]}},
 {'type': 'Feature',
  'id': 'nyu_2451_34572.298',
```

```
  'geometry': {'type': 'Point',
   'coordinates': [-73.86172577555115, 40.85272297633017]},
  'geometry_name': 'geom',
  'properties': {'name': 'Bronxdale',
   'stacked': 1,
   'annoline1': 'Bronxdale',
   'annoline2': None,
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Bronx',
   'bbox': [-73.86172577555115,
    40.85272297633017,
    -73.86172577555115,
    40.85272297633017]}},
 {'type': 'Feature',
  'id': 'nyu_2451_34572.299',
  'geometry': {'type': 'Point',
   'coordinates': [-73.85931863221647, 40.86578787802982]},
  'geometry_name': 'geom',
  'properties': {'name': 'Allerton',
   'stacked': 1,
   'annoline1': 'Allerton',
   'annoline2': None,
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Bronx',
   'bbox': [-73.85931863221647,
    40.86578787802982,
    -73.85931863221647,
    40.86578787802982]}},
 {'type': 'Feature',
  'id': 'nyu_2451_34572.300',
  'geometry': {'type': 'Point',
   'coordinates': [-73.90152264513144, 40.8703923914147]},
  'geometry_name': 'geom',
  'properties': {'name': 'Kingsbridge Heights',
   'stacked': 2,
   'annoline1': 'Kingsbridge',
   'annoline2': 'Heights',
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Bronx',
   'bbox': [-73.90152264513144,
    40.8703923914147,
    -73.90152264513144,
    40.8703923914147]}},
 {'type': 'Feature',
  'id': 'nyu_2451_34572.301',
  'geometry': {'type': 'Point',
   'coordinates': [-73.94817709920184, 40.64692606658579]},
  'geometry_name': 'geom',
  'properties': {'name': 'Erasmus',
   'stacked': 1,
   'annoline1': 'Erasmus',
   'annoline2': None,
   'annoline3': None,
   'annoangle': 0.0,
   'borough': 'Brooklyn',
   'bbox': [-73.94817709920184,
    40.64692606658579,
    -73.94817709920184,
```

```
       40.64692606658579]}},
     {'type': 'Feature',
      'id': 'nyu_2451_34572.302',
      'geometry': {'type': 'Point',
       'coordinates': [-74.00011136202637, 40.75665808227519]},
      'geometry_name': 'geom',
      'properties': {'name': 'Hudson Yards',
       'stacked': 2,
       'annoline1': 'Hudson',
       'annoline2': 'Yards',
       'annoline3': None,
       'annoangle': 0.0,
       'borough': 'Manhattan',
       'bbox': [-74.00011136202637,
        40.75665808227519,
        -74.00011136202637,
        40.75665808227519]}},
     {'type': 'Feature',
      'id': 'nyu_2451_34572.303',
      'geometry': {'type': 'Point',
       'coordinates': [-73.80553002968718, 40.58733774018741]},
      'geometry_name': 'geom',
      'properties': {'name': 'Hammels',
       'stacked': 1,
       'annoline1': 'Hammels',
       'annoline2': None,
       'annoline3': None,
       'annoangle': 0.0,
       'borough': 'Queens',
       'bbox': [-73.80553002968718,
        40.58733774018741,
        -73.80553002968718,
        40.58733774018741]}},
     {'type': 'Feature',
      'id': 'nyu_2451_34572.304',
      'geometry': {'type': 'Point',
       'coordinates': [-73.76596781445627, 40.611321691283834]},
      'geometry_name': 'geom',
      'properties': {'name': 'Bayswater',
       'stacked': 1,
       'annoline1': 'Bayswater',
       'annoline2': None,
       'annoline3': None,
       'annoangle': 0.0,
       'borough': 'Queens',
       'bbox': [-73.76596781445627,
        40.611321691283834,
        -73.76596781445627,
        40.611321691283834]}},
     {'type': 'Feature',
      'id': 'nyu_2451_34572.305',
      'geometry': {'type': 'Point',
       'coordinates': [-73.94563070334091, 40.756091297094706]},
      'geometry_name': 'geom',
      'properties': {'name': 'Queensbridge',
       'stacked': 1,
       'annoline1': 'Queensbridge',
       'annoline2': None,
       'annoline3': None,
       'annoangle': 0.0,
       'borough': 'Queens',
```

```
      'bbox': [-73.94563070334091,
       40.756091297094706,
       -73.94563070334091,
       40.756091297094706]}},
    {'type': 'Feature',
     'id': 'nyu_2451_34572.306',
     'geometry': {'type': 'Point',
      'coordinates': [-74.08173992211962, 40.61731079252983]},
     'geometry_name': 'geom',
     'properties': {'name': 'Fox Hills',
      'stacked': 2,
      'annoline1': 'Fox',
      'annoline2': 'Hills',
      'annoline3': None,
      'annoangle': 0.0,
      'borough': 'Staten Island',
      'bbox': [-74.08173992211962,
       40.61731079252983,
       -74.08173992211962,
       40.61731079252983]}}],
   'crs': {'type': 'name', 'properties': {'name': 'urn:ogc:def:crs:EPSG::432
6'}},
   'bbox': [-74.2492599487305,
    40.5033187866211,
    -73.7061614990234,
    40.9105606079102]}
```


Notice how all the relevant data is in the features key, which is basically a list of the neighborhoods. So, let's define a new variable that includes this data

In [7]:

```
neighborhoods_data = newyork_data['features']
```

In [8]:

```
## Lets take a look at the first item
neighborhoods_data[0]
```

Out[8]:


```
{'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]}}
```

Tranform the data into a pandas dataframe

The next task is essentially transforming this data of nested Python dictionaries into a pandas dataframe. So let's start by creating an empty dataframe.

In [9]:

```
# define the dataframe columns
column_names = ['Borough', 'Neighborhood', 'Latitude', 'Longitude']

# instantiate the dataframe
neighborhoods = pd.DataFrame(columns=column_names)
```

Take a look at the empty dataframe to confirm that the columns are as intended.

In [10]:

```
neighborhoods
```

Out[10]:

	Borough	Neighborhood	Latitude	Longitude

Then let's loop through the data and fill the dataframe one row at a time.

In [11]:

```
for data in neighborhoods_data:
    borough = neighborhood_name = data['properties']['borough']
    neighborhood_name = data['properties']['name']

    neighborhood_latlon = data['geometry']['coordinates']
    neighborhood_lat = neighborhood_latlon[1]
    neighborhood_lon = neighborhood_latlon[0]

    neighborhoods = neighborhoods.append({'Borough': borough,
                                          'Neighborhood': neighborhood_name,
                                          'Latitude': neighborhood_lat,
                                          'Longitude': neighborhood_lon}, ignore_index=
True)
```

In [12]:

```
## Examine the resulting dataframe
neighborhoods.head()
```

Out[12]:

	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

Make sure that the dataset has all 5 boroughs and 306 neighborhoods

In [13]:

```
print('The dataframe has {} boroughs and {} neighborhoods.'.format(
        len(neighborhoods['Borough'].unique()),
        neighborhoods.shape[0]
    )
)
```

```
The dataframe has 5 boroughs and 306 neighborhoods.
```

Now we want to concentrate specifically on the Manhattan area of NewYork

In [14]:

```
manhattan_data = neighborhoods[neighborhoods['Borough'] == 'Manhattan'].reset_index(dro
p=True)
manhattan_data.head()
```

Out[14]:

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

A consolidated list of Manhattan subway metro stops was obtained from different sources like Wikipedia and Google Maps - https://www.google.com/maps/search/manhattan+subway+metro+stations/@40.7837297,-74.1033043,11z/data (https://www.google.com/maps/search/manhattan+subway+metro+stations/@40.7837297,-74.1033043,11z/dat The geolocation was obtained using Nominatum and the compiled data has been updated on 'MH_subway.csv' which has been uploaded on the server. A list of places for rent was collected by web-browsing real estate companies in Manhattan and they have been again compiled into a 2 csv file - 'MH_flat_price' and 'MH_rent_latlong'. The latitude and longtitude was measured using Nominatum. Both the files have been uploaded here.

2.4 How the data will be used to solve the problem

The data will be used as follows: Use 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.

2.5 Mapping of Data

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. Mehtodology Section :

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 stragegy:

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, rental price and similar venues to Singapore. This visual approach and maps with popups labels allow quick identification of location, price and feature, thus making the selection very easy.

The procesing of these DATA and its mapping will allow to answer 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

London Map - Current residence and venues in neighborhood

for comparison to future Manhattan renting place

In [15]:

