Capstone Project - The battle of Neighborhood

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1. Introduction

1.1 Background

Toronto is the capital city of the province of Ontario, southeastern Canada. It is the most populous city in Canada, a multicultural city, and the country's financial and commercial center, with a current population of 6,139,000 in 2019.

Its location on the northwestern shore of Lake Ontario, which forms part of the border between Canada and the United States, and its access to Atlantic shipping via the St. Lawrence Seaway and to major U.S. industrial centers via the Great Lakes have enabled Toronto to become an important international trading center. Moreover, the city is positioned on the edge of some of the best farmland in Canada, with a climate favorable to growing a wide range of crops, thereby making Toronto a transportation, distribution, and manufacturing center.

Since the second half of the 20th century the city has grown phenomenally, from a rather sedate provincial town—"Toronto the Good"—to a lively, thriving, metropolitan area

Brief history about Toronto

People have travelled through and inhabited the Toronto area, located on a broad sloping plateau interspersed with rivers, deep ravines, and urban forest, for more than 10,000 years. After the broadly disputed Toronto Purchase, when the Mississauga surrendered the area to the British Crown, the British established the town of **York** in 1793 and later designated it as the capital of Upper Canada. During the War of 1812, the town was the site of the Battle of York and suffered heavy damage by United States troops. **York** was renamed and incorporated in 1834, as the city of **Toronto**. It was designated as the capital of the province of Ontario in 1867 during Canadian Confederation.

1.2 Problem

Objective

The aim of this report is to study and analyze the neighborhoods of Toronto city and group them into similar clusters and, to analyze those clusters to gather meaningful information. That information can be used to find out neighborhoods that are same as your current neighborhood or at least similar.

Target Audience

This information provided by this report would be valuable for people who are interested in relocating to different part of the city and are looking to find new neighborhoods that are very similar to their existing neighborhood.

Interest

Now let me explain the context of this Capstone project through a scenario. Say you live on the west side of the city of Toronto in Canada. You love your neighborhood, mainly because of all the great amenities and other types of venues that exist in the neighborhood, such as gourmet fast food joints, pharmacies, parks, graduate schools and so on. Now say you receive a job offer from a great company on the other side of the city with great career prospects. However, given the far distance from your current place you unfortunately must move if you decide to accept the offer.
Wouldn't it be great if you are able to determine neighborhoods on the other side of the city that are the same as your current neighborhood, and if not perhaps similar neighborhoods that are at least closer to your new job?

2 Data Description

To consider the objective stated above, we can list the below data sources used for the analysis.

a) Toronto Neighborhood Data

The following Wikipedia page was scraped to pull out the necessary information: https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M
The information obtained i.e. the table of postal codes, borough and neighborhood was transformed into a pandas data frame for further analysis.

b) Coordinate data for each Neighborhood in Toronto

The following csv file was used to get the latitude and longitude for the Neighborhood http://cocl.us/Geospatial_data

c) Foursquare data for locational information

Use the following venue/user/explore data through foursquare data source.
https://api.foursquare.com/v2/venues/explore?xxx
https://api.foursquare.com/v2/venues/search?xxx
https://api.foursquare.com/v2/users/xxx

3 Data Acquisition, Cleaning and Exploratory Analysis

a. Scrape the Wikipedia page to get data and convert into Pandas dataframe

To start with our analysis, we used the **Beautiful Soup** package to transform the Wikipedia data into a pandas dataframe.
Kindly see figure below;

	Postalcode	Borough	Neighborhood
0	M3A	North York	Parkwoods
1	M4A	North York	Victoria Village
2	M5A	Downtown Toronto	Regent Park, Harbourfront
3	M6A	North York	Lawrence Manor, Lawrence Heights
4	M7A	Downtown Toronto	Queen's Park, Ontario Provincial Government

We also got the coordinate data for all neighborhoods in Toronto using the csv file and converted into a pandas dataframe.

	Postal Code	Latitude	Longitude
0	M1B	43.806686	-79.194353
1	M1C	43.784535	-79.160497
2	M1E	43.763573	-79.188711
3	M1G	43.770992	-79.216917
4	M1H	43.773136	-79.239476

The dataframe's were merged i.e. adding the coordinate dataframe to the original dataframe.

