Abstract

Machine learning allows for the creation of computational models capable of identifying patterns in multidimensional datasets. I have tried to leverage venue data from Foursquare's 'Places API' and a machine learning algorithm called 'kmeans clustering' to identify 'New York City' neighborhoods of similarity towards food and restaurant business profiles'.

Introduction

Background

For the whole world the year 2007 to 2008 was known as the global financial crisis which unsurprisingly severely affected the restaurant industry in the United States. In mid 2008 A CNN Money report noted that the casual dining chains were taking a major hit as people turned to cheaper food alternatives.[1] Unsurprisingly, this state of economic unrest severely affected the restaurant industry. A number of restaurant businesses filed for bankruptcy and closed their doors. At the same time, the job market was just as bleak, with unemployment rates reaching up to 10% in the years following the Great Recession. After the economy bounced back it was reported increased US food sales year after year, with 2017 total retail and food services sales reaching 5.75 trillion in 2019.[2]

According to NRA (National Restaurants Association), as of 2017 there are over one million foods and restaurant service in the united states among these 26,697 were located in NYC. The restaurant industry shows in increase of 62% between 2000 and 2015.

Problem

The decision to open your own restaurant is an exciting one. You get to be your own boss and you do not have to worry about making money for anyone other than yourself. Being independent has its perks but it also has its costs-literally and figuratively. There are two ways that you can satisfy your dream, either you have to buy the existing restaurant or start a new restaurant. In either way one of the main challenging questions is which neighborhood is best for which type of food and restaurant service type. The project try to quantify food related services in NYC neighbor hoods and cluster them in their similarity characteristics so that it helps to make informed decision to start new business in food and restaurant service

Stakeholders

From the model, quantifying NYC neighborhoods similarities based on their food and restaurant service venues, developed the following stakeholders might be interested to got some informed decision making points.

- Business owners : Those who wants to open a new restaurants in NYC this model will help them to identify which neighborhood is more interested in whci type of food or restaurant service.
- Private and government service sector company – Some company might be interested in particular type of restaurant when they open their office in particular area for the sake of their employee.

Methodology

Data Sources

NYU Spatial Data Repository : [3]

New York City Neighborhood Names 2014: This New York City Neighborhood Names point file was created as a guide to New York City's neighborhoods that appear on the web resource, "New York: A City of Neighborhoods." NYU spatial data .

Foursquare 'Places API' [4]

Foursquare 'Places API' I will be using Foursquare's 'Places API' to acquire data related to 'venues' (as defined by Foursquare) categorized to be somehow associated with food and restaurants. It is important to note that foursquare defines a 'venue' as a place that one can go to, or checkin to, and that a 'venue' is not necessarily food or restaurant venue but can be any establishment such as a music or type of retail shop. Each Foursquare 'venue' is assigned a 'category' and each 'category' is associated with a particular 'categoryID'. The list of food and restaurant related categories included in this project are presented below.

Table : 1 List of food and restaurant related categories and their categoryid as presented in Foursqaure

Category	CategoryID
Afghan Restaurant	503288ae91d4c4b30a586d67
African Restaurant	4bf58dd8d48988d1c8941735
American Restaurant	4bf58dd8d48988d14e941735
Asian Restaurant	4bf58dd8d48988d142941735
Filipino Restaurant	4eb1bd1c3b7b55596b4a748f
Himalayan Restaurant	52e81612bcbc57f1066b79fb
Hotpot Restaurant	52af0bd33cf9994f4e043bdd
Indonesian Restaurant	4deefc054765f83613cdba6f
Japanese Restaurant	4bf58dd8d48988d111941735
Korean Restaurant	4bf58dd8d48988d113941735
Malay Restaurant	4bf58dd8d48988d156941735
Mongolian Restaurant	4eb1d5724b900d56c88a45fe
Noodle House	4bf58dd8d48988d1d1941735
Satay Restaurant	56aa371be4b08b9a8d57350e
Thai Restaurant	4bf58dd8d48988d149941735
Tibetan Restaurant	52af39fb3cf9994f4e043be9
Australian Restaurant	4bf58dd8d48988d169941735
Austrian Restaurant	52e81612bcbc57f1066b7a01
BBQ Joint	4bf58dd8d48988d1df931735
Bagel Shop	4bf58dd8d48988d179941735
Bakery	4bf58dd8d48988d16a941735

