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Segmenting and Clustering Neighborhoods in New York City

Introduction

In this lab, you will learn how to convert addresses into their equivalent latitude and longitude values. Also, you will use the Foursquare API to explore neighborhoods in New York City. You will use the **explore** function to get the most common venue categories in each neighborhood, and then use this feature to group the neighborhoods into clusters. You will use the *k*-means clustering algorithm to complete this task. Finally, you will use the Folium library to visualize the neighborhoods in New York City and their emerging clusters.

His is the name *Mahmud Hasan*

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Before we get the data and start exploring it, let's download all the dependencies that we will need.

In [3]:

```
pip install geopy
```

Collecting geopy

Downloading <https://files.pythonhosted.org/packages/53/fc/3d1b47e8e82ea12c25203929efb1b964918a77067a874b2c7631e2ec35ec/geopy-1.21.0-py2.py3-none-any.whl>
(104kB)

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Collecting geographiclib<2,>=1.49 (from geopy)

Downloading <https://files.pythonhosted.org/packages/8b/62/26ec95a98ba64299163199e95ad1b0e34ad3f4e176e221c40245f211e425/geographiclib-1.50-py3-none-any.whl>

Installing collected packages: geographiclib, geopy

Successfully installed geographiclib-1.50 geopy-1.21.0

Note: you may need to restart the kernel to use updated packages.

In [4]:

```
import numpy as np # Library to handle data in a vectorized manner

import pandas as pd # Library for data analysis
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)

import json # Library to handle JSON files

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

import requests # Library to handle requests
from pandas.io.json import json_normalize # transform JSON file into a pandas dataframe

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

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

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

print('Libraries imported.')
```

Libraries imported.

1. Download and Explore Dataset

Neighborhood has a total of 5 boroughs and 306 neighborhoods. In order to segment 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 latitude and longitude 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)

For your convenience, I downloaded the files and placed it on the server, so you can simply run a `wget` command and access the data. So let's go ahead and do that.

In [5]:

```
!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 [6]:

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

Let's take a quick look at the data.

In [7]:

```
newyork_data
```

Out[7]:

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```

```
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```

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```
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-73.93053108817338,
40.67503986503237]}},
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'geometry': {'type': 'Point',
'coordinates': [-73.90331684852599, 40.67786104769531]}},
'geometry_name': 'geom',
'properties': {'name': 'Broadway Junction',
'stacked': 2,
'annoline1': 'Broadway',
'annoline2': 'Junction',
'annoline3': None,
'annoangle': 0.0,
'borough': 'Brooklyn',
'bbox': [-73.90331684852599,
40.67786104769531,
-73.90331684852599,
40.67786104769531]}},
{'type': 'Feature',
'id': 'nyu_2451_34572.284',
'geometry': {'type': 'Point',
'coordinates': [-73.9887528074504, 40.70317632822692]}},
'geometry_name': 'geom',
'properties': {'name': 'Dumbo',
'stacked': 1,
'annoline1': 'Dumbo',
'annoline2': None,
'annoline3': None,
'annoangle': 0.0,
'borough': 'Brooklyn',
'bbox': [-73.9887528074504,
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-73.9887528074504,
40.70317632822692]}},
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'id': 'nyu_2451_34572.285',
'geometry': {'type': 'Point',
'coordinates': [-74.12059399718001, 40.60180957631444]}},
'geometry_name': 'geom',
'properties': {'name': 'Manor Heights',
'stacked': 2,
'annoline1': 'Manor',
'annoline2': 'Heights',
'annoline3': None,
'annoangle': 0.0,
'borough': 'Staten Island',
```