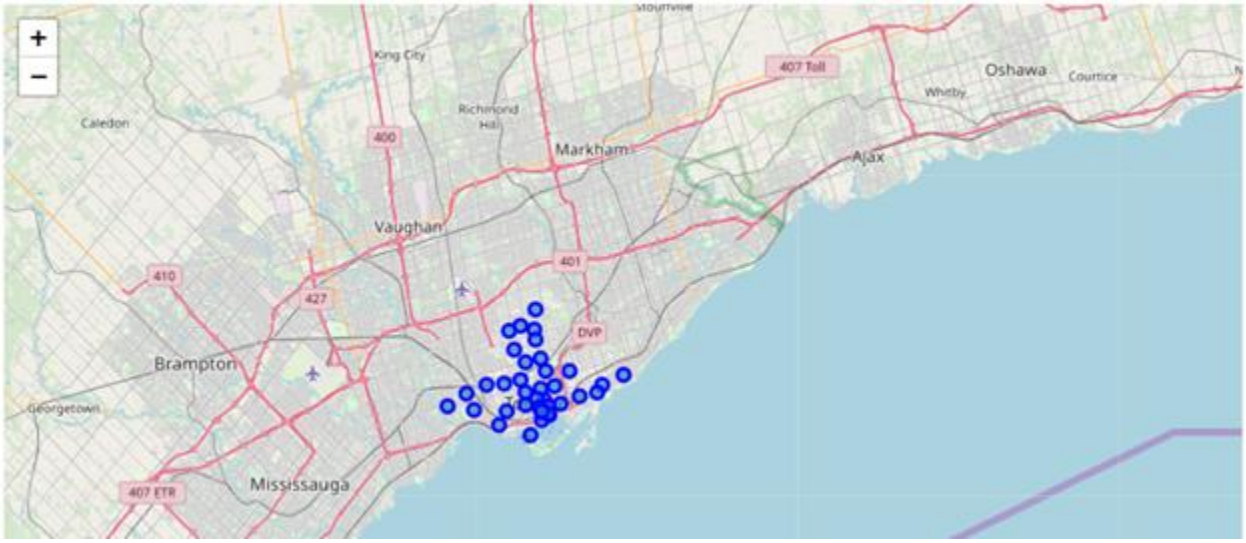
	Postalcode	Borough	Neighborhood	Latitude	Longitude
0	M1B	Scarborough	Malvern, Rouge	43.806686	-79.194353
1	M1C	Scarborough	Rouge Hill, Port Union, Highland Creek	43.784535	-79.160497
2	M1E	Scarborough	Guildwood, Morningside, West Hill	43.763573	-79.188711
3	M1G	Scarborough	Woburn	43.770992	-79.216917
4	M1H	Scarborough	Cedarbrae	43.773136	-79.239476

b. Generating a map of Toronto and plotting the Neighborhood data on it

We first filter the data to find boroughs containing the word "Toronto",

	Postalcode	Borough	Neighborhood	Latitude	Longitude
37	M4E	East Toronto	The Beaches	43.676357	-79.293031
41	M4K	East Toronto	The Danforth West, Riverdale	43.679557	-79.352188
42	M4L	East Toronto	India Bazaar, The Beaches West	43.668999	-79.315572
43	M4M	East Toronto	Studio District	43.659526	-79.340923
44	M4N	Central Toronto	Lawrence Park	43.728020	-79.388790

We then use the python **folium** library to visualize geographic details of Toronto and its boroughs. I created a map of Toronto with boroughs superimposed on top using the latitude and longitude values to get the visual as below:



c. Utilizing Foursquare API to explore the neighborhoods

Next, start utilizing the Foursquare API to explore the neighborhoods and segment them. We set the LIMIT parameter to **100**, which would limit the number of venues returned by the Foursquare API and the radius of 50 meter. Below is the first five (5) list of Nearby Venues for the various Towns (Borough) i.e. McCowan Park, Price Chopper

	Borough	Borough Latitude	Borough Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Scarborough	43.744734	-79.239476	McCowan Park	43.745089	-79.239336	Playground
1	Scarborough	43.799525	-79.318389	Price Chopper	43.799445	-79.318563	Grocery Store
2	North York	43.803762	-79.363452	New York Fries	43.803664	-79.363905	Fast Food Restaurant
3	Central Toronto	43.704324	-79.388790	Jules Cafe Patisserie	43.704138	-79.388413	Dessert Shop
4	Central Toronto	43.704324	-79.388790	Thobors Boulangerie Patisserie Café	43.704514	-79.388616	Café

d. Analyze each neighborhood

Using One Hot Encoding, the data frame was standardized and the data was grouped by neighborhoods, we created a new data frame consisting of the top 10 venues in each neighborhood.