Belgian Restaurant	52e81612bcbc57f1066b7a02
Bistro	52e81612bcbc57f1066b79f1
Breakfast Spot	4bf58dd8d48988d143941735
Bubble Tea Shop	52e81612bcbc57f1066b7a0c
Buffet	52e81612bcbc57f1066b79f4
Burger Joint	4bf58dd8d48988d16c941735
Cafeteria	4bf58dd8d48988d128941735
Café	4bf58dd8d48988d16d941735
Cajun / Creole Restaurant	4bf58dd8d48988d17a941735
Caribbean Restaurant	4bf58dd8d48988d144941735
Caucasian Restaurant	5293a7d53cf9994f4e043a45
Coffee Shop	4bf58dd8d48988d1e0931735
Comfort Food Restaurant	52e81612bcbc57f1066b7a00
Creperie	52e81612bcbc57f1066b79f2
Czech Restaurant	52f2ae52bcbc57f1066b8b81
Deli / Bodega	4bf58dd8d48988d146941735
Dessert Shop	4bf58dd8d48988d1d0941735
Diner	4bf58dd8d48988d147941735
Donut Shop	4bf58dd8d48988d148941735
Dumpling Restaurant	4bf58dd8d48988d108941735
Dutch Restaurant	5744ccdfe4b0c0459246b4d0
Eastern European Restaurant	4bf58dd8d48988d109941735
English Restaurant	52e81612bcbc57f1066b7a05
Falafel Restaurant	4bf58dd8d48988d10b941735
Fast Food Restaurant	4bf58dd8d48988d16e941735
Fish & Chips Shop	4edd64a0c7ddd24ca188df1a
Fondue Restaurant	52e81612bcbc57f1066b7a09
Food Court	4bf58dd8d48988d120951735
Food Stand	56aa371be4b08b9a8d57350b
Food Truck	4bf58dd8d48988d1cb941735
French Restaurant	4bf58dd8d48988d10c941735
Fried Chicken Joint	4d4ae6fc7a7b7dea34424761
Friterie	55d25775498e9f6a0816a37a
Gastropub	4bf58dd8d48988d155941735
German Restaurant	4bf58dd8d48988d10d941735
Gluten-free Restaurant	4c2cd86ed066bed06c3c5209
Greek Restaurant	4bf58dd8d48988d10e941735
Halal Restaurant	52e81612bcbc57f1066b79ff
Hawaiian Restaurant	52e81612bcbc57f1066b79fe
Hot Dog Joint	4bf58dd8d48988d16f941735
Hungarian Restaurant	52e81612bcbc57f1066b79fa
Indian Restaurant	4bf58dd8d48988d10f941735
Irish Pub	52e81612bcbc57f1066b7a06

Italian Restaurant	4bf58dd8d48988d110941735
Jewish Restaurant	52e81612bcbc57f1066b79fd
Juice Bar	4bf58dd8d48988d112941735
Kebab Restaurant	5283c7b4e4b094cb91ec88d7
Latin American Restaurant	4bf58dd8d48988d1be941735
Mac & Cheese Joint	4bf58dd8d48988d1bf941735
Mediterranean Restaurant	4bf58dd8d48988d1c0941735
Mexican Restaurant	4bf58dd8d48988d1c1941735
Middle Eastern Restaurant	4bf58dd8d48988d115941735
Modern European Restaurant	52e81612bcbc57f1066b79f9
Molecular Gastronomy Restaurant	4bf58dd8d48988d1c2941735
Pakistani Restaurant	52e81612bcbc57f1066b79f8
Pet Café	56aa371be4b08b9a8d573508
Pizza Place	4bf58dd8d48988d1ca941735
Polish Restaurant	52e81612bcbc57f1066b7a04
Portuguese Restaurant	4def73e84765ae376e57713a
Poutine Place	56aa371be4b08b9a8d5734c7
Restaurant	4bf58dd8d48988d1c4941735
Russian Restaurant	5293a7563cf9994f4e043a44
Salad Place	4bf58dd8d48988d1bd941735
Sandwich Place	4bf58dd8d48988d1c5941735
Scandinavian Restaurant	4bf58dd8d48988d1c6941735
Scottish Restaurant	5744ccdde4b0c0459246b4a3
Seafood Restaurant	4bf58dd8d48988d1ce941735
Slovak Restaurant	56aa371be4b08b9a8d57355a
Snack Place	4bf58dd8d48988d1c7941735
Soup Place	4bf58dd8d48988d1dd931735
Southern / Soul Food Restaurant	4bf58dd8d48988d14f941735
Spanish Restaurant	4bf58dd8d48988d150941735
Sri Lankan Restaurant	5413605de4b0ae91d18581a9
Steakhouse	4bf58dd8d48988d1cc941735
Swiss Restaurant	4bf58dd8d48988d158941735
Tea Room	4bf58dd8d48988d1dc931735
Theme Restaurant	56aa371be4b08b9a8d573538
Truck Stop	57558b36e4b065ecebd306dd
Turkish Restaurant	4f04af1f2fb6e1c99f3db0bb
Ukrainian Restaurant	52e928d0bcbc57f1066b7e96
Vegetarian / Vegan Restaurant	4bf58dd8d48988d1d3941735
Wings Joint	4bf58dd8d48988d14c941735

Data Retrieval

Neighborhood Name & Location Data The '2014 New York City neighborhood Names' dataset hosted by NYU's Spatial Data Repository was first downloaded as a JSON file and imported into a Jupyter Notebook to merge with Foursquare Food and Restaurant Related Venue Data

```
with open('NYC data set.json') as json_data:
    newyork_data = json.load(json_data)
nyc_neighborhood_data = newyork_data['features']
nyc_neighborhood_data[5]
```


```
{'type': 'Feature',
 'id': 'nyu_2451_34572.6',
 'geometry': {'type': 'Point',
  'coordinates': [-73.90281798724604, 40.88168737120521]},
 'geometry_name': 'geom',
 'properties': {'name': 'Kingsbridge',
  'stacked': 1,
  'annoline1': 'Kingsbridge',
  'annoline2': None,
  'annoline3': None,
  'annoangle': 0.0,
  'borough': 'Bronx',
  'bbox': [-73.90281798724604,
   40.88168737120521,
   -73.90281798724604,
   40.88168737120521]}}
```


