Final Exam - IBM Data Science Capstone - Week 2 Submission

Business Problem Introduction

Companies opening up new store fronts, have to deal with a myriad of issues: business licenses, regulatory requirements, sales and business taxes, competitors, and of course the biggest item: location, location, location. Positioning a store front in an advantageous location is one of, if not the, most important, key factor in a business's ability to survive and thrive. The business problem this analysis attempts to solve, is to assist business owners with finding a set of potential locations to maximize their chances of success in opening a new store front. The specific "client" that this study will address, is a business owner that wants to open a new upscale (Steakhouse) restaurant in the Toronto Canada area.

The overall strategy will be to find the highest revenue generating areas, in combination with the lowest number of potential competitors, within a given area. In addition, the total number of other nearby (non-restaurant) venues will be factored in, which act as additional "magnets" to entice more customers and foot traffic into the area that the business operates in.

Both a text summary of the best potential neighborhoods, as well as a Folium map showing the city of Toronto and the selected potential neighborhoods in graphic form, will be produced by the project.

Who Would be Interested

The typical client for this kind of service would be any business that wanted to open a new storefront in any of Toronto's neighborhoods. The customer would be able to get a list of the top 10 neighborhoods that would have the best desired "draw" characteristics, as well as good potential (under-served areas) for the target business.

While this specific project focuses on selecting restaurant locations, any type of store front business (not just restaurants) could be evaluated, by changing the target venue.

Data To Be Used

For this analysis, the following data is needed, in the form of CSV files that will be downloaded and generated as part of the reproducible source input data for this project:

- Toronto Open Data Portal providing Toronto Neighbor Names and Demographic data for each neightborhood
- Nominatim network REST API used to retrive geo-coding data (latitude and longitude) for each neighborhood
- Foursquare Labs network REST API to search and extract Venue information about each neighborhood

Methodology and Analysis Section

This section includes the data related import and processing modules, including exploratory data analysis based on plots, and processing of data loaded into Python Pandas data frames, to massage and cluster the data being used.

First, setup all the python libraries dependencies that we will need.

In [30]:

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

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

#!conda install -c conda-forge geopy --yes # uncomment this line if you haven't co
from geopy.geocoders import Nominatim   # convert an address into latitude and lo

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

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

# 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 ha
import folium                               # map rendering library

## !pip install beautifulsoup4
from bs4 import BeautifulSoup               # pull in HTML screen scraper support

import csv                                  # CSV processing

from pathlib import Path                    # File exists checking

import time                                 # for sleep function

print ('python Libraries have been imported.')
```

```
python Libraries have been imported.
```

Download and Explore Datasets

Load Neighborhoods and associated Real Estate Prices data

In order to segement the neighborhoods and explore them, create a dataset that contains all the Toronto neighborhoods and their associated districts, based upon XLS/CSV data downloaded from the Toronto Data portal.

In [31]:

```
# Retrieved CSV list of neighborhoods and associated housing data from Toronto's
# webpage, from their Open Data Portal at URL:
#  https://www.toronto.ca/city-government/data-research-maps/open-data/open-data-
# Their XLSX data was downloaded and converted to CSV format in local directory
# Read in that CSV

# convert the Toronto neighborhoods CSV file into a pandas dataframe, then print

df_toronto_base_raw = pd.read_csv ('Toronto_WB-Housing.csv')

print ('Toronto Neighbourhods and Housing CSV dataset loaded!')
print ('Raw Toronto Neighbourhoods shape is: ', df_toronto_base_raw.shape)

df_toronto_base_raw.head (10)
```

```
Toronto Neighbourhods and Housing CSV dataset loaded!
Raw Toronto Neighbourhoods shape is:  (140, 12)
```

Out[31]:

	Neighbourhood	Neighbourhood Id	Home Prices	Mid-Century Highrise Households	Mid-Century Highrise Population	Percent Mid-Century Highrise Households	Percent Mid-Century Highrise Population	Re Ap
0	West Humber-Clairville	1	317508	690	1810	6.8	5.3	
1	Mount Olive-Silverstone-Jamestown	2	251119	4110	13395	42.9	40.9	
2	Thistletown-Beaumond Heights	3	414216	430	1260	13.4	12.4	
3	Rexdale-Kipling	4	392271	600	1050	15.2	10.0	

Data Wrangling/Cleaning

This section cleans up the data we received, dropping any NaN housing data, removing any duplicates, and dropping any un-needed columns.

In [32]:

```
# drop any neighbourhoods that lack housing price data  (should not be any, but ju
df_toronto_base_raw.dropna (subset=['Home Prices'], inplace=True)

# drop any duplicates  (should not be any, but just to be sure)
df_toronto_base_raw.drop_duplicates (subset=None, keep='first', inplace=True)

# drop unneeded columns (aka grab just the columns we really need)
df_toronto = df_toronto_base_raw[['Neighbourhood','Home Prices']]

# clean things up by sorting into alpha order, then reset Pandas index to renumbe
df_toronto.sort_values (by=['Neighbourhood'],ascending=True,inplace=True)  # sort
df_toronto = df_toronto.reset_index (drop=True)

print ('Cleaned Toronto Neighbourhoods shape is: ', df_toronto.shape)

df_toronto.head (10)
```

```
Cleaned Toronto Neighbourhoods shape is:  (140, 2)