```
import numpy as np # library to handle data in a vectorized manner
import time
import pandas as pd # library for data analsysis
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)

import json # library to handle JSON files
import requests # library to handle requests
from pandas.io.json import json_normalize # tranform JSON file into a pandas dataframe

!conda install -c conda-forge geopy --yes # uncomment this line if you haven't complete
d the Foursquare API lab
from geopy.geocoders import Nominatim # convert an address into latitude and longitude
 values

!conda install -c conda-forge folium=0.5.0 --yes # uncomment this line if you haven't c
ompleted the Foursquare API lab
import folium # map rendering library
import folium # map rendering library
from folium import plugins

# Matplotlib and associated plotting modules
import matplotlib.cm as cm
import matplotlib.colors as colors

import seaborn as sns

# import k-means from clustering stage
from sklearn.cluster import KMeans

print('Libraries imported.')
```

```
Solving environment: done


==> WARNING: A newer version of conda exists. <==
  current version: 4.5.11
  latest version: 4.7.12

Please update conda by running

    $ conda update -n base -c defaults conda



# All requested packages already installed.

Solving environment: done


==> WARNING: A newer version of conda exists. <==
  current version: 4.5.11
  latest version: 4.7.12

Please update conda by running

    $ conda update -n base -c defaults conda



# All requested packages already installed.

Libraries imported.
```

In [16]:

```
# 61A Harrow View Harrow Middlesex HA1 1RF, London
address = 'HA1 1BB, London'
geolocator = Nominatim()
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('The geograpical coordinate of London home are {}, {}.'.format(latitude, longitud
e))
```

```
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:3: DeprecationWarning: Using Nominatim with the default "geopy/
1.20.0" `user_agent` is strongly discouraged, as it violates Nominatim's T
oS https://operations.osmfoundation.org/policies/nominatim/ and may possib
ly cause 403 and 429 HTTP errors. Please specify a custom `user_agent` wit
h `Nominatim(user_agent="my-application")` or by overriding the default `u
ser_agent`: `geopy.geocoders.options.default_user_agent = "my-applicatio
n"`. In geopy 2.0 this will become an exception.
  This is separate from the ipykernel package so we can avoid doing import
s until

The geograpical coordinate of London home are 51.5792506219278, -0.3366546
50465704.
```

In [17]:

```
london_neighborhood_latitude=51.5792506219278
london_neighborhood_longitude=-0.336654650465704
```

In [18]:

```
CLIENT_ID = '3KXGMKM5RUPRL4RVTLPHMDM0URPYG2CCHMQNRBPZXH1LIGOQ' # your Foursquare ID
CLIENT_SECRET = 'EITLOMN03TU4MFEI3EJMBOSPQ425W1Q4R0VVSYLD4CMMCBWY' # your Foursquare Se
cret
VERSION = '20180605' # Foursquare API version
```

In [19]:

```
LIMIT = 100 # limit of number of venues returned by Foursquare API
radius = 500 # define radius
# create URL
url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}&v={}
&ll={},{}&radius={}&limit={}'.format(
    CLIENT_ID,
    CLIENT_SECRET,
    VERSION,
    london_neighborhood_latitude,
    london_neighborhood_longitude,
    radius,
    LIMIT)
url # display URL
```

Out[19]:

```
'https://api.foursquare.com/v2/venues/explore?&client_id=3KXGMKM5RUPRL4RVT
LPHMDM0URPYG2CCHMQNRBPZXH1LIGOQ&client_secret=EITLOMN03TU4MFEI3EJMBOSPQ425
W1Q4R0VVSYLD4CMMCBWY&v=20180605&ll=51.5792506219278,-0.336654650465704&rad
ius=500&limit=100'
```

In [20]:

```
# results display is hidden for report simplification
results = requests.get(url).json()
#results
```

Function that extracts the category of the venue - borrow from the Foursquare lab.

In [21]:

```
def get_category_type(row):
    try:
        categories_list = row['categories']
    except:
        categories_list = row['venue.categories']

    if len(categories_list) == 0:
        return None
    else:
        return categories_list[0]['name']
```

In [22]:

```
venues = results['response']['groups'][0]['items']
LNnearby_venues = json_normalize(venues) # flatten JSON
# filter columns
filtered_columns = ['venue.name', 'venue.categories', 'venue.location.lat', 'venue.loca
tion.lng']
LNnearby_venues =LNnearby_venues.loc[:, filtered_columns]
# filter the category for each row
LNnearby_venues['venue.categories'] = LNnearby_venues.apply(get_category_type, axis=1)
# clean columns
LNnearby_venues.columns = [col.split(".")[-1] for col in LNnearby_venues.columns]

LNnearby_venues.shape
```

Out[22]:

```
(39, 4)
```

In [23]:

```
# Venues near current London residence place
LNnearby_venues.head(10)
```

Out[23]:

	name	categories	lat	lng
0	Kebab Land	Middle Eastern Restaurant	51.580034	-0.335987
1	The Chocolate Room	Chocolate Shop	51.580970	-0.333788
2	O'Neill's	Irish Pub	51.580524	-0.334012
3	Nando's	Portuguese Restaurant	51.581665	-0.333119
4	Costa Coffee	Coffee Shop	51.581614	-0.337093
5	Pret A Manger	Sandwich Place	51.581589	-0.336928
6	The Trinity Bar	Bar	51.579124	-0.333766
7	M&S Simply Food	Grocery Store	51.579040	-0.337109
8	Primark	Clothing Store	51.580858	-0.336767
9	The Gym London Harrow on the Hill	Gym	51.580833	-0.340597

Map of London residence place with venues in Neighborhood - for reference

In [24]:

```
latitude=51.5792506219278
longitude=-0.336654650465704
# create map of Singapore place  using latitude and longitude values
map_ln = folium.Map(location=[latitude, longitude], zoom_start=18)
# add markers to map
for lat, lng, label in zip(LNnearby_venues['lat'], LNnearby_venues['lng'], LNnearby_ven
ues['name']):
    label = folium.Popup(label, parse_html=True)
    folium.RegularPolygonMarker(
        [lat, lng],
        number_of_sides=30,
        radius=7,
        popup=label,
        color='blue',
        fill_color='#0f0f0f',
        fill_opacity=0.6,
    ).add_to(map_ln)

map_ln
```

Out[24]:

Manhattan Neighborhoods

In [25]:

```
manhattan_data.head()
```

Out[25]:

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

In [26]:

```
manhattan_data.tail()
```

Out[26]:

	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

Manhattan Borough neighborhoods - data with top 10 clustered venues

In [27]:

```
manhattan_merged = pd.read_csv('manhattan_merged.csv')
manhattan_merged.head()
```

Out[27]:

	Borough	Neighborhood	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue
0	Manhattan	Marble Hill	40.876551	-73.910660	2	Coffee Shop	Discount Store	Yoga Studio
1	Manhattan	Chinatown	40.715618	-73.994279	2	Chinese Restaurant	Cocktail Bar	Dim Sum Restaurant
2	Manhattan	Washington Heights	40.851903	-73.936900	4	Café	Bakery	Mobile Phone Shop
3	Manhattan	Inwood	40.867684	-73.921210	3	Mexican Restaurant	Lounge	Pizza Place
4	Manhattan	Hamilton Heights	40.823604	-73.949688	0	Mexican Restaurant	Coffee Shop	Café

Map of Manhattan neighborhoods with top 10 clustered venues

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

In [28]:

```
# create map of Manhattan using latitude and longitude values from Nominatim
latitude= 40.7308619
longitude= -73.9871558