Neighborhood Name & Location Data

The 'Borough', 'Neighborhood', 'Latitude', and 'Longitude' values associated with each neighborhood were then converted from JSON to a Pandas DataFrame that serves as the foundation of the analysis.

```
column_names = ['Borough', 'Neighborhood', 'Latitude', 'Longitude']

nyc_neighborhoods = pd.DataFrame(columns=column_names)

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

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

    nyc_neighborhoods = nyc_neighborhoods.append({'Borough': borough,
                                          'Neighborhood': neighborhood_name,
                                          'Latitude': neighborhood_lat,
                                          'Longitude': neighborhood_lon}, ignore_index=True)
nyc_neighborhoods.head(5)
```

Foursquare Food and Restaurant Related Venue Data

Food and restaurant related venues associated with each New York City neighborhood was created by recursively sending 'get' requests to the predefined endpoint, making sure the results are specific to venues with food and restaurant related 'category IDs'. For each neighborhood, we can include all of the selected category IDs in a single 'get' request by passing them as comma separated values. Shown below is a function that creates the required url and an example:

Function To Retrieve All Food-Related Venues Per Neighborhood

```
]: radius = 100
def getNearbyFoodVenues(neighborhoods, latitudes, longitudes, radius=100):
    endpoint = 'https://api.foursquare.com/v2/venues/search?'
    venues_list = []

    for hood_name, lat, lng in zip(neighborhoods, latitudes, longitudes):

        url = createURL(endpoint, CLIENT_ID, CLIENT_SECRET, VERSION, lat, lng, radius, categoryId, limit)

        results = requests.get(url).json()['response']['venues']

        for item in results:
            venue_name = item['name']
            venue_category = item['categories'][0]['name']
            venue_lat = item['location']['lat']
            venue_lng = item['location']['lng']
            try:
                venue_city = item['location']['city']
            except:
                venue_city = 'N/A'
            venue_state = item['location']['state']

            venues_list.append([(hood_name,
                                 lat,
                                 lng,
                                 venue_name,
                                 venue_category,
                                 venue_lat,
                                 venue_lng,
                                 venue_city,
                                 venue_state
                                )])

    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 Name',
                             'Venue Category',
                             'Venue Latitude',
                             'Venue Longitude',
                             'Venue City',
                             'Venue State'
                            ]
    return nearby_venues

venues_data = getNearbyFoodVenues(nyc_neighborhoods['Neighborhood'],
                                  nyc_neighborhoods['Latitude'],
                                  nyc_neighborhoods['Longitude'],
                                  radius
                                 )
```

Calculating the number of venues We Retrieved?

```
print(venues_data.shape)
venues_data.head(5)
```

```
(1503, 9)
```

9]:

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue Name	Venue Category	Venue Latitude	Venue Longitude	Venue City	Venue State
0	Kingsbridge	40.881687	-73.902818	Silhouette Restaurant & Lounge	Latin American Restaurant	40.880706	-73.902687	Bronx	NY
1	Kingsbridge	40.881687	-73.902818	Ocean Dip Seafood	Seafood Restaurant	40.880771	-73.903375	Bronx	NY
2	Kingsbridge	40.881687	-73.902818	Vickies Pizza	Pizza Place	40.881003	-73.903336	Bronx	NY
3	Woodlawn	40.898273	-73.867315	Rambling House	Pub	40.898439	-73.867197	Bronx	NY
4	Woodlawn	40.898273	-73.867315	Sean's Quality Deli	Deli / Bodega	40.897595	-73.867151	Bronx	NY

Our dataframe has 1503 venues pulled from foursquare.

Exploratory Data Analysis

The dataframe has shown that the venues are belonged into three venue state namely NJ, NY and New York with frequency of 2, 1463 and 38 respectively.

Check the states where the venues belongs in?

```
venues_data.groupby('Venue State')['Venue State'].count()
```

12]:

```
Venue State
NJ             2
NY          1463
New York      38
```

The dataframe has shown also there are 121 uniue venue categories with 187 of maximum number of venue in it and the minimum of 1.

```
n_unique = len(venues_data['Venue Category'].unique())
print(f'There are {n_unique} unique venue categories in this dataframe')
venues_data.groupby('Venue Category')['Venue Category'].count().sort_values(ascending=False)
```

```
There are 121 unique venue categories in this dataframe

Venue Category
Deli / Bodega                     187
Pizza Place                       100
Food Truck                         86
Chinese Restaurant                 81
Coffee Shop                        77
Bakery                             52
Café                               49
Italian Restaurant                 48
American Restaurant                44
Mexican Restaurant                 40
Ice Cream Shop                     34
Sandwich Place                     32
Restaurant                         29
Juice Bar                          27
Caribbean Restaurant               27
Diner                              26
Bagel Shop                         25
Korean Restaurant                  22
Burger Joint                       21
Dessert Shop                       20
Sushi Restaurant                   19
Thai Restaurant                    18
Donut Shop                         17
Fried Chicken Joint                17
Japanese Restaurant                16
Vegetarian / Vegan Restaurant      16
Fast Food Restaurant               16
Indian Restaurant                  16
Greek Restaurant                   16
Asian Restaurant                   14
                                  ...
Bike Shop                           1
Bistro                              1
Yoga Studio                         1
Comfort Food Restaurant             1
Newsstand                           1
```

There are 38 venues which has no venue cities not mentioned. These records has any meaningful impact for our model analysis so that we are going to remove from our dataframe.