E:\K\Anaconda_v3.6\lib\site-packages\ipykernel_launcher.py:11: SettingWithCopyW
arning:
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-docs/stab
le/indexing.html#indexing-view-versus-copy (http://pandas.pydata.org/pandas-doc
s/stable/indexing.html#indexing-view-versus-copy)
  # This is added back by InteractiveShellApp.init_path()
```

Out[32]:

	Neighbourhood	Home Prices
0	Agincourt North	375307
1	Agincourt South-Malvern West	332710
2	Alderwood	504233
3	Annex	993491
4	Banbury-Don Mills	613647
5	Bathurst Manor	568877
6	Bay Street Corridor	457787
7	Bayview Village	533089
8	Bayview Woods-Steeles	784397
9	Bedford Park-Nortown	1191040

In [33]:
```
# show a histogram of Real Estate (Home) price disribution

plt.figure(figsize=(16,6))
plt.hist (df_toronto['Home Prices'],16)
plt.title('Figure 1 - Toronto Neighbourhood Real Estate Price Distribution')
plt.show()
```

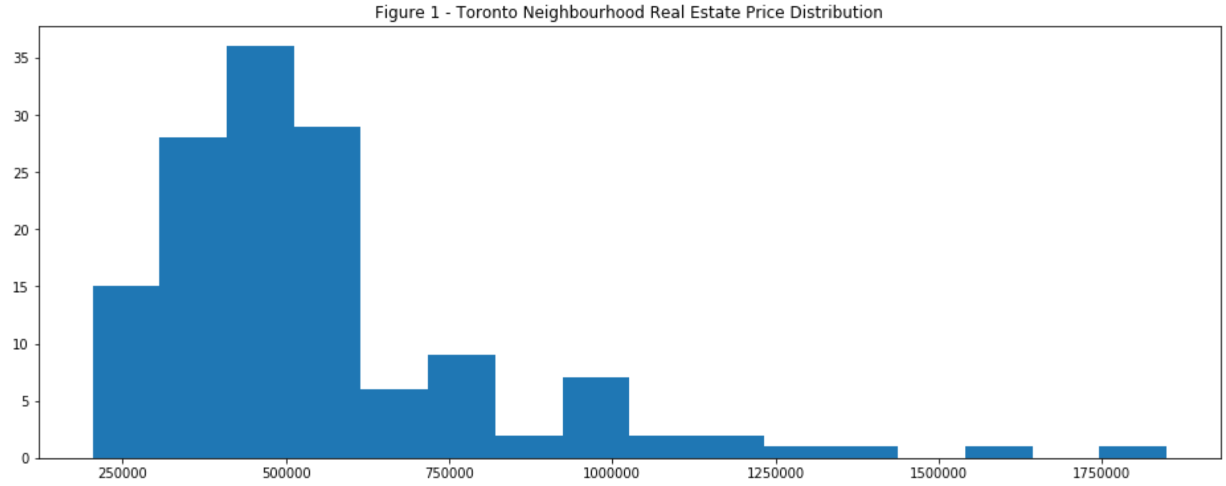


Figure 1 - Toronto Neighbourhood Real Estate Price Distribution

In [34]:
```
# and also get basic stats on the Home Prices data
# Bottom line is we want to target neighbourhoods with Home Prices of 548K and hi

df_toronto.describe()
```

Out[34]:

	Home Prices
count	1.400000e+02
mean	5.481934e+05
std	2.676674e+05
min	2.041040e+05
25%	3.749645e+05
50%	4.912100e+05
75%	5.902160e+05
max	1.849084e+06

In [35]:

```
# Check if the Toronto Neighbourhood geo dataset has been created. If not, create
# Skip re-building the file, if the CSV dataset already exists. Are approx 140 en

my_file = Path ("Toronto_Geospatial_Coordinates.csv")
if (my_file.is_file() == False):
    # file does NOT exist. Must create it
    geolocator = Nominatim()     # instantiate the lookup object
    Nominatim (user_agent="my-application")   # set specific application name to


    csv_geo_file = open ('Toronto_Geospatial_Coordinates.csv', 'w')
    csv_writer   = csv.writer (csv_geo_file)
    csv_writer.writerow (['Neighbourhood', 'Home Prices', 'Latitude', 'Longitude'

    # NOTE: Nominatim limits stuff to maximum of 1 request per second !!!  (we ne
    # loop thru the above pandas dataset and append the Neighbourhood name to Sea
    # and then do a lookup on that, and save it into a csv file by neighbourhood
    for i in range(0, len(df_toronto)):
        Neighbourhood  = df_toronto.iloc[i]['Neighbourhood']
        Housing_Price = df_toronto.iloc[i]['Home Prices']
        # a bit brute force, but we only have to do it once (for 127 u)
        address    = Neighbourhood + ', Toronto, Canada'
        location   = geolocator.geocode (address)
        if (location != None):
           Latitude   = location.latitude
           Longitude  = location.longitude
        # if null, will just use the previous Lat/Long as default
        csv_writer.writerow ([Neighbourhood, Housing_Price, Latitude, Longitude])
        print ('Address coords to {} are {}, {}.'.format(address, Latitude, Longi
        #
        time.sleep (2)   # Delays for 2 seconds to make Novatim happy. Can also u

    csv_geo_file.close()
    print ('Toronto Geo Coordinates file write complete')
```

In [36]:

```
# import the CSV file Toronto_Geospatial_Coordinates.csv that we created earlier,

df_toronto_neighborhood_geo = pd.read_csv ('Toronto_Geospatial_Coordinates.csv')

print ("Total Neighbourhoods: " + str(df_toronto_neighborhood_geo ['Neighbourhood
print ('Shape of Toronto Neighborhood Geo coordinate shape is ', df_toronto_neigh

df_toronto_neighborhood_geo .head (10)
```

```
Total Neighbourhoods: 140
Shape of Toronto Neighborhood Geo coordinate shape is  (140, 4)
```

Out[36]:

	Neighbourhood	Home Prices	Latitude	Longitude
0	Agincourt North	375307	43.808038	-79.266439
1	Agincourt South-Malvern West	332710	43.808038	-79.266439
2	Alderwood	504233	43.601717	-79.545232
3	Annex	993491	43.670338	-79.407117
4	Banbury-Don Mills	613647	43.734804	-79.357243
5	Bathurst Manor	568877	43.763893	-79.456367
6	Bay Street Corridor	457787	43.665275	-79.387528
7	Bayview Village	533089	43.769197	-79.376662
8	Bayview Woods-Steeles	784397	43.798127	-79.382973
9	Bedford Park-Nortown	1191040	43.798127	-79.382973

In [ ]:

```
```

==

Setup Four Square credentials

==

In [37]:

```
# use the 4-Square segmenting/clustering thing
CLIENT_ID = '50BIQWK4SFVUM420YXDPJCP2BGLEJORINZQAZF0SHQEREVIX' # my Foursquare ID
CLIENT_SECRET = '4OF5PFQ0PF4JX5RVA3FF52TNZMBU2JZRIQ00JCH1UDOHHKCW' # my Foursquar
VERSION = '20180605' # Foursquare API version or '20180604'
# CAUTION LIMIT must be same as shape (103). If set to 100 (default) later
# processing dies because the frame shapes don't match (103 vs 100)
LIMIT = 100
print ('Your credentials:')
print ('CLIENT_ID: ' + CLIENT_ID)
print ('CLIENT_SECRET: ' + CLIENT_SECRET)
print ('VERSION: ' + VERSION)
#print ('LIMIT: ' + LIMIT)
```

```
Your credentials:
CLIENT_ID: 50BIQWK4SFVUM420YXDPJCP2BGLEJORINZQAZF0SHQEREVIX
CLIENT_SECRET: 4OF5PFQ0PF4JX5RVA3FF52TNZMBU2JZRIQ00JCH1UDOHHKCW
VERSION: 20180605
```

Set up Python Functions Needed for processing Four-Square Results

In [9]:

```
# function to extract basic category for restaraunts and other things
# Venue Cataegory often has two part names, e.g. Restaraunt will have Venues of '.
# This logic extracts the basic category, e.g. just 'Restaraunt'

def gen_basic_category (category_name):
    name_elements = category_name.split()
    if (len(name_elements) > 1):
        # split returned a tuple with multiple elements. for restaurant, skip the
        if (name_elements[1] == 'Restaurant'):
            return (name_elements[1])
    return (name_elements[0])
```

In [10]:

```
# returns indication if the category is a restaurant or not. 1 = yes, 0 = no
# This logic extracts the basic category, e.g. just 'Restaraunt'

def is_restaurant (category_name, cumul_count_str):
    cumul_count = int(cumul_count_str)
    name_elements = category_name.split()
    if (len(name_elements) > 1):
        # split returned a tuple with multiple elements. for restaurant, skip the
        if (name_elements[1] == 'Restaurant'):
            cumul_count = cumul_count + 1
    return str(cumul_count)
```

In [11]:

```
# returns indication if the category is a steakhouse or not. 1 = yes, 0 = no
# This logic extracts the basic category, e.g. just 'Restaurant' or 'Steakhouse'

def is_steakhouse (category_name, cumul_count_str):
    cumul_count = int(cumul_count_str)
    name_elements = category_name.split()
    if (category_name == 'Steakhouse'):
       cumul_count = cumul_count + 1
    if (category_name == 'SteakHouse'):
       cumul_count = cumul_count + 1
    return str(cumul_count)
```

Function to Search for All Venues in an Area (neighborhood)

In [16]:

```
# generic search for all venues in an area
#def  getNearbyVenues (name, lat, lng, radius=1000):
def  getNearbyVenues (names, latitudes, longitudes, radius=1000):

    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_
            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. only allows STR
        rest_count  = str(0)
        steak_count = str(0)
        venues_list.append ([(
                name,
                ven['venue']['name'],
                ven['venue']['categories'][0]['name'],
                gen_basic_category (ven['venue']['categories'][0]['name']),
                ven['venue']['location']['lat'],
                ven['venue']['location']['lng'],
                lat,
                lng)    for ven in results])
        # end for

    nearby_venues = pd.DataFrame ([item for venue_list in venues_list for item in

    nearby_venues.columns = ['Neighbourhood',
                  'Venue',
                  'Venue_Category',
                  'Venue_Basic_Category',
                  'Venue Latitude',
                  'Venue Longitude',
                  'Neighborhood Latitude',
                  'Neighborhood Longitude']

    return (nearby_venues)
```

Function to Search for a Specific Venue in an Area

In [12]:

```
# search for a specific type of Venue (food store, electronics store, restaraunt,

def  searchNearbyVenues (names, latitudes, longitudes, search_arg, radius=1000):

    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_
            CLIENT_ID,
            CLIENT_SECRET,
            VERSION,
            lat,
            lng,
            search_arg,
            radius,
            LIMIT)

        # make the GET request, and get returned JSON result
        results = requests.get(url).json()["response"]['groups'][0]['items']

        # extract and return only relevant information for each nearby venue from
        venues_list.append ([(
                name,
                ven['venue']['name'],
                ven['venue']['categories'][0]['name'],
                gen_basic_category (ven['venue']['categories'][0]['name']),
                ven['venue']['location']['lat'],
                ven['venue']['location']['lng'],
                lat,
                lng)   for ven in results])
        # end for

    # convert the collected list of JSON-based venue entries into a Pandas Datafr
    nearby_venues = pd.DataFrame ([item for venue_list in venues_list for item in
    #
    # set the names of the columns to use in the new DataFrame
    nearby_venues.columns = ['Neighbourhood',
                  'Venue',
                  'Venue_Category',
                  'Venue_Basic_Category',
                  'Venue Latitude',
                  'Venue Longitude',
                  'Neighborhood Latitude',
                  'Neighborhood Longitude']

    return (nearby_venues)
```

Function to Extract type of Venue (Category) from the returned Four-Square data

All the returned information is in the *items* key. This extracts the Category type

In [13]:
```
# 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']
```

In [ ]:
```
```

Explore the set of Venues in each of the Neighborhoods

Run Query for all the venues in a set of neighborhoods, and create a new dataframe called *toronto_venues*.

In [263]:
```
# invoke the 4-Square functions for each of the 140 neighbourhoods,
# and save the results in a data frame

toronto_venues = getNearbyVenues (names      = df_toronto_neighborhood_geo ['Neig
                                  latitudes  = df_toronto_neighborhood_geo l['Lat
                                  longitudes = df_toronto_neighborhood_geo ['Long
                                 )
```

```
Agincourt North
Agincourt South-Malvern West
Alderwood
Annex
Banbury-Don Mills
Bathurst Manor
Bay Street Corridor
Bayview Village
Bayview Woods-Steeles
Bedford Park-Nortown
Beechborough-Greenbrook
Bendale
Birchcliffe-Cliffside
Black Creek
Blake-Jones
Briar Hill-Belgravia
Bridle Path-Sunnybrook-York Mills
Broadview North
Brookhaven-Amesbury
Cabbagetown-South St.James Town
```

Check the size and shape of the resulting dataframe

In [264]:

```
print ("Total Unique Neighbourhoods returned with Venues: " + str(toronto_venues[
print ('Total number and shape of venues results returned=', toronto_venues.shape
toronto_venues.head (10)
```

```
Total Unique Neighbourhoods returned with Venues: 140
Total number and shape of venues results returned= (5863, 10)
```

Out[264]:

	Neighbourhood	Venue	Venue_Category	Venue_Basic_Category	Venue_Restaurant_Count	Ve
0	Agincourt North	Saravanaa Bhavan South Indian Restaurant	Indian Restaurant	Restaurant	1	
1	Agincourt North	Samosa King - Embassy Restaurant	Indian Restaurant	Restaurant	1	
2	Agincourt North	Booster Juice	Juice Bar	Juice	0	
3	Agincourt North	Shoppers Drug Mart	Pharmacy	Pharmacy	0	
4	Agincourt North	Dollarama	Discount Store	Discount	0	
5	Agincourt North	The Beer Store	Beer Store	Beer	0	
6	Agincourt North	Subway	Sandwich Place	Sandwich	0	
7	Agincourt North	TD Canada Trust	Bank	Bank	0	
8	Agincourt North	Congee Town 太皇名粥	Chinese Restaurant	Restaurant	1	
9	Agincourt North	Tim Hortons	Coffee Shop	Coffee	0	

In [265]:

```
# For debugging, save a copy of the returned toronto_venues dataframe
debug_flag1 = True
if (debug_flag1 == True):
    toronto_venues.to_csv ('toronto_all_venues.csv')
#   df.to_csv('results.csv', index=False, header=True)   # strips off Index colum
```

In [38]:

```
# For debugging, restore the copy of the returned toronto_venues dataframe (resta
debug_flag2 = True
if (debug_flag2 == True):
    toronto_venues = []
    toronto_venues = pd.read_csv ('toronto_all_venues.csv')
    toronto_venues.head (5)
```

Get how many Total venues were returned by Four-Square (all neighborhoods)

In [39]:
```
print ('{} total venues were returned by Foursquare.'.format(toronto_venues.shape
```

```
5863 total venues were returned by Foursquare.
```

Get how many unique categories can be curated from all the returned venues

In [40]:
```
print ('There are {} unique categories.'.format(len(toronto_venues['Venue_Categor
```

```
There are 310 unique categories.
```

Aggregate How many venues were returned for each neighborhood

In [41]:
```
toronto_venues.groupby ('Neighbourhood').count()
```

Out[41]:

	Unnamed: 0	Venue	Venue_Category	Venue_Basic_Category	Venue_Restaurant_(
Neighbourhood					
Agincourt North	31	31	31	31	
Agincourt South-Malvern West	31	31	31	31	
Alderwood	22	22	22	22	
Annex	100	100	100	100	
Banbury-Don Mills	27	27	27	27	
Bathurst Manor	16	16	16	16	
Bay Street Corridor	100	100	100	100	

Generate a column containing the Total Number of Venues in each neighborhood

In [42]:
```
# get a dataframe with the results of the groupby Neighborhood
toronto_venues_grouped = toronto_venues.groupby(['Neighbourhood']).size().reset_i
#toronto_venues_grouped.head(15)

# now merge the venue counts into the main Neighborhoods DataFrame
toronto_data_vm = pd.merge (df_toronto_neighborhood_geo, toronto_venues_grouped,
toronto_data_vm.head (15)
```

Out[42]:

	Neighbourhood	Home Prices	Latitude	Longitude	Venues_Count
0	Agincourt North	375307	43.808038	-79.266439	31
1	Agincourt South-Malvern West	332710	43.808038	-79.266439	31
2	Alderwood	504233	43.601717	-79.545232	22
3	Annex	993491	43.670338	-79.407117	100
4	Banbury-Don Mills	613647	43.734804	-79.357243	27
5	Bathurst Manor	568877	43.763893	-79.456367	16
6	Bay Street Corridor	457787	43.665275	-79.387528	100
7	Bayview Village	533089	43.769197	-79.376662	54
8	Bayview Woods-Steeles	784397	43.798127	-79.382973	8
9	Bedford Park-Nortown	1191040	43.798127	-79.382973	8
10	Beechborough-Greenbrook	440179	43.798127	-79.382973	8
11	Bendale	329355	43.753520	-79.255336	19
12	Birchcliffe-Cliffside	522905	43.753520	-79.255336	19
13	Black Creek	235143	43.741365	-79.496962	13
14	Blake-Jones	571246	43.741365	-79.496962	13

Generate aggregate counts of total Restaraunts and (competitive) Steak Houses for each neighborhood

In [43]:

```
# make the Neighbourhood column as the index, instead of numeric 0-n
# This makes it easy to do row-based .iloc lookups
toronto_data_vm.set_index ('Neighbourhood', inplace=True)

# groupby doesn't give us the counts we want, so we have to do it the old fashion
# and loop through each venue's row, lookup its neighborhood, and add to the neigh
# count if there is a Steak House or Restaraunt venue in that neighborhood.

toronto_data_vm ['Venue_Num_Steakhouses'] = 0    # create new columns and clear i
toronto_data_vm ['Venue_Num_Restaraunts'] = 0

for i in range(len(toronto_venues)):                         # walk thru Venue Da
    nhood    = toronto_venues.iloc[i]['Neighbourhood']       # get neighborhood n
    ven_type = toronto_venues.iloc[i]['Venue_Basic_Category']
    if (ven_type == 'Steakhouse' or ven_type == 'SteakHouse'):
        val = toronto_data_vm.get_value (nhood, 'Venue_Num_Steakhouses')  # Brute
        val += 1
        toronto_data_vm.set_value (nhood, 'Venue_Num_Steakhouses', val)   # works
    if (ven_type == 'Restaurant'):
        val = toronto_data_vm.get_value (nhood, 'Venue_Num_Restaraunts')
        val += 1
        toronto_data_vm.set_value (nhood, 'Venue_Num_Restaraunts', val)
    #print (str(i) + '   ' + nhood + '   ' + ven_type)