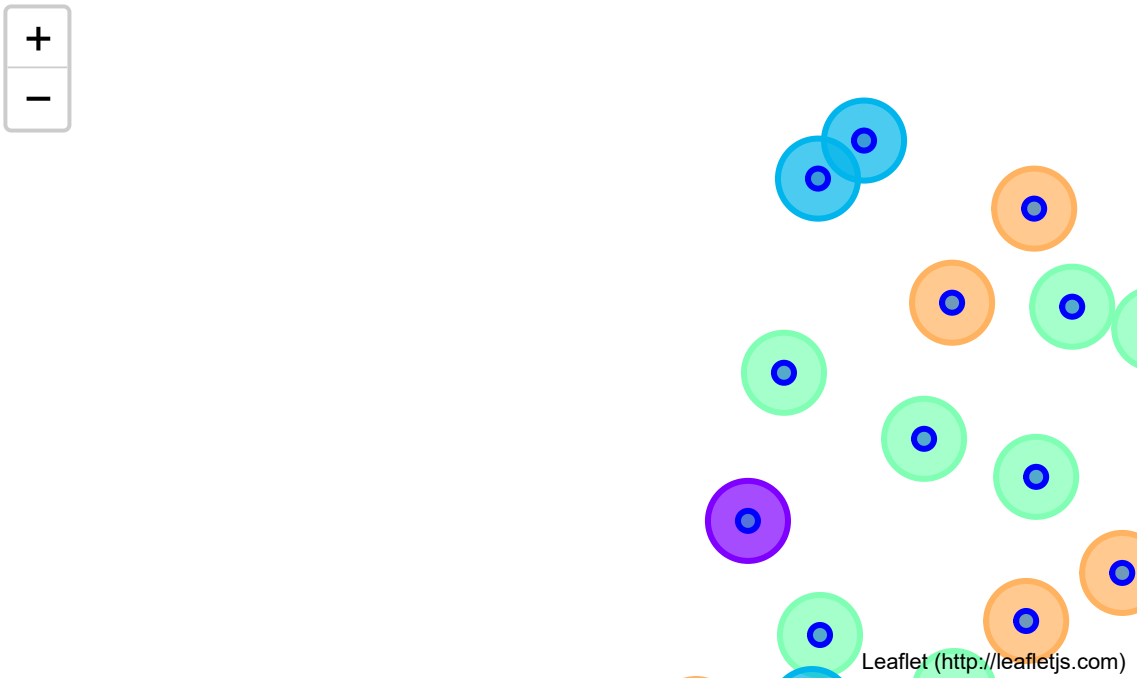
kclusters=5
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=13)

# set color scheme for the clusters
x = np.arange(kclusters)
ys = [i+x+(i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(manhattan_merged['Latitude'], manhattan_merged['Longi
tude'], manhattan_merged['Neighborhood'], manhattan_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=20,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)
  # add markers for rental places to map
for lat, lng, label in zip(manhattan_data['Latitude'], manhattan_data['Longitude'], man
hattan_data['Neighborhood']):
    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_clusters)


map_clusters
```

Out[28]:



Examine a paticular Cluster - print venues¶

After examining several cluster data , I concluded that cluster # 2 resembles closer the Singapore place, therefore providing guidance as to where to look for the future apartment.

Assign a value to 'kk' to explore a given cluster.

In [29]:

```
## kk is the cluster number to explore
kk = 2
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == kk, manhattan_merged.columns
[[1] + list(range(5, manhattan_merged.shape[1]))]]
```

Out[29]:

	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	7 C
0	Marble Hill	Coffee Shop	Discount Store	Yoga Studio	Steakhouse	Supplement Shop	Tennis Stadium	
1	Chinatown	Chinese Restaurant	Cocktail Bar	Dim Sum Restaurant	American Restaurant	Vietnamese Restaurant	Salon / Barbershop	
6	Central Harlem	African Restaurant	Seafood Restaurant	French Restaurant	American Restaurant	Cosmetics Shop	Chinese Restaurant	
9	Yorkville	Coffee Shop	Gym	Bar	Italian Restaurant	Sushi Restaurant	Pizza Place	Re
14	Clinton	Theater	Italian Restaurant	Coffee Shop	American Restaurant	Gym / Fitness Center	Hotel	Wi
23	Soho	Clothing Store	Boutique	Women's Store	Shoe Store	Men's Store	Furniture / Home Store	Re
26	Morningside Heights	Coffee Shop	American Restaurant	Park	Bookstore	Pizza Place	Sandwich Place	
34	Sutton Place	Gym / Fitness Center	Italian Restaurant	Furniture / Home Store	Indian Restaurant	Dessert Shop	American Restaurant	
39	Hudson Yards	Coffee Shop	Italian Restaurant	Hotel	Theater	American Restaurant	Café	

Map of Manhattan places for rent

Several Manhattan real estate webs were webscrapped to collect rental data, as mentioned in section 2.0 . The resut was summarized in a csv file for direct reading, in order to consolidate the proces.

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 algorythm and Nominatim.

In [34]:

```
# csv files with rental places with basic data but still wihtout geodata ( latitude and longitude)
# pd.read_csv(' le.csv', header=None, nrows=5)
mh_rent=pd.read_csv('MH_flats_price.csv')
mh_rent.head()
```

Out[34]:

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
0	West 105th Street	Upper West Side	2.94	5.0	3400	10000	NaN	NaN
1	East 97th Street	Upper East Side	3.57	3.0	2100	7500	NaN	NaN
2	West 105th Street	Upper West Side	1.89	4.0	2800	5300	NaN	NaN
3	CARMINE ST.	West Village	3.03	2.0	1650	5000	NaN	NaN
4	171 W 23RD ST.	Chelsea	3.45	2.0	1450	5000	NaN	NaN

In [35]:

```
mh_rent.tail()
```

Out[35]:

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
139	200 East 72nd Street	Rental in Lenox Hill	5.15	3.0	1700	8750	NaN	NaN
140	50 Murray Street	No fee rental in Tribeca	7.11	2.0	1223	8700	NaN	NaN
141	300 East 56th Street	No fee rental in Midtown East	3.87	3.0	2100	8118	NaN	NaN
142	1930 Broadway	No fee rental in Central Park West	5.06	2.0	1600	8095	NaN	NaN
143	33 West 9th Street	Rental in Greenwich Village	6.67	2.0	1500	10000	NaN	NaN

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

Data was stored in a csv file for simplifaction report purposes and saving code processing time in future.

In [36]:

```
#from geopy.exc import GeocoderTimedOut

#def do_geocode(address):
 #   try:
  #      return geopy.geocode(address)
   # except GeocoderTimedOut:
    #    return do_geocode(address)

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)
    ##location = do_geocode(address)
    latitude = location.latitude
    longitude = location.longitude
    mh_rent['Lat'][n]=latitude
    mh_rent['Long'][n]=longitude

    print(n,latitude,longitude)
    time.sleep(10)