Are there any 'null' values in the dataset?

```
venues_data.isnull().values.any()
```

```
.6]: True
```

```
null_counts= venues_data.isnull()
print(null_counts)
```

```
null_counts= null_counts.sum(axis=0)
null_counts
```

```
Neighborhood              0
Neighborhood Latitude     0
Neighborhood Longitude    0
Venue Name                0
Venue Category            0
Venue Latitude            0
Venue Longitude           0
Venue City               38
Venue State               0
dtype: int64
```

How many unique venues are there?

```
[17]: n_unique_venues = len(venues_data['Venue Name'].unique())
      print(f'There are {n_unique_venues} unique venues in the venues dataset')
```

```
There are 1409 unique venues in the venues dataset
```

The dataframe has 1409 unique venues.

Data Preprocessing

Data Cleaning

a) *We have removed all venue records with venue city name different from "NY" or "Ney York" from the data frame.*
b) *We have droped all NaN values from venue city*

The dataframe shows there are 38 Nan records. So we have remove them as it has no impact for our model.

```
null_counts= venues_data.isnull()
null_counts= null_counts.sum(axis=0)
null_counts
```

```
Neighborhood              0
Neighborhood Latitude     0
Neighborhood Longitude    0
Venue Name                0
Venue Category            0
Venue Latitude            0
Venue Longitude           0
Venue City               38
Venue State               0
dtype: int64
```

I have used the dropna function to drop nan values

```
venue_data = venues_data.dropna(how='any')
venue_data
```

```
Neighborhood               0
Neighborhood Latitude      0
Neighborhood Longitude     0
Venue Name                 0
Venue Category             0
Venue Latitude             0
Venue Longitude            0
Venue City                38
Venue State                0
dtype: int64
```

c) The list of venue category predefined for make our analysis easy. I have also deleted all other category other than predefined venue categories which are related with food and restaurant services.

Remove entries that are not associated with food or resturant categories

```
food_related_categories = ['Afghan Restaurant','African Restaurant','American Restaurant','Asian Restaurant','Filipino Restau
'Himalayan Restaurant','Hotpot Restaurant','Indonesian Restaurant','Japanese Restaurant','Korean Restaurant','Malay Restaurar
'Mongolian Restaurant','Noodle House','Satay Restaurant','Thai Restaurant','Tibetan Restaurant','Austrian Restaurant','BBQ Jo
'Bagel Shop','Bakery','Belgian Restaurant','Bistro','Breakfast Spot','Bubble Tea Shop','Buffet','Burger Joint','Cafeteria',
'Café','Cajun / Creole Restaurant','Caribbean Restaurant','Caucasian Restaurant','Coffee Shop','Comfort Food Restaurant',
'Creperie','Czech Restaurant','Deli / Bodega','Dessert Shop','Diner','Donut Shop','Dumpling Restaurant','Dutch Restaurant',
'Eastern European Restaurant','English Restaurant','Falafel Restaurant','Fast Food Restaurant','Fish & Chips Shop','Fondue Re
'Food Court','Food Stand','Food Truck','French Restaurant','Fried Chicken Joint','Friterie','Gastropub','German Restaurant',
'Gluten-free Restaurant','Greek Restaurant','Halal Restaurant','Hawaiian Restaurant','Hot Dog Joint','Hungarian Restaurant',
'Indian Restaurant','Irish Pub','Italian Restaurant','Jewish Restaurant','Juice Bar','Kebab Restaurant','Latin American Resta
'Mac & Cheese Joint','Mediterranean Restaurant','Mexican Restaurant','Middle Eastern Restaurant','Modern European Restaurant'
'Molecular Gastronomy Restaurant','Pakistani Restaurant','Pet Café','Pizza Place','Polish Restaurant','Portuguese Restaurant'
'Poutine Place','Restaurant','Russian Restaurant','Salad Place','Sandwich Place','Scandinavian Restaurant','Scottish Restaura
'Seafood Restaurant','Slovak Restaurant','Snack Place','Soup Place','Southern / Soul Food Restaurant','Spanish Restaurant',
'Sri Lankan Restaurant','Steakhouse','Swiss Restaurant','Tea Room','Theme Restaurant','Truck Stop','Turkish Restaurant','Ukra
'Vegetarian / Vegan Restaurant','Wings Joint']
ny_food_venues = ny_venue_data_with_city[ny_venue_data_with_city['Venue Category'].isin(food_related_categories)]
delta = ny_venue_data_with_city.shape[0] - ny_food_venues.shape[0]
print(f'{delta} entries were removed based on "Venue Category" not being related to food')
print(ny_food_venues['Venue Category'].unique())
ny_food_venues.head(5)
```

d) The image below shows the total number of entries and number of unique entries in the ny_foodc_venues dataframe. As previously mentioned, some venues are assigned to multiple neighborhoods because the venue is within 500 meters of the neighborhood's centroid location.