```

'bbox': [-74.12059399718001,
40.60180957631444,
-74.12059399718001,
40.60180957631444]}},
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'id': 'nyu_2451_34572.286',
'geometry': {'type': 'Point',
'coordinates': [-74.13208447484298, 40.60370692627371]}},
'geometry_name': 'geom',
'properties': {'name': 'Willowbrook',
'stacked': 1,
'annoline1': 'Willowbrook',
'annoline2': None,
'annoline3': None,
'annoangle': 0.0,
'borough': 'Staten Island',
'bbox': [-74.13208447484298,
40.60370692627371,
-74.13208447484298,
40.60370692627371]}},
{'type': 'Feature',
'id': 'nyu_2451_34572.287',
'geometry': {'type': 'Point',
'coordinates': [-74.21776636068567, 40.541139922091766]}},
'geometry_name': 'geom',
'properties': {'name': 'Sandy Ground',
'stacked': 2,
'annoline1': 'Sandy',
'annoline2': 'Ground',
'annoline3': None,
'annoangle': 0.0,
'borough': 'Staten Island',
'bbox': [-74.21776636068567,
40.541139922091766,
-74.21776636068567,
40.541139922091766]}},
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'id': 'nyu_2451_34572.288',
'geometry': {'type': 'Point',
'coordinates': [-74.12727240604946, 40.579118742961214]}},
'geometry_name': 'geom',
'properties': {'name': 'Egbertville',
'stacked': 1,
'annoline1': 'Egbertville',
'annoline2': None,
'annoline3': None,
'annoangle': 0.0,
'borough': 'Staten Island',
'bbox': [-74.12727240604946,
40.579118742961214,
-74.12727240604946,
40.579118742961214]}},
{'type': 'Feature',
'id': 'nyu_2451_34572.289',
'geometry': {'type': 'Point',
'coordinates': [-73.89213760232822, 40.56737588957032]}},
'geometry_name': 'geom',

```

```

'properties': {'name': 'Roxbury',
'stacked': 1,
'annoline1': 'Roxbury',
'annoline2': None,
'annoline3': None,
'annoangle': 0.0,
'borough': 'Queens',
'bbox': [-73.89213760232822,
40.56737588957032,
-73.89213760232822,
40.56737588957032]}},
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'id': 'nyu_2451_34572.290',
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'coordinates': [-73.95918459428702, 40.598525095137255]},
'geometry_name': 'geom',
'properties': {'name': 'Homecrest',
'stacked': 1,
'annoline1': 'Homecrest',
'annoline2': None,
'annoline3': None,
'annoangle': 0.0,
'borough': 'Brooklyn',
'bbox': [-73.95918459428702,
40.598525095137255,
-73.95918459428702,
40.598525095137255]}},
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'id': 'nyu_2451_34572.291',
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'coordinates': [-73.88114319200604, 40.716414511158185]},
'geometry_name': 'geom',
'properties': {'name': 'Middle Village',
'stacked': 2,
'annoline1': 'Middle',
'annoline2': 'Village',
'annoline3': None,
'annoangle': 0.0,
'borough': 'Queens',
'bbox': [-73.88114319200604,
40.716414511158185,
-73.88114319200604,
40.716414511158185]}},
{'type': 'Feature',
'id': 'nyu_2451_34572.292',
'geometry': {'type': 'Point',
'coordinates': [-74.20152556457658, 40.52626406734812]},
'geometry_name': 'geom',
'properties': {'name': "Prince's Bay",
'stacked': 2,
'annoline1': "Prince's",
'annoline2': 'Bay',
'annoline3': None,
'annoangle': 0.0,
'borough': 'Staten Island',
'bbox': [-74.20152556457658,
40.52626406734812,

```

```
-74.20152556457658,
40.52626406734812]]}},
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 'id': 'nyu_2451_34572.293',
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 'coordinates': [-74.13792663771568, 40.57650629379489]},
 'geometry_name': 'geom',
 'properties': {'name': 'Lighthouse Hill',
 'stacked': 2,
 'annoline1': 'Lighthouse',
 'annoline2': 'Hill',
 'annoline3': None,
 'annoangle': 0.0,
 'borough': 'Staten Island',
 'bbox': [-74.13792663771568,
 40.57650629379489,
 -74.13792663771568,
 40.57650629379489]}},
{'type': 'Feature',
 'id': 'nyu_2451_34572.294',
 'geometry': {'type': 'Point',
 'coordinates': [-74.22957080626941, 40.51954145748909]},
 'geometry_name': 'geom',
 'properties': {'name': 'Richmond Valley',
 'stacked': 2,
 'annoline1': 'Richmond',
 'annoline2': 'Valley',
 'annoline3': None,
 'annoangle': 0.0,
 'borough': 'Staten Island',
 'bbox': [-74.22957080626941,
 40.51954145748909,
 -74.22957080626941,
 40.51954145748909]}},
{'type': 'Feature',
 'id': 'nyu_2451_34572.295',
 'geometry': {'type': 'Point',
 '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]}},
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'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]}},
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'id': 'nyu_2451_34572.299',
'geometry': {'type': 'Point',
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'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]}},
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 '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,
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    -73.80553002968718,
    40.58733774018741]]},
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    '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]}},
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    '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::4326'}}},

```

```
'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 [8]:

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

Let's take a look at the first item in this list.