print('Geodata completed')
```

```
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:13: DeprecationWarning: Using Nominatim with the default "geop
y/1.20.0" `user_agent` is strongly discouraged, as it violates Nominatim's
ToS https://operations.osmfoundation.org/policies/nominatim/ and may possi
bly cause 403 and 429 HTTP errors. Please specify a custom `user_agent` wi
th `Nominatim(user_agent="my-application")` or by overriding the default `
user_agent`: `geopy.geocoders.options.default_user_agent = "my-applicatio
n"`. In geopy 2.0 this will become an exception.
  del sys.path[0]
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:18: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:19: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

```
0 40.7997711 -73.9662127
1 40.785255 -73.9473498
2 40.7997711 -73.9662127
3 40.730523 -74.0018726
4 40.7441181 -73.9952986
5 40.7296308947368 -74.0044396842105
6 40.7905011 -73.971814
7 40.77432445 -73.9528355356558
8 40.7791759 -73.9507943
9 40.7729692 -73.9582529
10 40.7489204 -74.0070372
11 40.741274 -73.975343
12 40.741274 -73.975343
13 40.7814292 -73.9541758
14 40.741274 -73.975343
15 40.7489204 -74.0070372
16 40.7441181 -73.9952986
17 40.7682243 -73.9606386
18 40.744392 -73.9937220008557
19 40.7729692 -73.9582529
20 40.7729692 -73.9582529
21 40.7729692 -73.9582529
22 40.78274985 -73.9503837703951
23 40.72804555 -74.0014756325424
24 40.7049117 -74.01494
25 40.7759672 -73.9556097
26 40.7842778 -73.9814338
27 40.778834 -73.953789
28 40.8230404 -73.948841218702
29 40.7911766 -73.9523161546756
30 40.7140514285714 -74.0096081428571
31 40.7143027 -74.00768025
32 40.76222965 -73.9756807792635
33 40.7511512 -74.0040704475092
34 40.74873265 -73.9901121731928
35 40.7669023 -73.9620628
36 40.77701435 -73.9886093585106
37 40.7887449 -73.967049
38 40.7629089 -73.9617727
39 40.7759413 -73.9527735
40 40.7596221538462 -73.9591424615385
41 40.7842778 -73.9814338
42 40.7142983 -74.0094222
```

```
---------------------------------------------------------------------------
-
OSError                                   Traceback (most recent call las
t)
~/conda/envs/python/lib/python3.6/urllib/request.py in do_open(self, http_
class, req, **http_conn_args)
   1317                 h.request(req.get_method(), req.selector, req.dat
a, headers,
-> 1318                           encode_chunked=req.has_header('Transfer-
encoding'))
   1319             except OSError as err: # timeout error

~/conda/envs/python/lib/python3.6/http/client.py in request(self, method,
 url, body, headers, encode_chunked)
   1238         """Send a complete request to the server."""
-> 1239         self._send_request(method, url, body, headers, encode_chun
ked)
   1240

~/conda/envs/python/lib/python3.6/http/client.py in _send_request(self, me
thod, url, body, headers, encode_chunked)
   1284             body = _encode(body, 'body')
-> 1285         self.endheaders(body, encode_chunked=encode_chunked)
   1286

~/conda/envs/python/lib/python3.6/http/client.py in endheaders(self, messa
ge_body, encode_chunked)
   1233             raise CannotSendHeader()
-> 1234         self._send_output(message_body, encode_chunked=encode_chun
ked)
   1235

~/conda/envs/python/lib/python3.6/http/client.py in _send_output(self, mes
sage_body, encode_chunked)
   1025         del self._buffer[:]
-> 1026         self.send(msg)
   1027

~/conda/envs/python/lib/python3.6/http/client.py in send(self, data)
    963             if self.auto_open:
--> 964                 self.connect()
    965             else:

~/conda/envs/python/lib/python3.6/http/client.py in connect(self)
   1391
-> 1392             super().connect()
   1393

~/conda/envs/python/lib/python3.6/http/client.py in connect(self)
    935         self.sock = self._create_connection(
--> 936             (self.host,self.port), self.timeout, self.source_addre
ss)
    937         self.sock.setsockopt(socket.IPPROTO_TCP, socket.TCP_NODELA
Y, 1)

~/conda/envs/python/lib/python3.6/socket.py in create_connection(address,
 timeout, source_address)
    723     if err is not None:
--> 724         raise err
    725     else:
```

```
~/conda/envs/python/lib/python3.6/socket.py in create_connection(address,
 timeout, source_address)
    712                 sock.bind(source_address)
--> 713             sock.connect(sa)
    714             # Break explicitly a reference cycle

OSError: [Errno 99] Cannot assign requested address

During handling of the above exception, another exception occurred:

URLError                                  Traceback (most recent call las
t)
~/conda/envs/python/lib/python3.6/site-packages/geopy/geocoders/base.py in
_call_geocoder(self, url, timeout, raw, requester, deserializer, **kwargs)
    354         try:
--> 355             page = requester(req, timeout=timeout, **kwargs)
    356         except Exception as error:

~/conda/envs/python/lib/python3.6/urllib/request.py in open(self, fullurl,
data, timeout)
    525
--> 526         response = self._open(req, data)
    527

~/conda/envs/python/lib/python3.6/urllib/request.py in _open(self, req, da
ta)
    543         result = self._call_chain(self.handle_open, protocol, prot
ocol +
--> 544                                   '_open', req)
    545         if result:

~/conda/envs/python/lib/python3.6/urllib/request.py in _call_chain(self, c
hain, kind, meth_name, *args)
    503             func = getattr(handler, meth_name)
--> 504             result = func(*args)
    505             if result is not None:

~/conda/envs/python/lib/python3.6/urllib/request.py in https_open(self, re
q)
   1360             return self.do_open(http.client.HTTPSConnection, req,
-> 1361                 context=self._context, check_hostname=self._check_
hostname)
   1362

~/conda/envs/python/lib/python3.6/urllib/request.py in do_open(self, http_
class, req, **http_conn_args)
   1319             except OSError as err: # timeout error
-> 1320                 raise URLError(err)
   1321             r = h.getresponse()

URLError: <urlopen error [Errno 99] Cannot assign requested address>

During handling of the above exception, another exception occurred:

GeocoderServiceError                      Traceback (most recent call las
t)
<ipython-input-36-d4a37ed4b126> in <module>
     12     address=(mh_rent['Address'][n]+ ' , '+' Manhattan NY ')
     13     geolocator = Nominatim()
---> 14     location = geolocator.geocode(address)
     15     ##location = do_geocode(address)
```

```
     16     latitude = location.latitude

~/conda/envs/python/lib/python3.6/site-packages/geopy/geocoders/osm.py in
geocode(self, query, exactly_one, timeout, limit, addressdetails, languag
e, geometry, extratags, country_codes, viewbox, bounded)
    385
    386         return self._parse_json(
--> 387             self._call_geocoder(url, timeout=timeout), exactly_one
    388         )
    389

~/conda/envs/python/lib/python3.6/site-packages/geopy/geocoders/base.py in
_call_geocoder(self, url, timeout, raw, requester, deserializer, **kwargs)
    384                 if "timed out" in message:
    385                     raise GeocoderTimedOut('Service timed out')
--> 386             raise GeocoderServiceError(message)
    387
    388         if hasattr(page, 'getcode'):

GeocoderServiceError: [Errno 99] Cannot assign requested address
```

In [37]:

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

Out[37]:

```
(144, 8)
```

In [38]:

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

Out[38]:

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
0	West 105th Street	Upper West Side	2.94	5.0	3400	10000	40.799771	-73.966213
1	East 97th Street	Upper East Side	3.57	3.0	2100	7500	40.785255	-73.947350
2	West 105th Street	Upper West Side	1.89	4.0	2800	5300	40.799771	-73.966213
3	CARMINE ST.	West Village	3.03	2.0	1650	5000	40.730523	-74.001873
4	171 W 23RD ST.	Chelsea	3.45	2.0	1450	5000	40.744118	-73.995299

In [39]:

```
mh_rent.tail()
```

Out[39]:

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
139	200 East 72nd Street	Rental in Lenox Hill	5.15	3.0	1700	8750	NaN	NaN
140	50 Murray Street	No fee rental in Tribeca	7.11	2.0	1223	8700	NaN	NaN
141	300 East 56th Street	No fee rental in Midtown East	3.87	3.0	2100	8118	NaN	NaN
142	1930 Broadway	No fee rental in Central Park West	5.06	2.0	1600	8095	NaN	NaN
143	33 West 9th Street	Rental in Greenwich Village	6.67	2.0	1500	10000	NaN	NaN

In [40]:

```
# Drop the row which has no value, there is some issue with the geocode encoder with th
e present notebook hance had to take this option for the sake of time
mh_rent.dropna(inplace=True)
```

In [41]:

```
mh_rent.tail()
```

Out[41]:

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
38	305 East 63rd Street	Rental in Lenox Hill	6.47	3.0	1392	9000	40.762909	-73.961773
39	303 East 83rd Street	No fee rental in Yorkville	6.79	4.0	1759	11950	40.775941	-73.952773
40	1113 York Avenue	Rental in Lenox Hill	6.29	3.0	1750	11000	40.759622	-73.959142
41	393 West End Avenue	Rental in Riverside Dr./West End Ave.	6.16	3.0	1622	9995	40.784278	-73.981434
42	51 Murray Street	Rental in Tribeca	5.63	2.0	1600	9000	40.714298	-74.009422

In [42]:

```
mh_rent.shape
```

Out[42]:

```
(43, 8)
```

Manhattan apartment rent price statistics

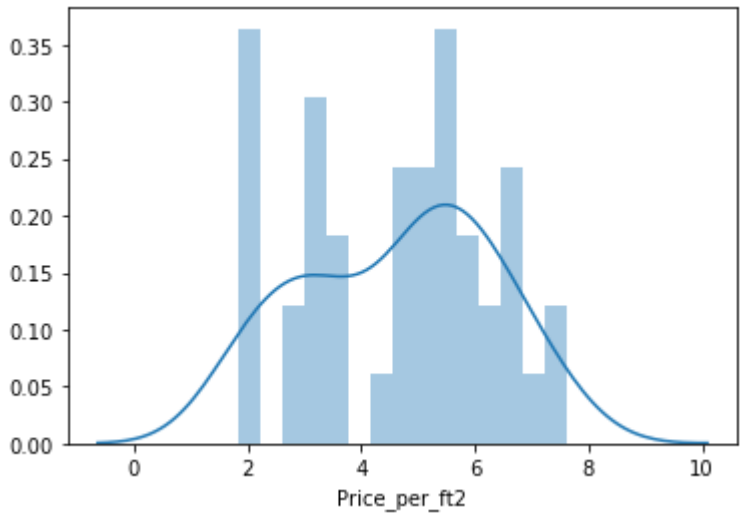
import seaborn as sns sns.distplot(mh_rent['Rent_Price'],bins=15)

In [43]:

```
import seaborn as sns
sns.distplot(mh_rent['Price_per_ft2'],bins=15)
```