How many food venue entries are left?

```
n_entries = ny_food_venues.shape[0]
print(f'There are {n_entries} entries in the ny_food_venues dataframe')
```

```
There are 1271 entries in the ny_food_venues dataframe
```

How many unique food venues are left?

```
n_unique_entries = len(ny_food_venues['Venue Name'].unique())
print(f'There are {n_unique_entries} unique entries in the ny_food_venues dataframe')
```

```
There are 1188 unique entries in the ny_food_venues dataframe
```

OneHotEncoding Venue Categories

In order to use Foursquare's category values to find similar neighborhoods based on food venues, a onehotencoding representation of each entry was created using Pandas' 'get_dummies' function. The result was a dataframe of New York City food elated venues

where entry venue category is represented by a value of 1 in the column of matching venue category:

One-Hot-Encode Venue Categories

```
ny_venue_category_onehot = pd.get_dummies(ny_food_venues[['Venue Category']], prefix="", prefix_sep="")

ny_venue_category_onehot['Neighborhood'] = ny_food_venues['Neighborhood']

fixed_columns = [ny_venue_category_onehot.columns[-1]] + list(ny_venue_category_onehot.columns[:-1])
ny_venue_category_onehot = ny_venue_category_onehot[fixed_columns]

print(ny_venue_category_onehot.shape)
ny_venue_category_onehot.head()
```

```
(1271, 74)
```

7]:

	Neighborhood	Afghan Restaurant	African Restaurant	American Restaurant	Asian Restaurant	BBQ Joint	Bagel Shop	Bakery	Bistro	Breakfast Spot	...	Snack Place	Southern / Soul Food Restaurant	Spanish Restaurant	Sri Lankan Restaurant
0	Kingsbridge	0	0	0	0	0	0	0	0	0	...	0	0	0	0
1	Kingsbridge	0	0	0	0	0	0	0	0	0	...	0	0	0	0
2	Kingsbridge	0	0	0	0	0	0	0	0	0	...	0	0	0	0
4	Woodlawn	0	0	0	0	0	0	0	0	0	...	0	0	0	0
5	Woodlawn	0	0	0	0	0	0	0	0	0	...	0	0	0	0

5 rows × 74 columns

Feature Generation

After encoding the dataset of food and restaurant related in New York city then used to quantify to assess the profile of each neighborhood. For each venue category, the percent distribution of venues across each neighborhood was calculated. This information would then be used to fit a KMeans clustering algorithm to the data in an effort to determine neighborhoods of similar food venue profile.

For each venue category, determine the percentage of entities in each neighborhood

```
venue_mean = pd.DataFrame()
for category, total in venue_totals.items():
    venue_mean[category] = venue_counts[category].apply(lambda x: x / total)
venue_mean = venue_mean.reindex(sorted(venue_mean.columns), axis=1).reset_index()
venue_mean.head(5)
```

8]:

	Neighborhood	Afghan Restaurant	African Restaurant	American Restaurant	Asian Restaurant	Filipino Restaurant	Himalayan Restaurant	Hotpot Restaurant
0	Allerton	0.0	0.0	0.0	0.000000	0.0	0.0	0.0
1	Arlington	0.0	0.0	0.0	0.000000	0.0	0.0	0.0
2	Arrochar	0.0	0.0	0.0	0.000000	0.0	0.0	0.0
3	Astoria	0.0	0.0	0.0	0.000000	0.0	0.0	0.0
4	Bath Beach	0.0	0.0	0.0	0.071429	0.0	0.0	0.0

Creating a dataframe that shows the top 5 venue categories each neighborhood is known for

```
def return_top_venue_categories(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]
```

```
num_top_venues = 5

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('{}{} Top Venue Category'.format(ind+1, indicators[ind]))
    except:
        columns.append('{}th Top Venue Category'.format(ind+1))

neighborhoods_top_venue_categories = pd.DataFrame(columns=columns)
neighborhoods_top_venue_categories['Neighborhood'] = venue_mean['Neighborhood']

for ind in np.arange(venue_mean.shape[0]):
    neighborhoods_top_venue_categories.iloc[ind, 1:] = return_top_venue_categories(venue_mean.iloc[ind, :], num_top_venues)

neighborhoods_top_venue_categories.head(5)
```

!9]:

	Neighborhood	1st Top Venue Category	2nd Top Venue Category	3rd Top Venue Category	4th Top Venue Category	5th Top Venue Category
0	Allerton	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
1	Arlington	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
2	Arrochar	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
3	Astoria	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
4	Bath Beach	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant

Results

Cluster Modeling

Scikitlearn's KMeans clustering was used to determine similar neighborhoods based on food venue percentage. The image below shows the data being scaled and the KMeans model being created:

Create a KMeans Model To Cluster Neighborhoods

```
kclusters = 15

venue_grouped_clustering = venue_mean.drop('Neighborhood', 1)
kmeans = KMeans(n_clusters=kclusters, random_state=0).fit(venue_grouped_clustering)

kmeans.labels_
```