	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue
0	Central Toronto	Supermarket	Liquor Store	Furniture / Home Store	Dessert Shop	Park	Italian Restaurant	Coffee Shop	Seafood Restaurant	Bowling Alley
1	Downtown Toronto	Coffee Shop	Café	Performing Arts Venue	Gym	Deli / Bodega	Sushi Restaurant	Art Gallery	Concert Hall	Bakery
2	East Toronto	Trail	Yoga Studio	Diner	Coffee Shop	College Gym	Concert Hall	Cosmetics Shop	Dance Studio	Deli / Bodega
3	East York	Coffee Shop	Sporting Goods Shop	Sandwich Place	Housing Development	Indian Restaurant	College Gym	Concert Hall	Cosmetics Shop	Dance Studio
4	Etobicoke	Dance Studio	Coffee Shop	Pizza Place	Diner	College Gym	Concert Hall	Cosmetics Shop	Deli / Bodega	Dessert Shop

From the results there were some common venue categories in the neighborhoods. So there is a need to segment these similarities for easy identification.

4 Predictive modeling

4.1 Clustering Algorithm

K-means is vastly used for clustering and useful when you need to discover insights of unlabeled data.

K-means uses Euclidean distance hence doesn't work well with categorical variables. The unsupervised K-means algorithm was used to cluster the neighborhoods. K-Means algorithm is one of the most common method for clustering and discovering insights.

We use a k-cluster value of 5 to split the neighborhoods into 5 different clusters based on the similarity of the venues.

4.2 Results

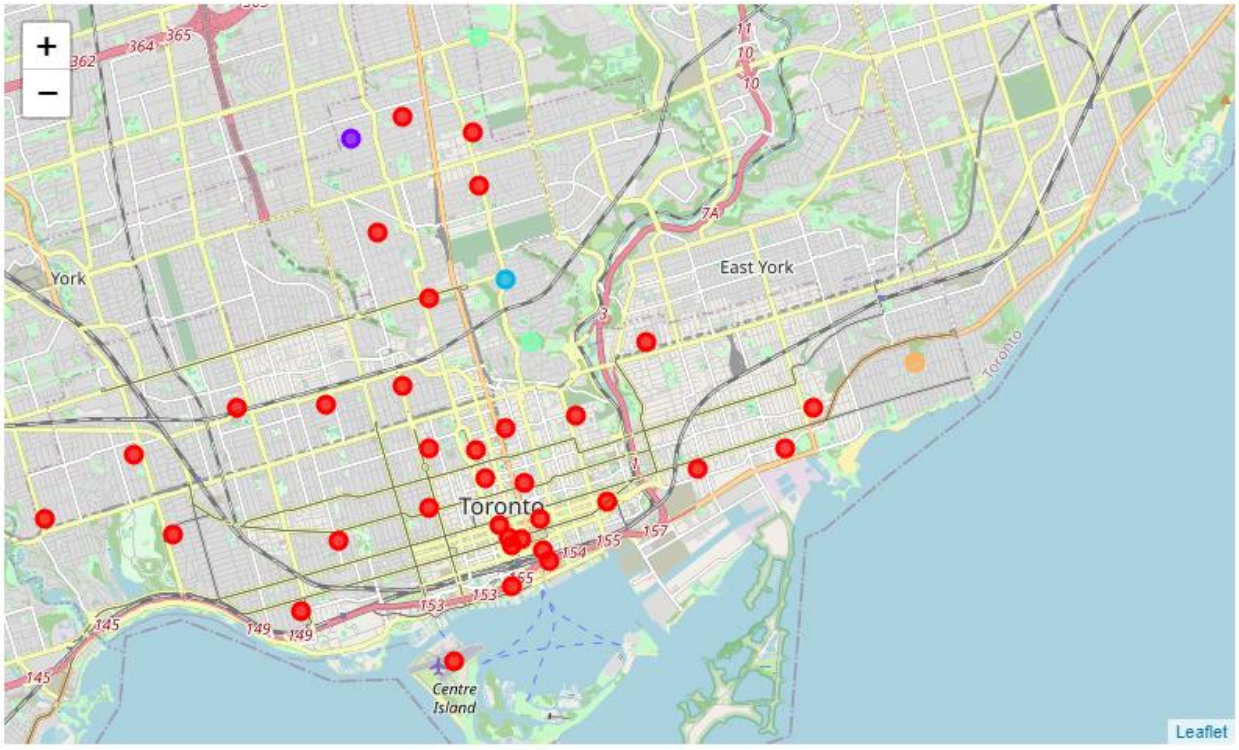
a. Adding the Cluster Labels to the Venue Data

After using K-means algorithm for clustering of the data, the cluster labels were then added to easily identify when neighborhood belong to the different clusters. The below table depicts the clustered data along with the top 10 most common venues in that cluster.