Out[43]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f03eaf7a2e8>
```

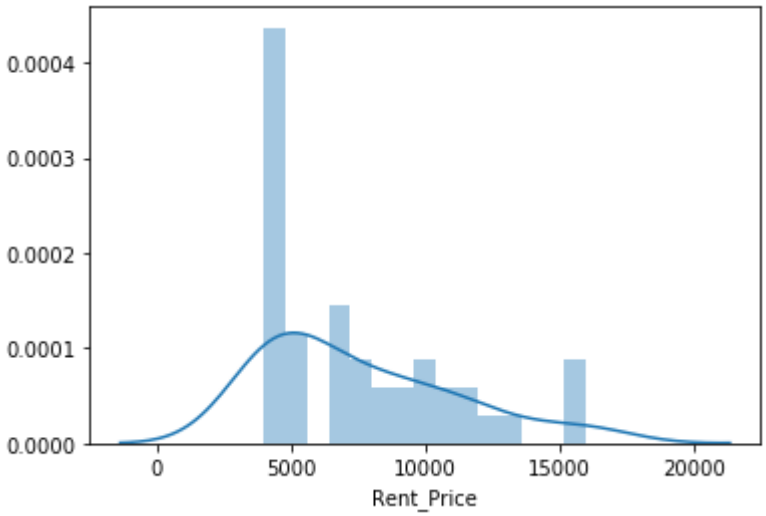


In [44]:

```
import seaborn as sns
sns.distplot(mh_rent['Rent_Price'],bins=15)
```

Out[44]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f03dff06630>
```

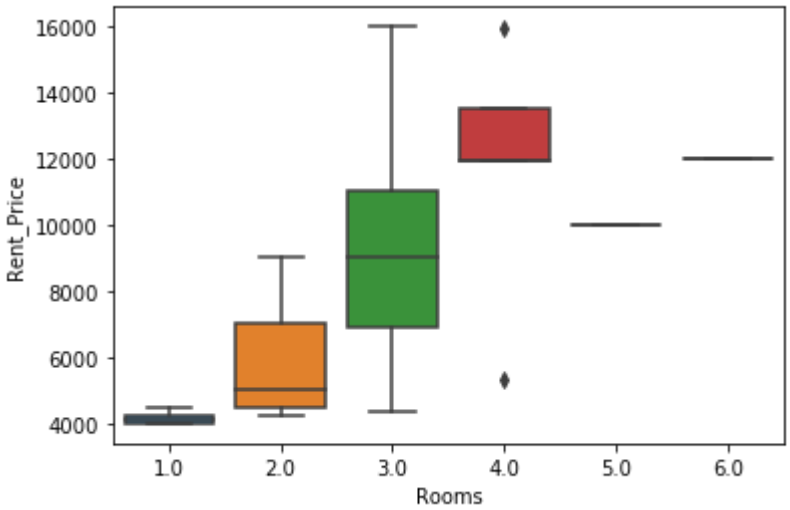


In [45]:

```
sns.boxplot(x='Rooms', y= 'Rent_Price', data=mh_rent)
```

Out[45]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f03dfed16a0>
```



The mean rental value of Manhattan is somewhere near 7000 dollar which is on a slighlty higher side than the budget of 5000 dollar

Map of Manhattan apartments for rent

The popups will indicate the address and the monthly price for rent thus making it convenient to select the target appartment with the price condition estipulated (max US5000)

In [46]:

```
# create map of Manhattan using latitude and longitude values from Nominatim
latitude= 40.7308619
longitude= -73.9871558

map_manhattan_rent = folium.Map(location=[latitude, longitude], zoom_start=12.5)

# add markers to map
for lat, lng, label in zip(mh_rent['Lat'], mh_rent['Long'],'$ ' + mh_rent['Rent_Price']
.astype(str)+ ',  '+ mh_rent['Address']):
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker([lat, lng],radius=6,popup=label,color='green',fill=True,fill_co
lor='#2149xx',fill_opacity=0.7,parse_html=False).add_to(map_manhattan_rent)

map_manhattan_rent
```

Out[46]:

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 an insightful way to explore rental possibilites

In [47]:

```
# create map of Manhattan using latitude and longitude values from Nominatim
latitude= 40.7308619
longitude= -73.9871558

# create map with clusters
kclusters=5
map_clusters2 = folium.Map(location=[latitude, longitude], zoom_start=13)

# set color scheme for the clusters
x = np.arange(kclusters)
ys = [i+x+(i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(manhattan_merged['Latitude'], manhattan_merged['Longi
tude'], manhattan_merged['Neighborhood'], manhattan_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=20,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters2)

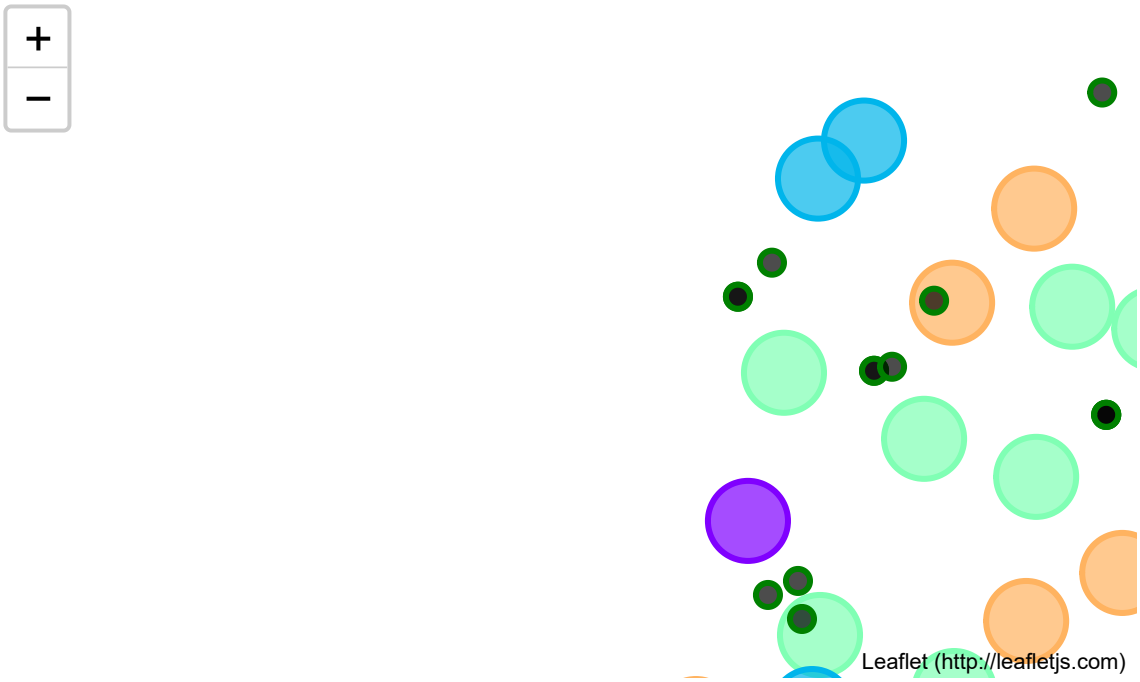
# add markers to map for rental places
for lat, lng, label in zip(mh_rent['Lat'], mh_rent['Long'],'$ ' + mh_rent['Rent_Price']
.astype(str)+ mh_rent['Address']):
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=6,
        popup=label,
        color='green',
        fill=True,
        fill_color='#2149xx',
        fill_opacity=0.7,
        parse_html=False).add_to(map_clusters2)

    # Adds tool to the top right
from folium.plugins import MeasureControl
map_manhattan_rent.add_child(MeasureControl())

# FMeasurement ruler icon to establish distnces on map
from folium.plugins import FloatImage
url = ('https://media.licdn.com/mpr/mpr/shrinknp_100_100/AAEAAQAAAAAAAAlgAAAAJGE3OTA4YT
dlLTkzZjUtNDFjYy1iZThlLWQ5OTNkYzlhNzM4OQ.jpg')
FloatImage(url, bottom=5, left=85).add_to(map_manhattan_rent)

map_clusters2
```

Out[47]:



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

In the map above, examination of appartments with rental place below 5000/month is straightforwad while knowing the venues around it.

We could find an appartment with at the right price and in a location with desirable venues. The next step is to see if it is located near a subway metro station, in next cells work.

In [48]:

```
## kk is the cluster number to explore
kk = 3
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == kk, manhattan_merged.columns
[[1] + list(range(5, manhattan_merged.shape[1]))]]
```

Out[48]:

	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	7 C
3	Inwood	Mexican Restaurant	Lounge	Pizza Place	Café	Wine Bar	Bakery	A Re
5	Manhattanville	Deli / Bodega	Italian Restaurant	Seafood Restaurant	Mexican Restaurant	Sushi Restaurant	Beer Garden	
10	Lenox Hill	Sushi Restaurant	Italian Restaurant	Coffee Shop	Gym / Fitness Center	Pizza Place	Burger Joint	
12	Upper West Side	Italian Restaurant	Bar	Bakery	Vegetarian / Vegan Restaurant	Indian Restaurant	Coffee Shop	Cc
16	Murray Hill	Sandwich Place	Hotel	Japanese Restaurant	Gym / Fitness Center	Coffee Shop	Salon / Barbershop	
17	Chelsea	Coffee Shop	Italian Restaurant	Ice Cream Shop	Bakery	Nightclub	Theater	Ar
18	Greenwich Village	Italian Restaurant	Sushi Restaurant	French Restaurant	Clothing Store	Chinese Restaurant	Café	Re
27	Gramercy	Italian Restaurant	Restaurant	Thrift / Vintage Store	Cocktail Bar	Bagel Shop	Coffee Shop	
29	Financial District	Coffee Shop	Hotel	Gym	Wine Shop	Steakhouse	Bar	Re
31	Noho	Italian Restaurant	French Restaurant	Cocktail Bar	Gift Shop	Bookstore	Grocery Store	I Re
32	Civic Center	Gym / Fitness Center	Bakery	Italian Restaurant	Cocktail Bar	French Restaurant	Sandwich Place	
35	Turtle Bay	Italian Restaurant	Coffee Shop	Steakhouse	Wine Bar	Sushi Restaurant	Hotel	
36	Tudor City	Café	Park	Pizza Place	Mexican Restaurant	Greek Restaurant	Sushi Restaurant	
38	Flatiron	Italian Restaurant	American Restaurant	Gym	Gym / Fitness Center	Yoga Studio	Vegetarian / Vegan Restaurant	

Mapping Manhattan Subway locations

Manhattan subway metro locations (address) was obtained from webscrapping 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 obtain via Nominatim using the algorythm below

In [49]:

```
# A csv file summarized the subway station and the addresses for next step to determine geodata
mh=pd.read_csv('NYC_subway_list.csv')
mh.head()
```

Out[49]:

	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

In [50]:

```
#  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 longitud for each subway metro station and add them to dataframe

In [51]:

```
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(10)

print('Geodata completed')
```

```
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:3: DeprecationWarning: Using Nominatim with the default "geopy/
1.20.0" `user_agent` is strongly discouraged, as it violates Nominatim's T
oS https://operations.osmfoundation.org/policies/nominatim/ and may possib
ly cause 403 and 429 HTTP errors. Please specify a custom `user_agent` wit
h `Nominatim(user_agent="my-application")` or by overriding the default `u
ser_agent`: `geopy.geocoders.options.default_user_agent = "my-applicatio
n"`. In geopy 2.0 this will become an exception.
  This is separate from the ipykernel package so we can avoid doing import
s until
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  import sys
/home/jupyterlab/conda/envs/python/lib/python3.6/site-packages/ipykernel_l
auncher.py:8: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

```
0 40.8618571 -73.9245089
1 40.764201 -73.954413
2 40.7127281 -74.0060152
3 40.8479915 -73.939785
4 40.764201 -73.954413
5 40.7256842 -73.9977263
6 40.7587979 -73.9623427
7 40.7587979 -73.9623427
8 40.7202174 -73.99372
9 40.7530381632653 -74.0038601836735
10 40.764201 -73.954413
11 40.764201 -73.954413
12 40.7127281 -74.0060152
13 40.7587979 -73.9623427
14 40.764201 -73.954413
15 40.764201 -73.954413
16 40.7663058 -73.9601825
17 40.7127281 -74.0060152
18 40.7587979 -73.9623427
19 40.7127281 -74.0060152
20 40.7127281 -74.0060152
21 40.764201 -73.954413
22 40.764201 -73.954413
23 40.7127281 -74.0060152
24 40.764201 -73.954413
25 40.7127281 -74.0060152
26 40.7244125 -73.998317
27 40.8618571 -73.9245089
28 40.7127281 -74.0060152
29 40.764201 -73.954413
30 40.764201 -73.954413
31 40.764201 -73.954413
32 40.7127281 -74.0060152
33 40.7127281 -74.0060152
34 40.7401651 -73.9863046
35 40.764201 -73.954413
36 40.7127281 -74.0060152
37 40.764201 -73.954413
38 40.764201 -73.954413
39 41.50160425 -73.9592157045435
40 40.764201 -73.954413
41 40.7684096 -73.981987
42 40.7587979 -73.9623427
43 40.764201 -73.954413
44 40.76429 -73.97282
45 40.7571476 -73.9720784
46 40.764201 -73.954413
47 40.7587979 -73.9623427
48 40.7729692 -73.9582529
49 40.7286179 -74.0053112
50 40.764201 -73.954413
51 40.7119091 -74.008034
52 40.7127281 -74.0060152
53 40.7127281 -74.0060152
54 40.7587979 -73.9623427
55 40.7587979 -73.9623427
56 40.7127281 -74.0060152
57 40.7127281 -74.0060152
58 40.7587979 -73.9623427
59 40.8499781 -73.9386594
60 40.710358 -74.00782
```

```
61 40.7587979 -73.9623427
62 40.764201 -73.954413
63 40.764201 -73.954413
64 40.764201 -73.954413
65 40.858113 -73.932983
66 40.7614119 -73.9643222
67 40.7127281 -74.0060152
68 40.764201 -73.954413
69 40.764201 -73.954413
70 40.7127281 -74.0060152
71 40.764201 -73.954413
72 40.764201 -73.954413
73 40.7587979 -73.9623427
74 40.7127281 -74.0060152
75 40.7598088 -73.9992819
Geodata completed
```

Save dataframe to csv file

In [52]:

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

Out[52]:

```
(76, 4)
```

In [54]:

```
mh=pd.read_csv('MH_subway.csv')
print(mh.shape)
mh.head()
```

```
(76, 4)
```

Out[54]:

	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	40.764201	-73.954413
2	Broad St	New York, NY 10005, USA	40.712728	-74.006015
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	40.764201	-73.954413

In [55]:

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

Out[55]:

```
(23, 4)
```

In [56]:

```
mhsub1.tail()
```

Out[56]:

	sub_station	sub_address	lat	long
18	59 St-Lexington Av Station	E 60th St, New York, NY 10065, USA	40.761412	-73.964322
19	57 Street Station	New York, NY 10019, United States	40.764201	-73.954413
20	23 Street Station	New York, NY 10010, United States	40.758798	-73.962343
21	14 Street / 8 Av	New York, NY 10014, United States	40.712728	-74.006015
22	MTA New York City	525 11th Ave, New York, NY 10018, USA	40.759809	-73.999282

MAP of Manhattan showing the location of subway stations¶

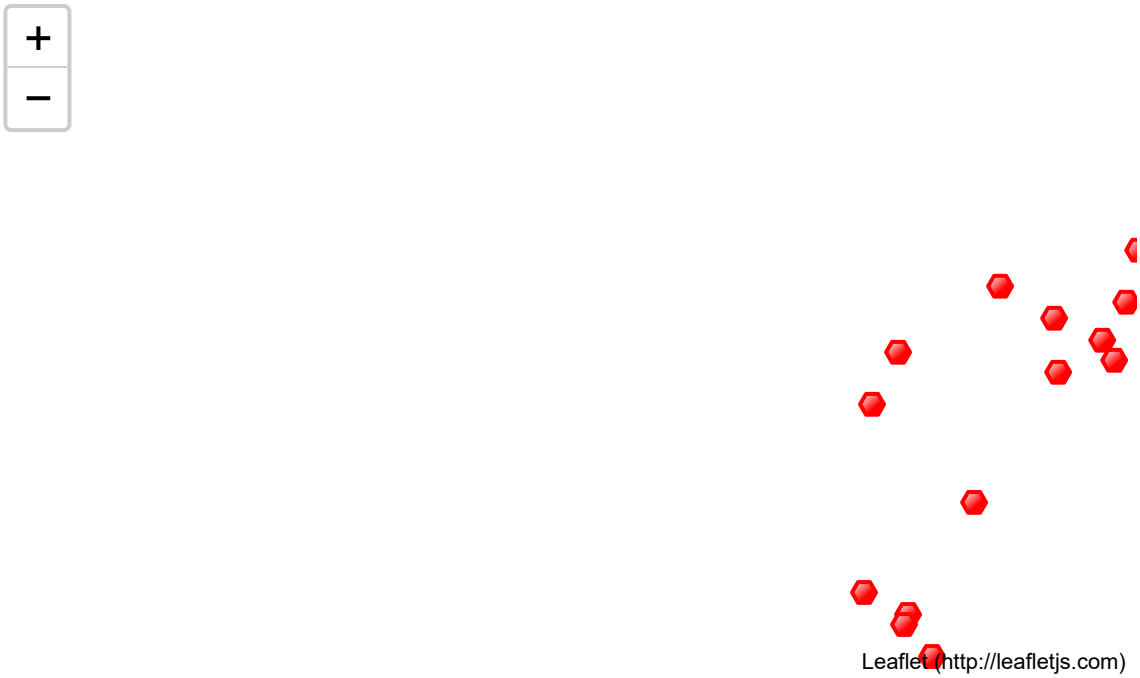
In [57]:

```
# map subway stations
# create map of Manhattan using latitude and longitude values obtain previoulsy via Mon
inatim geolocator
latitude=40.7308619
longitude=-73.9871558

map_mhsub1 = folium.Map(location=[latitude, longitude], zoom_start=12)

# add markers of subway locations to map
for lat, lng, label in zip(mhsub1['lat'], mhsub1['long'],  mhsub1['sub_station'].astype
(str) ):
    label = folium.Popup(label, parse_html=True)
    folium.RegularPolygonMarker([lat,lng],number_of_sides=6,radius=6,popup=label,color=
'red',fill_color='red',fill_opacity=2.5,).add_to(map_mhsub1)
map_mhsub1
```

Out[57]:



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

Now, we can visualize the desirable rental places and their nearest subway station. 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 an specific subway station¶

In [58]:

```
mh_rent.head()
```

Out[58]:

	Address	Area	Price_per_ft2	Rooms	Area-ft2	Rent_Price	Lat	Long
0	West 105th Street	Upper West Side	2.94	5.0	3400	10000	40.799771	-73.966213
1	East 97th Street	Upper East Side	3.57	3.0	2100	7500	40.785255	-73.947350
2	West 105th Street	Upper West Side	1.89	4.0	2800	5300	40.799771	-73.966213
3	CARMINE ST.	West Village	3.03	2.0	1650	5000	40.730523	-74.001873
4	171 W 23RD ST.	Chelsea	3.45	2.0	1450	5000	40.744118	-73.995299

In [59]:

```
# create map of Manhattan using latitude and longitude values from Nominatim
latitude= 40.7308619
longitude= -73.9871558

map_manhattan_rent = folium.Map(location=[latitude, longitude], zoom_start=13.3)

# add markers to map
for lat, lng, label in zip(mh_rent['Lat'], mh_rent['Long'],'$ ' + mh_rent['Rent_Price']
.astype(str)+ mh_rent['Address']):
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=6,
        popup=label,
        color='orange',
        fill=True,
        fill_color='#1234ab',
        fill_opacity=0.7,
        parse_html=False).add_to(map_manhattan_rent)

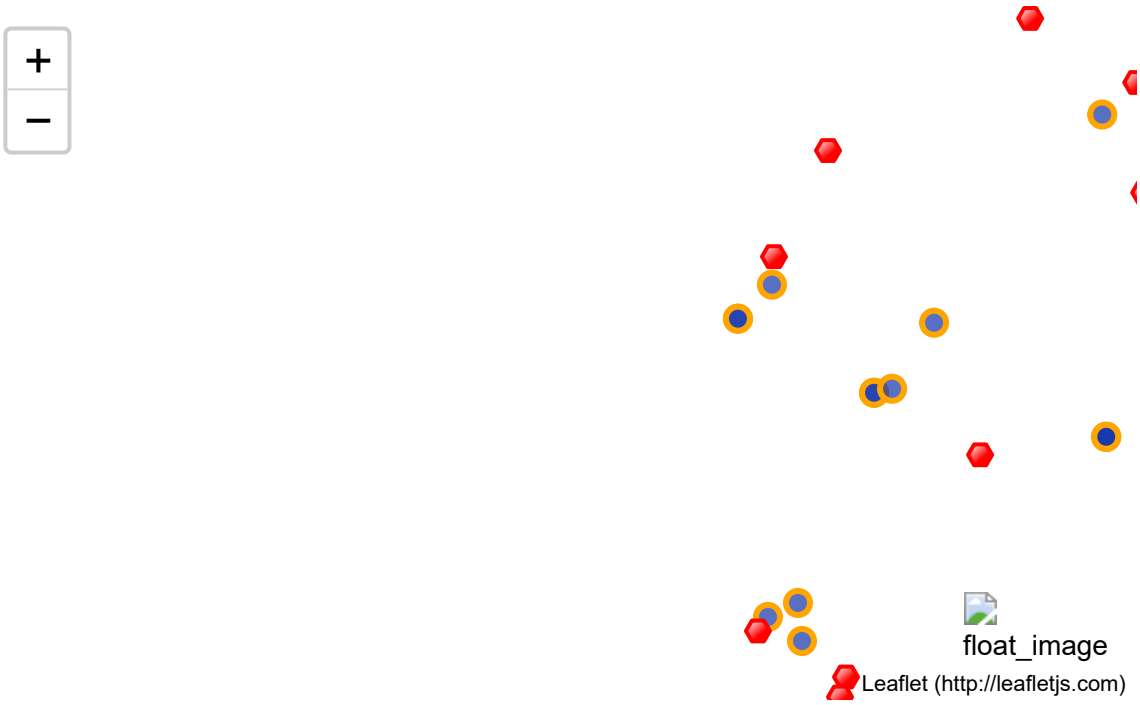
    # add markers of subway locations to map
for lat, lng, label in zip(mhsub1['lat'], mhsub1['long'],  mhsub1['sub_station'].astype
(str) ):
    label = folium.Popup(label, parse_html=True)
    folium.RegularPolygonMarker(
        [lat, lng],
        number_of_sides=6,
        radius=6,
        popup=label,
        color='red',
        fill_color='red',
        fill_opacity=2.5,
    ).add_to(map_manhattan_rent)

    # Adds tool to the top right
from folium.plugins import MeasureControl
map_manhattan_rent.add_child(MeasureControl())

# Measurement ruler icon tool to measure distances in map
from folium.plugins import FloatImage
url = ('https://media.licdn.com/mpr/mpr/shrinknp_100_100/AAEAAQAAAAAAAAlgAAAAJGE3OTA4YT
dlLTkzZjUtNDFjYy1iZThlLWQ5OTNkYzlhNzM4OQ.jpg')
FloatImage(url, bottom=5, left=85).add_to(map_manhattan_rent)

map_manhattan_rent
```

Out[59]:



4.0 Results

ONE CONSOLIDATE MAP

Let's consolidate all the required inforamtion to make the apartment selection in one 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

In [60]:

```
# create map of Manhattan using latitude and longitude values from Nominatim
latitude= 40.7308619
longitude= -73.9871558

map_mh_one = folium.Map(location=[latitude, longitude], zoom_start=13.3)

# add markers to map
for lat, lng, label in zip(mh_rent['Lat'], mh_rent['Long'],'$ ' + mh_rent['Rent_Price']
.astype(str)+ ', '+mh_rent['Address']):
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=6,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(map_mh_one)

    # add markers of subway locations to map
for lat, lng, label in zip(mhsub1['lat'], mhsub1['long'],  mhsub1['sub_station'].astype
(str) ):
    label = folium.Popup(label, parse_html=True)
    folium.RegularPolygonMarker(
        [lat, lng],
        number_of_sides=6,
        radius=6,
        popup=label,
        color='red',
        fill_color='red',
        fill_opacity=2.5,
    ).add_to(map_mh_one)


# set color scheme for the clusters
kclusters=5
x = np.arange(kclusters)
ys = [i+x+(i*x)**2 for i in range(kclusters)]
colors_array = cm.rainbow(np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]