toronto_data_vm.head(10)
```

```
E:\K\Anaconda_v3.6\lib\site-packages\ipykernel_launcher.py:20: FutureWarning: g
et_value is deprecated and will be removed in a future release. Please use .at
[] or .iat[] accessors instead
E:\K\Anaconda_v3.6\lib\site-packages\ipykernel_launcher.py:22: FutureWarning: s
et_value is deprecated and will be removed in a future release. Please use .at
[] or .iat[] accessors instead
E:\K\Anaconda_v3.6\lib\site-packages\ipykernel_launcher.py:16: FutureWarning: g
et_value is deprecated and will be removed in a future release. Please use .at
[] or .iat[] accessors instead
  app.launch_new_instance()
E:\K\Anaconda_v3.6\lib\site-packages\ipykernel_launcher.py:18: FutureWarning: s
et_value is deprecated and will be removed in a future release. Please use .at
[] or .iat[] accessors instead
```

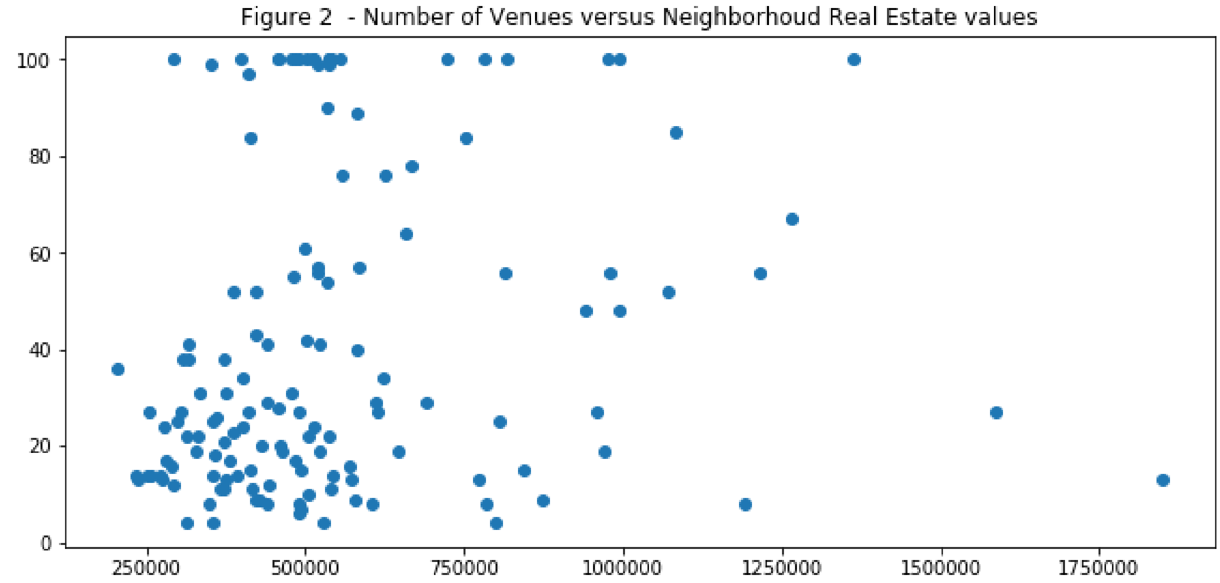
Out[43]:

	Home Prices	Latitude	Longitude	Venues_Count	Venue_Num_Steakhouses	Venue_Nu
Neighbourhood						
Agincourt North	375307	43.808038	-79.266439	31	0	
Agincourt South-Malvern West	332710	43.808038	-79.266439	31	0	
Alderwood	504233	43.601717	-79.545232	22	0	
Annex	993491	43.670338	-79.407117	100	0	
Banbury-Don Mills	613647	43.734804	-79.357243	27	0	
Bathurst Manor	568877	43.763893	-79.456367	16	0	

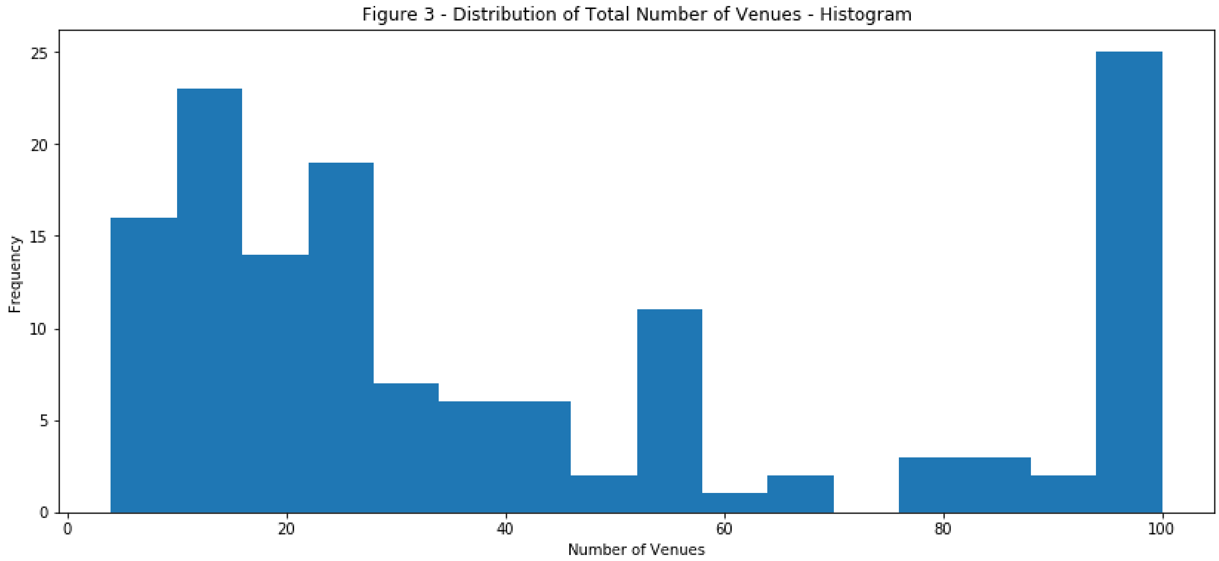
	Home Prices	Latitude	Longitude	Venues_Count	Venue_Num_Steakhouses	Venue_Nu
Neighbourhood						
Bay Street Corridor	457787	43.665275	-79.387528	100	1	
Bayview Village	533089	43.769197	-79.376662	54	0	
Bayview Woods-Steeles	784397	43.798127	-79.382973	8	0	
Bedford Park-Nortown	1191040	43.798127	-79.382973	8	0	

In [74]:

```
# do a X,Y scatter plot comparing # venues to Real Estate prices for each of the
# to see if there is any correlation
x = toronto_data_vm ['Home Prices']
y = toronto_data_vm ['Venues_Count']
plt.figure(figsize= (11,5))
plt.scatter (x,y)
plt.title ('Figure 2  - Number of Venues versus Neighborhoud Real Estate values')
plt.show()
```



In [54]:
```
plt.figure(figsize=(14,6))
plt.hist (toronto_data_vm ['Venues_Count'],16)
plt.xlabel('Number of Venues')
plt.ylabel('Frequency')
plt.title('Figure 3 - Distribution of Total Number of Venues - Histogram')
plt.show()
```



Analyze the Venues in Each Neighborhood

Use "one hot encoding" to create a numerical matrix of each type of venue in each neighborhood.

In [55]:
```
########################
#  one hot encoding
########################
toronto_onehot = pd.get_dummies (toronto_venues[['Venue_Category']], prefix="", p

# add neighbourhood column back into dataframe (gets appended to tail)
toronto_onehot['Neighbourhood'] = toronto_venues['Neighbourhood']
# then move that neighbourhood column to the first column
fixed_columns  = [toronto_onehot.columns[-1]] + list(toronto_onehot.columns[:-1])
toronto_onehot = toronto_onehot[fixed_columns]

toronto_onehot.head(35)
```

Out[55]:

	Neighbourhood	ATM	Accessories Store	Adult Boutique	Afghan Restaurant	African Restaurant	American Restaurant	Amphitheater
0	Agincourt North	0	0	0	0	0	0	0
1	Agincourt North	0	0	0	0	0	0	0
2	Agincourt North	0	0	0	0	0	0	0
3	Agincourt North	0	0	0	0	0	0	0
4	Agincourt North	0	0	0	0	0	0	0
5	Agincourt North	0	0	0	0	0	0	0
6	Agincourt North	0	0	0	0	0	0	0
7	Agincourt North	0	0	0	0	0	0	0
8	Agincourt North	0	0	0	0	0	0	0
9	Agincourt North	0	0	0	0	0	0	0
10	Agincourt North	0	0	0	0	0	0	0
11	Agincourt North	0	0	0	0	0	0	0
12	Agincourt North	0	0	0	0	0	0	0
13	Agincourt North	0	0	0	0	0	0	0
14	Agincourt North	0	0	0	0	0	0	0
15	Agincourt North	0	0	0	0	0	0	0
16	Agincourt North	0	0	0	0	0	0	0
17	Agincourt North	0	0	0	0	0	0	0
18	Agincourt North	0	0	0	0	0	0	0
19	Agincourt North	0	0	0	0	0	0	0
20	Agincourt North	0	0	0	0	0	0	0
21	Agincourt North	0	0	0	0	0	0	0
22	Agincourt North	0	0	0	0	0	0	0
23	Agincourt North	0	0	0	0	0	0	0
24	Agincourt North	0	0	0	0	0	0	0

	Neighbourhood	ATM	Accessories Store	Adult Boutique	Afghan Restaurant	African Restaurant	American Restaurant	Amphitheater
25	Agincourt North	0	0	0	0	0	0	0
26	Agincourt North	0	0	0	0	0	0	0
27	Agincourt North	0	0	0	0	0	0	0
28	Agincourt North	0	0	0	0	0	0	0
29	Agincourt North	0	0	0	0	0	0	0
30	Agincourt North	0	0	0	0	0	0	0
31	Agincourt South-Malvern West	0	0	0	0	0	0	0
32	Agincourt South-Malvern West	0	0	0	0	0	0	0
33	Agincourt South-Malvern West	0	0	0	0	0	0	0
34	Agincourt South-Malvern West	0	0	0	0	0	0	0

Get the new dataframe size.

In [56]:
```
toronto_onehot.shape
```

Out[56]:
```
(5863, 311)
```

Define Python Function to put Venues data into a *pandas* dataframe and sorting them in descending order

In [61]:
```
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]
```

In [75]:

```
x = toronto_data_vm.iloc[0:10, 0]       # verify the first 10 rows, and column 1
print (x)
```

```
Neighbourhood
Agincourt North                    375307
Agincourt South-Malvern West       332710
Alderwood                          504233
Annex                              993491
Banbury-Don Mills                  613647
Bathurst Manor                     568877
Bay Street Corridor                457787
Bayview Village                    533089
Bayview Woods-Steeles              784397
Bedford Park-Nortown              1191040
Name: Home Prices, dtype: int64
```

In [76]:

```
toronto_data_vm.head(10)
```

Out[76]:

	Home Prices	Latitude	Longitude	Venues_Count	Venue_Num_Steakhouses	Venue_Nu
Neighbourhood						
Agincourt North	375307	43.808038	-79.266439	31	0	
Agincourt South-Malvern West	332710	43.808038	-79.266439	31	0	
Alderwood	504233	43.601717	-79.545232	22	0	
Annex	993491	43.670338	-79.407117	100	0	
Banbury-Don Mills	613647	43.734804	-79.357243	27	0	
Bathurst Manor	568877	43.763893	-79.456367	16	0	
Bay Street Corridor	457787	43.665275	-79.387528	100	1	
Bayview Village	533089	43.769197	-79.376662	54	0	
Bayview Woods-Steeles	784397	43.798127	-79.382973	8	0	
Bedford Park-Nortown	1191040	43.798127	-79.382973	8	0	

Cluster the Neighborhoods

Run *k*-means to cluster the neighborhoods into several clusters.

Did previous runs using cluster sizes of 3,4,5,6. Using 3 seems to give the best results.

In [77]:

```
# set number of clusters:   3 yields 24 candidates and is well separated, 4 is mec
kclusters = 3

# No need to drop 'Neighbourhood' column, because we re-assigned it to be the inde
toronto_grouped_clustering = toronto_data_vm.drop (['Latitude','Longitude','Venue_
# print shape of resulting dataframe to be input to Kmeans
print ('Shape of KMeans input dataframe = ', toronto_grouped_clustering.shape)

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

# based on multiple runs for this Dataset, the Kmeans algorithm assigns the (Y va
# cluster at 0, and the highest cluster at kclusters-1
# Print out the total number of entries in the highest cluster
number_highend_hoods = np.count_nonzero (kmeans.labels_ == (kclusters-1))
print ('The number of high end Neighborhoods in the top cluster =', number_highen

# show the cluster labels generated for each row in the dataframe. The kmeans.labe
kmeans.labels_
```

```
Shape of KMeans input dataframe =  (140, 3)
The number of high end Neighborhoods in the top cluster = 24
```

Out[77]:

```
array([0, 0, 0, 2, 0, 0, 0, 0, 2, 1, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 2,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 2,
       1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 2, 0,
       2, 2, 2, 1, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0,
       2, 0, 0, 0, 0, 0, 2, 0, 0, 2, 0, 2, 0, 0, 0, 0, 1, 0, 2, 0, 0, 0,
       0, 1, 0, 2, 0, 0, 2, 0, 0, 2, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 2, 2, 2, 0, 0])
```

Create a new dataframe that includes the cluster number as well as rest of key neighborhood info (Housing Prices, Venue totals).

In [78]:

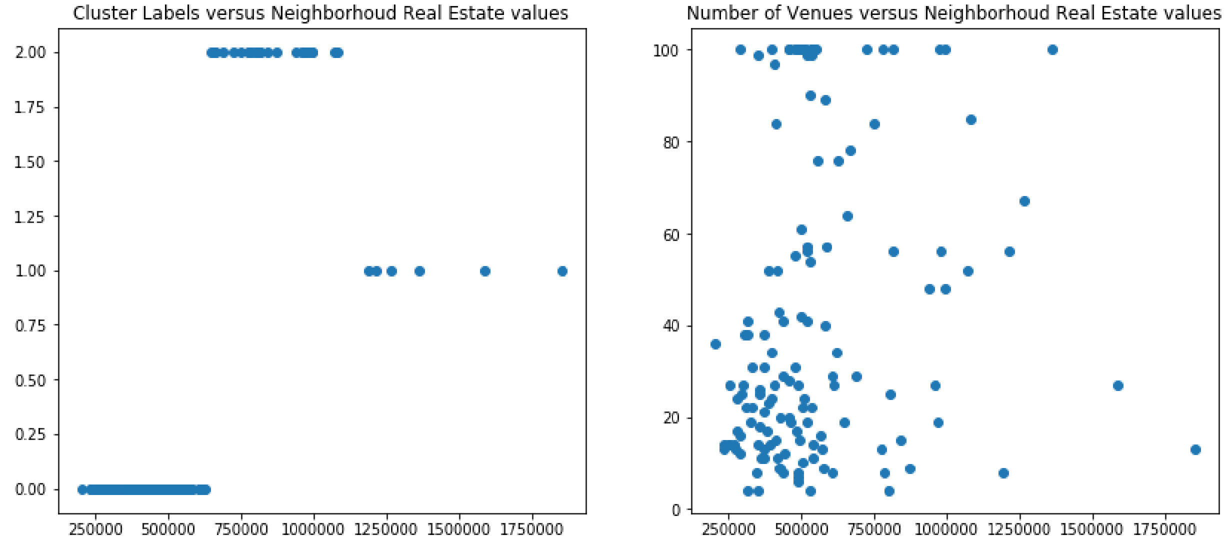
```
##########################################################################
# Append the Kmeans cluster labels to the summary Neighborhood data (Name, House I
##########################################################################

toronto_merged = toronto_data_vm

# add clustering labels from above Kmeans clustering
toronto_merged['Cluster Labels'] = kmeans.labels_

toronto_merged.head (10)
```

Out[78]:

	Home Prices	Latitude	Longitude	Venues_Count	Venue_Num_Steakhouses	Venue_Nu
Neighbourhood						
Agincourt North	375307	43.808038	-79.266439	31	0	
Agincourt South-Malvern West	332710	43.808038	-79.266439	31	0	
Alderwood	504233	43.601717	-79.545232	22	0	
Annex	993491	43.670338	-79.407117	100	0	
Banbury-Don Mills	613647	43.734804	-79.357243	27	0	
Bathurst Manor	568877	43.763893	-79.456367	16	0	
Bay Street Corridor	457787	43.665275	-79.387528	100	1	
Bayview Village	533089	43.769197	-79.376662	54	0	
Bayview Woods-Steeles	784397	43.798127	-79.382973	8	0	
Bedford Park-Nortown	1191040	43.798127	-79.382973	8	0	

In [79]:
```
# Show the neighbor cluster numbers and associated Housing Prices on a scatter pl
# and compare it side by each to the earlier scatterplot we did showing House Pri
print ("Figure 4")
fig, axes = plt.subplots (1,2, figsize=(14,6))
x1 = toronto_merged ['Home Prices']
y1 = toronto_merged ['Cluster Labels']
axes[0].set_title ('Cluster Labels versus Neighborhoud Real Estate values')
axes[0].scatter (x1,y1)

x2 = toronto_merged ['Home Prices']
y2 = toronto_merged ['Venues_Count']
axes[1].set_title ('Number of Venues versus Neighborhoud Real Estate values')
axes[1].scatter (x2,y2)

plt.show()
```

```
Figure 4
```



Create new dataframe and display the top 10 candidate neighborhoods

In [80]:

```
# extract just the venues matching the top cluster number.  Sort them in descendn

toronto_sorted_clusters = toronto_merged.sort_values('Cluster Labels', ascending=

# extract those high-end neighborhoods into their own dataframe
toronto_highest_cluster = toronto_sorted_clusters[:number_highend_hoods]

# then res0rt that to get the neighborhoods with the highest number venues, which
toronto_highest_sorted = toronto_highest_cluster.sort_values('Venues_Count', asce