Neighborhood	Latitude	Longitude	Cluster Labels	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue
The Beaches	43.676357	-79.293031	4	Trail	Health Food Store	Pub	Eastern European Restaurant	Discount Store	Dog Run	Doner Restaurant	Donut Shop
The Danforth West, Riverdale	43.679557	-79.352188	1	Greek Restaurant	Coffee Shop	Ice Cream Shop	Italian Restaurant	Furniture / Home Store	Pizza Place	Bookstore	Brewery
The Beaches West, India Bazaar	43.668999	-79.315572	5	Park	Gym	Pub	Liquor Store	Board Shop	Fast Food Restaurant	Burger Joint	Fish & Chips Shop
Studio District	43.659526	-79.340923	1	Café	Coffee Shop	Bakery	Italian Restaurant	American Restaurant	Yoga Studio	Comfort Food Restaurant	Seafood Restaurant
Lawrence Park	43.728020	-79.388790	0	Park	Swim School	Bus Line	Women's Store	Discount Store	Fast Food Restaurant	Farmers Market	Falafel Restaurant

b. Visualizing the resulting Clusters

We use the matplotlib and folium packages to visualize the clusters on a map of Toronto.



5 Conclusion

The goal of this analysis was carried out to find out similar neighborhoods for a person relocating within the city of Toronto.

As we analyze the results section, we can analyze the clusters and see similar neighborhoods in different parts of the city. For example, if we compare the different neighborhoods clustered in cluster 2.

	Cluster Labels	Neighborhood	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue
0	4	Berczy Park	Coffee Shop	Cocktail Bar	Beer Bar	Cheese Shop	Bakery	Restaurant	Farmers Market	Seafood Restaurant	Concert Hall	Liquor Store
1	4	Brockton, Parkdale Village, Exhibition Place	Café	Breakfast Spot	Nightclub	Coffee Shop	Pet Store	Climbing Gym	Burrito Place	Restaurant	Italian Restaurant	Stadium
2	4	Business reply mail Processing Centre, South C...	Light Rail Station	Auto Workshop	Pizza Place	Comic Shop	Restaurant	Burrito Place	Brewery	Skate Park	Spa	Farmers Market
3	4	CN Tower, King and Spadina, Railway Lands, Har...	Airport Service	Airport Lounge	Airport Terminal	Airport	Boutique	Sculpture Garden	Plane	Rental Car Location	Boat or Ferry	Harbor / Marina
4	4	Central Bay Street	Coffee Shop	Sandwich Place	Café	Italian Restaurant	Burger Joint	Bubble Tea Shop	Salad Place	Thai Restaurant	Restaurant	Portuguese Restaurant

As seen in the table above, if a person wished to move from a suburb region in Downtown Toronto to Central Toronto. If a person's current location were in the Neighborhood of Studio District in Downtown Toronto, which has venues like cafes, Gym, Art Gallery and Sushi restaurants nearby,

the person, would like to relocate to a neighborhood like North York which also has venues like Coffee Shops and Restaurants. This is just one example of how our data analysis can help people relocate from one part of the city to another.

In a world like ours driven by data, there are many real-life problems or scenarios where data can be used to find solutions to those problems. As seen in the example above, data was used to cluster neighborhoods in Toronto based on the most common venues in those neighborhoods hence someone that is searching for a neighborhood were there are shops, restaurants and gym places can use this data as a guide to relocate.

6 Future Directions

Model presented in this work mainly focuses on a fixed set of features without considering their correlation. An extended research may analyze the correlation among a broader set of features and apply feature selection method to pick up most significant drivers/features.

On the other hand, K-mean clustering is kind of simple clustering algorithm. It can be extended to density-based clustering (e.g. DBSCAN) for better and more flexible results.

References:

· https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M

· CSV for Coordinate data: http://cocl.us/Geospatial_data