0]:
```
array([ 0,  0,  0,  0,  7,  8,  0,  8,  0,  0,  0,  0,  0,  0,  0,  0,  0,
        0,  0,  0,  0,  7,  0,  0,  0,  8,  0,  0,  0,  8,  0,  0,  0,  7,
        0,  0,  0,  0,  0,  0,  0,  0,  8,  0,  0,  0, 12,  0,  0,  0,  0,
        5,  4,  0,  0,  0,  0,  0,  0,  0,  8,  8,  0,  7,  0,  0,  0,  0,
        0, 11,  0,  0,  0, 12,  8,  0,  0,  8,  8,  0,  7,  0, 10,  0,  0,
        6,  0, 14,  8,  0,  0,  0,  0,  0,  8,  1,  0,  2,  8,  0,  0,  0,
        0,  0,  0,  0,  0,  0,  9, 11,  0,  0,  0,  0,  0,  0,  8,  0,  5,
        3,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  6,
        0,  0,  8,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  0,  8,  0,  0,
        0,  8,  0,  8,  0,  0,  8,  0,  0,  0,  0,  8,  0,  8,  0,  0,  4,
        8,  0,  0, 11,  0,  0,  0,  0,  0,  0, 13,  0])
```

A new dataframe was created by merging neighborhood location data with cluster labels and top venue categories.

Creating a new dataframe merging neighborhood location data, top venue category by neighborhood, and cluster labels

```
#neighborhoods_top_venue_categories.insert(1,'Cluster Labels', kmeans.labels_)

ny_neighborhood_food_profile = nyc_neighborhoods.drop(columns=['Borough'])

ny_neighborhood_food_profile = ny_neighborhood_food_profile.join(neighborhoods_top_venue_categories.set_index('Neighborhood')

ny_neighborhood_food_profile.head()
```

Cluster Visualization

I have used folium visualization package to visualize clustered similar food and restaurant neighborhoods in Ney York city.

Creating A Visualization of The Clusters

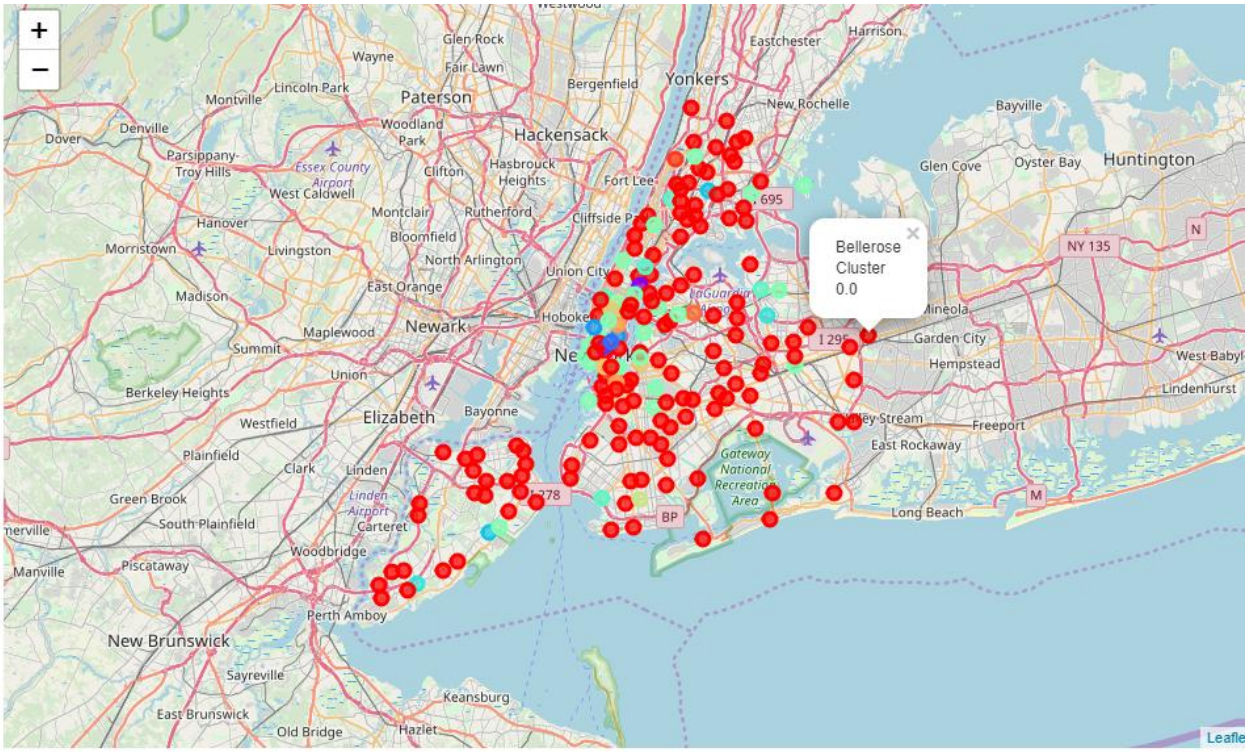
In [90]:

```
# create map
import matplotlib.cm as cm
import matplotlib.colors as colors
latitude = 40.730610
longitude = -73.935242
map_clusters = folium.Map(location=[latitude, longitude], zoom_start=10.45)

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

map_clusters
```



Cluster Evaluation

I have the following coded which iterates through and prints the results of each cluster:

```
for cluster in range(0, kclusters):
    print(f'Cluster {cluster}:')
    print(ny_neighborhood_food_profile.loc[ny_neighborhood_food_profile['Cluster Labels'] == cluster, ny_neighborhood_food_pr
```

The cluster detail list is presented at the appendix section. Let’ s try see some interesting results showed up from the kmeans clustering algorithm.

The majority of food and restaurant related services are accumulated in the first cluster and ninth cluster.

In the first cluster Hotspot restaurants are more abundant with Himalayan Restaurant**,** Filipino Restaurant, Asian Restaurant and American Restaurant following consecutively.

From cluster 2 upto cluster 7, it seems that there is no much food and restaurant venues. Each of them have two or one venues.

From cluster 10 to 14 also lower number of food and restaurant related venues.

Conclusion

Machine learning algorithm can applied to different multidimensional dataset to find meaningful patern and similarities among data. Cluster of food and restaurant related service in given city can generated with high level geo spatial data with additional parameters. But, in this project for leaning purpose we have limted radius as 500 and amount of data limit as 25. The result has shown clearly which areas are more prone for food and restaurant services and what type of restaurants' are more popular.

These findings can used start up and baseline for business owner who wants to start new restaurant business to conduct further investigation.

References

[1]https://money.cnn.com/2008/07/29/news/companies/restaurant_industry/index.htm?postversion=2008072919

[2]https:/data.bls.gov/timeseries/LNS14000000)

[3] 2014 New York City Neighborhood Names NYU Spatial Data Repository

[4]'Places API' Documentation Foursquare

Appendix

Clusters

Cluster 0:

	Neighborhood	1st Top Venue Category	2nd Top Venue Category	3rd Top Venue Category	4th Top Venue Category	5th Top Venue Category
5	Kingsbridge	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
7	Woodlawn	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
8	Norwood	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
9	Williamsbridge	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
15	Morris Heights	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
16	Fordham	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
18	West Farms	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
20	Melrose	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
21	Mott Haven	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
23	Longwood	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
25	Morrisania	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
26	Soundview	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
32	Van Nest	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
34	Belmont	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
36	North Riverdale	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
37	Pelham Bay	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
40	Castle Hill	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
41	Olinville	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
43	Concourse	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
44	Unionport	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
45	Edenwald	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
46	Bay Ridge	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
48	Sunset Park	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
50	Gravesend	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
51	Brighton Beach	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
53	Manhattan Terrace	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
56	East Flatbush	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
57	Kensington	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
58	Windsor Terrace	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
59	Prospect Heights	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
..	...	...	...	...	...	...
231	Dongan Hills	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
239	Charleston	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
244	Chelsea	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
249	Civic Center	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
254	Concord	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
258	Elm Park	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
263	Jamaica Hills	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
267	Claremont Village	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
268	Concourse Village	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
269	Mount Eden	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
270	Mount Hope	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
272	Hunters Point	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
273	Turtle Bay	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
274	Tudor City	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
278	Blissville	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
281	Weeksville	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
282	Broadway Junction	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
283	Dumbo	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
284	Manor Heights	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
285	Willowbrook	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
286	Sandy Ground	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
288	Roxbury	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
290	Middle Village	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
291	Prince's Bay	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
293	Richmond Valley	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
298	Allerton	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
300	Erasmus	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
301	Hudson Yards	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
304	Queensbridge	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant
305	Fox Hills	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant	American Restaurant

```
32     Filipino Restaurant       Asian Restaurant    American Restaurant
34     Filipino Restaurant       Asian Restaurant    American Restaurant
36     Filipino Restaurant       Asian Restaurant    American Restaurant
37     Filipino Restaurant       Asian Restaurant    American Restaurant
40     Filipino Restaurant       Asian Restaurant    American Restaurant
41     Filipino Restaurant       Asian Restaurant    American Restaurant
43     Filipino Restaurant       Asian Restaurant    American Restaurant
44     Filipino Restaurant       Asian Restaurant    American Restaurant
45     Filipino Restaurant       Asian Restaurant    American Restaurant
46     Filipino Restaurant       Asian Restaurant    American Restaurant
48     Filipino Restaurant       Asian Restaurant    American Restaurant
50     Filipino Restaurant       Asian Restaurant    American Restaurant
51     Filipino Restaurant       Asian Restaurant    American Restaurant
53     Filipino Restaurant       Asian Restaurant    American Restaurant
56     Filipino Restaurant       Asian Restaurant    American Restaurant
57     Filipino Restaurant       Asian Restaurant    American Restaurant
58     Filipino Restaurant       Asian Restaurant    American Restaurant
59     Filipino Restaurant       Asian Restaurant    American Restaurant
..                     ...                     ...                     ...
231    Filipino Restaurant       Asian Restaurant    American Restaurant
239    Filipino Restaurant       Asian Restaurant    American Restaurant
244    Filipino Restaurant       Asian Restaurant    American Restaurant
249    Filipino Restaurant       Asian Restaurant    American Restaurant
254    Filipino Restaurant       Asian Restaurant    American Restaurant
258    Filipino Restaurant       Asian Restaurant    American Restaurant
263    Filipino Restaurant       Asian Restaurant    American Restaurant
267    Filipino Restaurant       Asian Restaurant    American Restaurant
268    Filipino Restaurant       Asian Restaurant    American Restaurant
269    Filipino Restaurant       Asian Restaurant    American Restaurant
270    Filipino Restaurant       Asian Restaurant    American Restaurant
272    Filipino Restaurant       Asian Restaurant    American Restaurant
273    Filipino Restaurant       Asian Restaurant    American Restaurant
274    Filipino Restaurant       Asian Restaurant    American Restaurant
278    Filipino Restaurant       Asian Restaurant    American Restaurant
281    Filipino Restaurant       Asian Restaurant    American Restaurant
282    Filipino Restaurant       Asian Restaurant    American Restaurant
283    Filipino Restaurant       Asian Restaurant    American Restaurant
284    Filipino Restaurant       Asian Restaurant    American Restaurant
285    Filipino Restaurant       Asian Restaurant    American Restaurant
286    Filipino Restaurant       Asian Restaurant    American Restaurant
288    Filipino Restaurant       Asian Restaurant    American Restaurant
290    Filipino Restaurant       Asian Restaurant    American Restaurant
291    Filipino Restaurant       Asian Restaurant    American Restaurant
293    Filipino Restaurant       Asian Restaurant    American Restaurant
298    Filipino Restaurant       Asian Restaurant    American Restaurant
300    Filipino Restaurant       Asian Restaurant    American Restaurant
301    Filipino Restaurant       Asian Restaurant    American Restaurant
304    Filipino Restaurant       Asian Restaurant    American Restaurant
305    Filipino Restaurant       Asian Restaurant    American Restaurant

[139 rows x 6 columns]
```

Cluster 1:

```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
109   Lenox Hill      Afghan Restaurant    American Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
109      Hotpot Restaurant   Himalayan Restaurant    Filipino Restaurant
```

Cluster 2:

```
     Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
121  Little Italy      Hotpot Restaurant   Himalayan Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
121    Filipino Restaurant       Asian Restaurant    American Restaurant
```

Cluster 3:

```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
248         Noho   Himalayan Restaurant    American Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
248      Hotpot Restaurant    Filipino Restaurant       Asian Restaurant
```

Cluster 4:

```
     Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
118  East Village    Filipino Restaurant    American Restaurant
123  West Village    Filipino Restaurant    American Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
118      Hotpot Restaurant   Himalayan Restaurant       Asian Restaurant
123      Hotpot Restaurant   Himalayan Restaurant       Asian Restaurant
```

Cluster 5:

	Neighborhood	1st Top Venue Category	2nd Top Venue Category	3rd Top Venue Category	4th Top Venue Category	5th Top Venue Category
17	East Tremont	African Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
211	New Dorp	African Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant

Cluster 6:

	Neighborhood	1st Top Venue Category	2nd Top Venue Category	3rd Top Venue Category	4th Top Venue Category	5th Top Venue Category
184	Queensboro Hill	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant
236	Huguenot	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant

Cluster 7:

	Neighborhood	1st Top Venue Category	2nd Top Venue Category	3rd Top Venue Category	4th Top Venue Category	5th Top Venue Category
19	High Bridge	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant
79	Bath Beach	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant
113	Clinton	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant
138	Flushing	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant
247	Carnegie Hill	Asian Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	American Restaurant

Cluster 8:

	Neighborhood	1st Top Venue Category	2nd Top Venue Category	3rd Top Venue Category	4th Top Venue Category	5th Top Venue Category
12	City Island	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
31	Westchester Square	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
49	Greenpoint	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
55	Crown Heights	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
63	Bedford Stuyvesant	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
67	Red Hook	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
97	South Side	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
105	Central Harlem	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
111	Upper West Side	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
115	Murray Hill	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
117	Greenwich Village	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
120	Tribeca	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
127	Battery Park City	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
128	Financial District	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
139	Long Island City	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
160	Jamaica Center	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
180	Murray Hill	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
233	Grant City	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
271	Sutton Place	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
276	Flatiron	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
277	Sunnyside Gardens	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
280	Vinegar Hill	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant
299	Kingsbridge Heights	American Restaurant	Hotpot Restaurant	Himalayan Restaurant	Filipino Restaurant	Asian Restaurant

```
280   Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
299   Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
```
Cluster 9:
```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
114      Midtown    American Restaurant      Hotpot Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
114   Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
```
Cluster 10:
```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
289    Homecrest       Asian Restaurant      Hotpot Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
289   Himalayan Restaurant    Filipino Restaurant    American Restaurant
```
Cluster 11:
```
      Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
61    Williamsburg    American Restaurant      Hotpot Restaurant
250  Midtown South    American Restaurant      Hotpot Restaurant
279   Fulton Ferry    American Restaurant      Hotpot Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
61    Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
250   Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
279   Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
```
Cluster 12:
```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
86      Downtown       Asian Restaurant    American Restaurant
126     Gramercy       Asian Restaurant    American Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
86       Hotpot Restaurant   Himalayan Restaurant    Filipino Restaurant
126      Hotpot Restaurant   Himalayan Restaurant    Filipino Restaurant
```
Cluster 13:
```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
130     Woodside   Himalayan Restaurant      Hotpot Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
130    Filipino Restaurant       Asian Restaurant    American Restaurant
```
Cluster 14:
```
    Neighborhood 1st Top Venue Category 2nd Top Venue Category  \
102       Inwood    American Restaurant      Hotpot Restaurant

    3rd Top Venue Category 4th Top Venue Category 5th Top Venue Category
102   Himalayan Restaurant    Filipino Restaurant       Asian Restaurant
```