In [9]:

```
neighborhoods_data[0]
```

Out[9]:

```
{'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]}}
```

Transform 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 [10]:

```
# 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 [11]:

neighborhoods

Out[11]:

	Borough	Neighborhood	Latitude	Longitude
--	---------	--------------	----------	-----------

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

In [12]:

```
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
e)
```

Quickly examine the resulting dataframe.

In [13]:

neighborhoods.head()

Out[13]:

	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

And make sure that the dataset has all 5 boroughs and 306 neighborhoods.

In [14]:

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

The dataframe has 5 boroughs and 306 neighborhoods.

Use geopy library to get the latitude and longitude values of New York City.

In order to define an instance of the geocoder, we need to define a user_agent. We will name our agent *ny_explorer*, as shown below.

In [15]:

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

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

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

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

In [16]:

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

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

map_newyork
```

Out[16]:

Folium is a great visualization library. Feel free to zoom into the above map, and click on each circle mark to reveal the name of the neighborhood and its respective borough.

However, for illustration purposes, let's simplify the above map and segment and cluster only the neighborhoods in Manhattan. So let's slice the original dataframe and create a new dataframe of the Manhattan data.

In [17]:

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

Out[17]:

	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

Let's get the geographical coordinates of Manhattan.

In [18]:

```
address = 'Manhattan, NY'

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

The geographical coordinate of Manhattan are 40.7896239, -73.9598939.

As we did with all of New York City, let's visualize Manhattan the neighborhoods in it.

In [19]:

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

# add markers to map
for lat, lng, label in zip(manhattan_data['Latitude'], manhattan_data['Longitude'], manhattan_data['Neighborhood']):
    label = folium.Popup(label, parse_html=True)
    folium.CircleMarker(
        [lat, lng],
        radius=5,
        popup=label,
        color='blue',
        fill=True,
        fill_color='#3186cc',
        fill_opacity=0.7,
        parse_html=False).add_to(map_manhattan)

map_manhattan
```

Out[19]:

Next, we are going to start utilizing the Foursquare API to explore the neighborhoods and segment them.

Define Foursquare Credentials and Version

In [20]:

```
CLIENT_ID = 'your-client-ID' # your Foursquare ID
CLIENT_SECRET = 'your-client-secret' # your Foursquare Secret
VERSION = '20180605' # Foursquare API version

print('Your credentials:')
print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET: ' + CLIENT_SECRET)
```

```
Your credentials:
CLIENT_ID: your-client-ID
CLIENT_SECRET: your-client-secret
```

Let's explore the first neighborhood in our dataframe.

Get the neighborhood's name.

In [21]:

```
manhattan_data.loc[0, 'Neighborhood']
```

Out[21]:

```
'Marble Hill'
```

Get the neighborhood's latitude and longitude values.

In [22]:

```
neighborhood_latitude = manhattan_data.loc[0, 'Latitude'] # neighborhood latitude value
neighborhood_longitude = manhattan_data.loc[0, 'Longitude'] # neighborhood longitude value

neighborhood_name = manhattan_data.loc[0, 'Neighborhood'] # neighborhood name

print('Latitude and longitude values of {} are {}, {}'.format(neighborhood_name,
                                                                neighborhood_latitude,
                                                                neighborhood_longitude))
```

```
Latitude and longitude values of Marble Hill are 40.87655077879964, -73.91065
965862981.
```

Now, let's get the top 100 venues that are in Marble Hill within a radius of 500 meters.

First, let's create the GET request URL. Name your URL **url**.

In [23]:

```
# type your answer here
```

Double-click **here** for the solution.

Send the GET request and examine the results

In [24]:

```
results = requests.get(url).json()
results
```

```
-----
NameError                                Traceback (most recent call last)
<ipython-input-24-f048ffce0a17> in <module>
----> 1 results = requests.get(url).json()
      2 results
```

NameError: name 'url' is not defined

From the Foursquare lab in the previous module, we know that all the information is in the *items* key. Before we proceed, let's borrow the **get_category_type** function from the Foursquare lab.

In []:

```
# function that extracts the category of the venue
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']
```

Now we are ready to clean the json and structure it into a *pandas* dataframe.

In []:

```
venues = results['response']['groups'][0]['items']

nearby_venues = json_normalize(venues) # flatten JSON

# filter columns
filtered_columns = ['venue.name', 'venue.categories', 'venue.location.lat', 'venue.location.lng']
nearby_venues = nearby_venues.loc[:, filtered_columns]

# filter the category for each row
nearby_venues['venue.categories'] = nearby_venues.apply(get_category_type, axis=1)

# clean columns
nearby_venues.columns = [col.split(".")[0] for col in nearby_venues.columns]

nearby_venues.head()
```

And how many venues were returned by Foursquare?

In []:

```
print('{} venues were returned by Foursquare.'.format(nearby_venues.shape[0]))
```

2. Explore Neighborhoods in Manhattan

Let's create a function to repeat the same process to all the neighborhoods in Manhattan

In []:

```

def getNearbyVenues(names, latitudes, longitudes, radius=500):

    venues_list=[]
    for name, lat, lng in zip(names, latitudes, longitudes):
        print(name)

        # create the API request URL
        url = 'https://api.foursquare.com/v2/venues/explore?&client_id={}&client_secret={}
&v={}&ll={},{}&radius={}&limit={}'.format(
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            lat,
            lng,
            radius,
            LIMIT)

        # make the GET request
        results = requests.get(url).json()["response"]["groups"][0]["items"]

        # return only relevant information for each nearby venue
        venues_list.append([(
            name,
            lat,
            lng,
            v['venue']['name'],
            v['venue']['location']['lat'],
            v['venue']['location']['lng'],
            v['venue']['categories'][0]['name']) for v in results])

    nearby_venues = pd.DataFrame([item for venue_list in venues_list for item in venue_list])
    nearby_venues.columns = ['Neighborhood',
                            'Neighborhood Latitude',
                            'Neighborhood Longitude',
                            'Venue',
                            'Venue Latitude',
                            'Venue Longitude',
                            'Venue Category']

    return(nearby_venues)

```

Now write the code to run the above function on each neighborhood and create a new dataframe called **manhattan_venues**.

In []:

```
# type your answer here

manhattan_venues = getNearbyVenues(names=manhattan_data['Neighborhood'],
                                   latitudes=manhattan_data['Latitude'],
                                   longitudes=manhattan_data['Longitude']
                                   )
```

Double-click **here** for the solution.

Let's check the size of the resulting dataframe

In []:

```
print(manhattan_venues.shape)
manhattan_venues.head()
```

Let's check how many venues were returned for each neighborhood

In []:

```
manhattan_venues.groupby('Neighborhood').count()
```

Let's find out how many unique categories can be curated from all the returned venues

In []:

```
print('There are {} unique categories.'.format(len(manhattan_venues['Venue Category'].unique())))
```

3. Analyze Each Neighborhood

In []:

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

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

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

manhattan_onehot.head()
```

And let's examine the new dataframe size.

In []:

```
manhattan_onehot.shape
```

Next, let's group rows by neighborhood and by taking the mean of the frequency of occurrence of each category

In []:

```
manhattan_grouped = manhattan_onehot.groupby('Neighborhood').mean().reset_index()  
manhattan_grouped
```

Let's confirm the new size

In []:

```
manhattan_grouped.shape
```

Let's print each neighborhood along with the top 5 most common venues

In []:

```
num_top_venues = 5  
  
for hood in manhattan_grouped['Neighborhood']:  
    print("-----"+hood+"-----")  
    temp = manhattan_grouped[manhattan_grouped['Neighborhood'] == hood].T.reset_index()  
    temp.columns = ['venue', 'freq']  
    temp = temp.iloc[1:]  
    temp['freq'] = temp['freq'].astype(float)  
    temp = temp.round({'freq': 2})  
    print(temp.sort_values('freq', ascending=False).reset_index(drop=True).head(num_top_venues))  
    print('\n')
```

Let's put that into a *pandas* dataframe

First, let's write a function to sort the venues in descending order.

In []:

```
def return_most_common_venues(row, num_top_venues):  
    row_categories = row.iloc[1:]  
    row_categories_sorted = row_categories.sort_values(ascending=False)  
  
    return row_categories_sorted.index.values[0:num_top_venues]
```

Now let's create the new dataframe and display the top 10 venues for each neighborhood.

In []:

```
num_top_venues = 10

indicators = ['st', 'nd', 'rd']

# create columns according to number of top venues
columns = ['Neighborhood']
for ind in np.arange(num_top_venues):
    try:
        columns.append('{}{} Most Common Venue'.format(ind+1, indicators[ind]))
    except:
        columns.append('{}th Most Common Venue'.format(ind+1))

# create a new dataframe
neighborhoods_venues_sorted = pd.DataFrame(columns=columns)
neighborhoods_venues_sorted['Neighborhood'] = manhattan_grouped['Neighborhood']

for ind in np.arange(manhattan_grouped.shape[0]):
    neighborhoods_venues_sorted.iloc[ind, 1:] = return_most_common_venues(manhattan_grouped.iloc[ind, :], num_top_venues)

neighborhoods_venues_sorted.head()
```

4. Cluster Neighborhoods

Run *k*-means to cluster the neighborhood into 5 clusters.

In []:

```
# set number of clusters
kclusters = 5

manhattan_grouped_clustering = manhattan_grouped.drop('Neighborhood', 1)

# run k-means clustering
kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(manhattan_grouped_clustering)

# check cluster labels generated for each row in the dataframe
kmeans.labels_[0:10]
```

Let's create a new dataframe that includes the cluster as well as the top 10 venues for each neighborhood.

In []:

```
# add clustering labels
neighborhoods_venues_sorted.insert(0, 'Cluster Labels', kmeans.labels_)

manhattan_merged = manhattan_data

# merge toronto_grouped with toronto_data to add Latitude/Longitude for each neighborhood
manhattan_merged = manhattan_merged.join(neighborhoods_venues_sorted.set_index('Neighborhood'), on='Neighborhood')

manhattan_merged.head() # check the last columns!
```

Finally, let's visualize the resulting clusters

In []:

```
# create map
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=11)

# 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['Longitude'], manhattan_merged['Neighborhood'], manhattan_merged['Cluster Labels']):
    label = folium.Popup(str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker(
        [lat, lon],
        radius=5,
        popup=label,
        color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

5. Examine Clusters

Now, you can examine each cluster and determine the discriminating venue categories that distinguish each cluster. Based on the defining categories, you can then assign a name to each cluster. I will leave this exercise to you.

Cluster 1

In []:

```
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == 0, manhattan_merged.columns[[1]
+ list(range(5, manhattan_merged.shape[1]))]]
```

Cluster 2

In []:

```
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == 1, manhattan_merged.columns[[1]
+ list(range(5, manhattan_merged.shape[1]))]]
```

Cluster 3

In []:

```
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == 2, manhattan_merged.columns[[1]
+ list(range(5, manhattan_merged.shape[1]))]]
```

Cluster 4

In []:

```
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == 3, manhattan_merged.columns[[1]
+ list(range(5, manhattan_merged.shape[1]))]]
```

Cluster 5

In []:

```
manhattan_merged.loc[manhattan_merged['Cluster Labels'] == 4, manhattan_merged.columns[[1]
+ list(range(5, manhattan_merged.shape[1]))]]
```

Thank you for completing this lab!

This notebook was created by [Alex Akison \(https://www.linkedin.com/in/aklson/\)](https://www.linkedin.com/in/aklson/) and [Polong Lin \(https://www.linkedin.com/in/polonglin/\)](https://www.linkedin.com/in/polonglin/). I hope you found this lab interesting and educational. Feel free to contact us if you have any questions!

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