# extract the top 10 from that list, sorting them to have least # of competitive 
toronto_top_10_candidates = toronto_highest_sorted[:10].sort_values('Venue_Num_St
toronto_top_10_candidates.head(10)
```

Out[80]:

	Home Prices	Latitude	Longitude	Venues_Count	Venue_Num_Steakhouses	Venue_Nu
Neighbourhood						
North Riverdale	818592	43.665470	-79.352594	100	0	
Trinity-Bellwoods	723909	43.647627	-79.413879	100	0	
Palmerston-Little Italy	781568	43.655879	-79.410076	100	0	
Annex	993491	43.670338	-79.407117	100	0	
The Beaches	751945	43.671024	-79.296712	84	0	
Runnymede-Bloor West Village	666204	43.651778	-79.475923	78	0	
Wychwood	656868	43.682094	-79.423855	64	0	
Casa Loma	1083381	43.678111	-79.409408	85	1	
Mount Pleasant East	815247	43.708417	-79.390135	56	1	
Yonge-Eglinton	975449	43.706748	-79.398327	100	2	

In [71]:

```
```

Visualize the resulting candidate Neighborhoods in a Folium Map

In [81]:

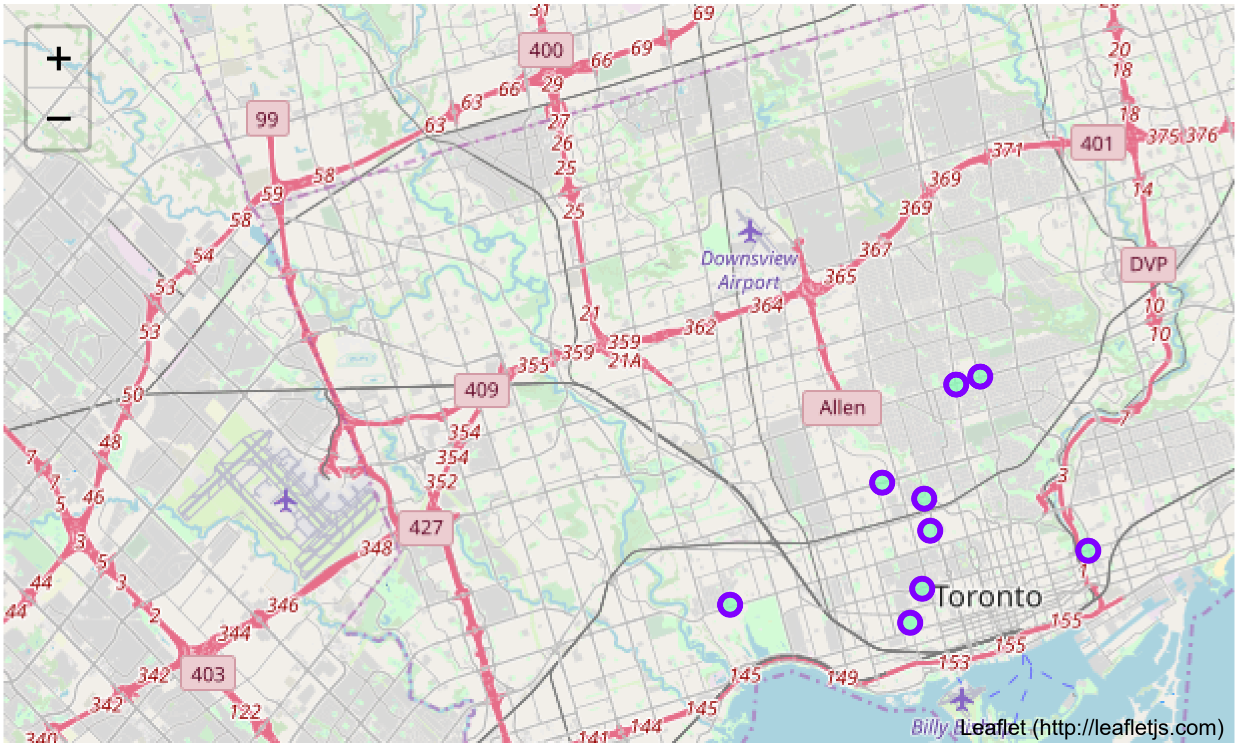
```
address = 'Toronto, CANADA'
geolocator = Nominatim()
location = geolocator.geocode (address)
latitude = location.latitude
longitude = location.longitude
#print ('The geograpical coordinates of Toronto are {}, {}.'.format(latitude, lon
```

```
E:\K\Anaconda_v3.6\lib\site-packages\ipykernel_launcher.py:2: DeprecationWarnin
g: Using Nominatim with the default "geopy/1.18.0" `user_agent` is strongly dis
couraged, as it violates Nominatim's ToS https://operations.osmfoundation.org/p
olicies/nominatim/ (https://operations.osmfoundation.org/policies/nominatim/) a
nd may possibly cause 403 and 429 HTTP errors. Please specify a custom `user_ag
ent` with `Nominatim(user_agent="my-application")` or by overriding the default
 `user_agent`: `geopy.geocoders.options.default_user_agent = "my-application"`.
 In geopy 2.0 this will become an exception.
```

In [82]:

```
# create a map showing the locations of the recommended "Top 10" neighborhoods

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 = {'b', 'g', 'r', 'c', 'm', 'y', 'k', 'w'};

colors_array = cm.rainbow (np.linspace(0, 1, len(ys)))
rainbow = [colors.rgb2hex(i) for i in colors_array]
#rainbow = ['g', 'r', 'c', 'm', 'y', 'k', 'w', 'b' ]  # always shows black !

# add markers to the map
markers_colors = []
#for lat, lon, poi, cluster in zip(toronto_merged['Latitude'], toronto_merged['Lo
# Note that toronto_merged.index = 'Neighbourhood' column
#for lat, lon, poi, cluster in zip(toronto_merged['Latitude'], toronto_merged['Lo
for lat, lon, poi, cluster in zip(toronto_top_10_candidates['Latitude'],toronto_t
    toronto_top_10_candidates.index, toronto_top_10_candidates['Cluster Labels'])
    label = folium.Popup (str(poi) + ' Cluster ' + str(cluster), parse_html=True)
    folium.CircleMarker (
        [lat, lon],
        radius=5,
        popup=label,
        color=rainbow[0], # color=rainbow[cluster-1],
        fill=True,
        fill_color=rainbow[cluster-1],
        fill_opacity=0.7).add_to(map_clusters)

map_clusters
```

Out[82]:



End of Data Analysis

See associated Report for further explanation of the results.