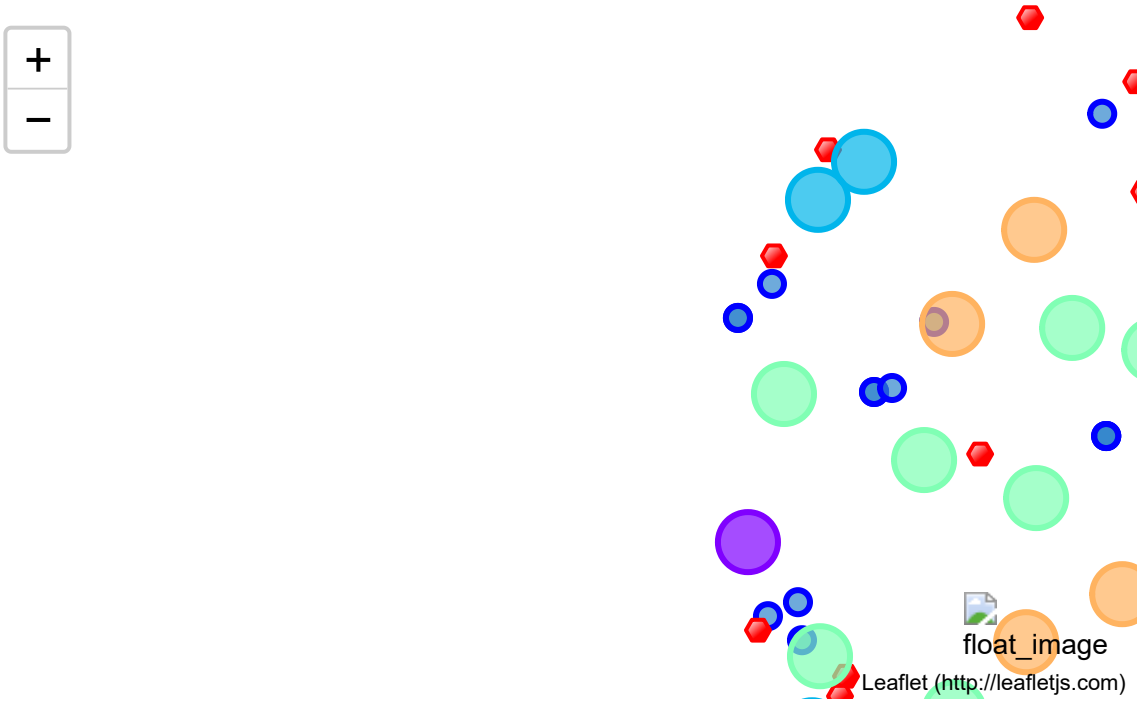
# add markers to the map
markers_colors = []
for lat, lon, poi, cluster in zip(manhattan_merged['Latitude'], manhattan_merged['Longi
tude'], manhattan_merged['Neighborhood'], manhattan_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=15,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_mh_one)

    # Adds tool to the top right
from folium.plugins import MeasureControl
map_mh_one.add_child(MeasureControl())
```

```
# Measurement ruler icon tool to measure distances in map
from folium.plugins import FloatImage
url = ('https://media.licdn.com/mpr/mpr/shrinknp_100_100/AAEAAQAAAAAAAAlgAAAAJGE3OTA4YTdlLTkzZjUtNDFjYy1iZThlLWQ5OTNkYzlhNzM4OQ.jpg')
FloatImage(url, bottom=5, left=85).add_to(map_mh_one)

map_mh_one
```

Out[60]:



Problem Resolution - Select the apartment for rent

The above consolidate map was used to explore options

After examining, I have chosen two locations that meet the budget requirements of <=5000 US Dollars and minimimum 2 rooms which I will assess to make a choice

- Apartment 1: 333 east 81st street, Rooms-3, Rent-4500 US Dollars, Cluster-0, Nearest subway-77th street Hudson
- Apartment 2: W 23RD ST, Area Chelsea, Rooms-2, Rent - 4250 US Dollars, Cluster-3, Nearest subway-34th street Hudson

Venues for Apartment 1 - Cluster 0

In [61]:

```
## kk is the cluster number to explore
kk = 0
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == kk, manhattan_merged.columns
[[1] + list(range(5, manhattan_merged.shape[1]))]]
```

Out[61]:

	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
4	Hamilton Heights	Mexican Restaurant	Coffee Shop	Café	Deli / Bodega	Pizza Place	Liquor Store	Indian Restaurant
8	Upper East Side	Italian Restaurant	Exhibit	Art Gallery	Bakery	Coffee Shop	French Restaurant	Cocktail Bar

Venues for Apartment 2 - Cluster 3

In [62]:

```
## kk is the cluster number to explore
kk = 3
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == kk, manhattan_merged.columns
[[1] + list(range(5, manhattan_merged.shape[1]))]]
```

Out[62]:

	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	7 C
3	Inwood	Mexican Restaurant	Lounge	Pizza Place	Café	Wine Bar	Bakery	A Re
5	Manhattanville	Deli / Bodega	Italian Restaurant	Seafood Restaurant	Mexican Restaurant	Sushi Restaurant	Beer Garden	
10	Lenox Hill	Sushi Restaurant	Italian Restaurant	Coffee Shop	Gym / Fitness Center	Pizza Place	Burger Joint	
12	Upper West Side	Italian Restaurant	Bar	Bakery	Vegetarian / Vegan Restaurant	Indian Restaurant	Coffee Shop	Cc
16	Murray Hill	Sandwich Place	Hotel	Japanese Restaurant	Gym / Fitness Center	Coffee Shop	Salon / Barbershop	
17	Chelsea	Coffee Shop	Italian Restaurant	Ice Cream Shop	Bakery	Nightclub	Theater	Ar
18	Greenwich Village	Italian Restaurant	Sushi Restaurant	French Restaurant	Clothing Store	Chinese Restaurant	Café	Re
27	Gramercy	Italian Restaurant	Restaurant	Thrift / Vintage Store	Cocktail Bar	Bagel Shop	Coffee Shop	
29	Financial District	Coffee Shop	Hotel	Gym	Wine Shop	Steakhouse	Bar	Re
31	Noho	Italian Restaurant	French Restaurant	Cocktail Bar	Gift Shop	Bookstore	Grocery Store	I Re
32	Civic Center	Gym / Fitness Center	Bakery	Italian Restaurant	Cocktail Bar	French Restaurant	Sandwich Place	
35	Turtle Bay	Italian Restaurant	Coffee Shop	Steakhouse	Wine Bar	Sushi Restaurant	Hotel	
36	Tudor City	Café	Park	Pizza Place	Mexican Restaurant	Greek Restaurant	Sushi Restaurant	
38	Flatiron	Italian Restaurant	American Restaurant	Gym	Gym / Fitness Center	Yoga Studio	Vegetarian / Vegan Restaurant	

Apartment Selection

Using the "one map" above, I was able to explore all possibilities since the popups provide the information needed for a good decision.

Apartment 1 rent cost is US4500 cheaper the budget US5000 with a extra room (total 3 room, my requirement is 2) than my requirement.Obviously that's my first choice initially. Now lets look at the other things.

- Apt 1 is located 487 meters from subway station at 77th Street. Venues for this apt are as of Cluster 0 and it is located on the Upper East side of Manhattan.It covers 2 neighborhoods - "Upper East Side" and "Hamilton Heights". The cluster neighborhood - "Upper East Side" has French, Italian restaurants, Coffee shops, Jucie Bar, Art Gallery etc, but being an Indian I have to visit the neighborhood of "Hamilton Heights" for Indian food as it is having the Indian restaurant.
- Apartment 2 rent cost is US4250, slightly cheaper and way low then the budget US5000 but having 2 rooms which is my actual requirement. 2nd choice because I'm getting an extra room for just 250US dollars in Apt1 with a semi-walkable Subway distance and all food/refreshment facilities with limited options. Apt 2 is located 567 meters from subway station at 34th Street slightly longer than the Apt1 option , but having immense food , hangout and refreshment options. Though it's a bit far away from subway compared to Apt1 and I need to catch subway everyday to work, still not a non-walkable distance. Based on my 2 bedroom requirement with a cheaper option of rent and higher option of other facilities and having easy access to other neighborhoods, I have selected this place to stay

Based on current London venues, I feel that Cluster 2 type of venues is a closer resemblance to my current place. That means that APARTMENT 2 is a better choice along with lower monthly rent as a bonus, is worth the slight extra walk I have to do to reach the subway. Infact a bit more will make me more healthier.

5.0 DISCUSSION

Very impressed with the overall organization, content and lab works presented during the Coursera IBM Certification Course

- I feel this Capstone project presented me a great opportunity to practice and apply the Data Science tools and methodologies learned.
- I have become a Data Science enthusiast now, despite of not coming from this background at all.
- I feel I have acquired a good starting point to become a professional Data Scientist and I will continue exploring to creating examples of practical cases and in fact I want to apply the knowledge in one of my own personal project which I'm going to start by the Spring of 2020

6.0 CONCLUSIONS

I feel rewarded with the efforts, time and money spent. I believe this course with all the topics covered is well worthy of appreciation.

This project has shown me a practical application to resolve a real situation and in fact I want to apply the knowledge in one of my own personal project which I'm going to start by the Spring of 2020. I would recommend for use in similar situations.

In [ ]: