

The Battle of Neighborhoods

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1. Introduction

Data science is an emerging field in which data management and analysis is carried out using various computer programming languages like python, R etc. Available data irrespective of its structure is processed through analytical, programming, visualization and business skills to draw valuable insights. These extracted insights play significant role in formulation of most appropriate and best solutions to various real world problems in both process and business perspectives. World being running towards fully digitalization, with internet of things around everywhere, it is very important to manage and analyse data in most meaningful and simple manner inorder to reduce the cost and effort of the system. For this reason, knowledge of data science with acquired skills is highly sorted out irrespective of the field of work we are into. With this introduction in place, would take you through an issue that would be addressed in this project where data science tools would help to understand the need better and equip with all required information for decision making.

1.1 Background

Toronto is the most popular and capital city of Ontario province in Canada. It is the largest city (population of 2,956,024 by July 2018) in Canada and fourth populous city in North America and a world leader in areas like business, finance, technology, entertainment and culture. Every year tens of thousands of newcomers from around the globe choose this city as their new home because of which Toronto is one of the most multicultural urban areas in the world. Their diverse cultures and communities have helped create Toronto's identity as a vibrant global city having a land area of 630 sq.km. Toronto's weather broadly follows patterns for each of the four seasons. During spring the average temperature during the day is about 12°C in March, April and early May. Summer in Toronto is at its warmest in July and August, with daytime temperatures averaging above 20°C and frequently rising above 30°C. Fall, or autumn, begins in September with mild temperatures falling steadily until the snowy winter season begins in December. Winter is Toronto's coldest season, with temperatures usually below 0°C and snow falling frequently. January and February are the coldest months where temperatures can drop below -25°C. As per Economist Intelligence Unit – Global Liveability Index 2019, Toronto ranks as 7th most liveable cities in the world which proves it as most livable and competitive cities in the world. Toronto's rankings in other fields like best hospitals, safety etc. confirm that it continues to offer a high quality of life for 2.9 million residents who choose to live and work here.

Snippets of Toronto's historical events: When Europeans first arrived at the site of present-day Toronto, the vicinity was inhabited by the Iroquois, who had displaced the Wyandot (Huron) people, occupants of the region for centuries before c. 1500. The name Toronto is likely derived from the Iroquoian word tkaronto, meaning "place where trees stand in the water". 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 Statement

Issue that has been considered in this capstone project is related to decision making regarding right neighborhood to reside when somebody has planned to migrate to a completely new city. Consider a situation where a person got a good job offer from a great company in the city of Toronto. This person currently is well settled in a far distant country India residing in an established residential neighborhood. However, given the promising career prospects that this new job is offering, relocation seems to be a valid choice. Now, obviously, this person would be looking for a neighborhood closer to the work place where all the amenities are available. Further, being an Indian origin, this person would love to choose a neighborhood with high rated Indian restaurants available around. So in this capstone project, we compare various neighborhoods in Toronto city in order to find out the most suitable neighborhood in terms of services and amenities. Also, best residential neighborhood with Indian restaurants nearby.

1.3 Objective

This study can be divided into two segments

- The first objective of this project is to capture publicly available details on Toronto city's neighborhoods and utilize them to analyze using machine learning algorithms and data visualization tools to find the best suitable neighborhood in Toronto city based on most common venues
- Second objective is to find the best suitable neighborhood in Toronto city where high rated Indian restaurants are available.

Target Group/Intended Audience

This analysis is intended to help all those who are frequent flyers to Toronto or relocated to Toronto and prefer to reside in a neighborhood with all the amenities and good rated Indian restaurants available in and around. This analysis also gives an understanding of the neighborhoods in the city where Indian restaurants are available and their counts in each area and the best place to eat based on ratings.

2. Data description

The following data would be needed for this project:

- Toronto City data that contains list of Boroughs, Neighborhoods
 - Data source : 'https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M'
 - Description: This data set contains the required information. And we will use this data set to explore various neighborhoods of Toronto city. This wiki data would be converted to pandas data frame and further used
- Geo-spatial coordinate data of Toronto city
 - Data source : 'https://cocl.us/Geospatial_data'
 - Description: This will give latitude and longitude data for every neighborhood in Toronto city
- Indian restaurants in each neighborhood Toronto city

- Data source: Foursquare API
- Description: All the venues in each neighborhood can be obtained using this API. Further, Indian restaurants can be filtered from this list

3. Methodology

Step 1: Information obtained from the wiki page is scraped and created into a data frame with postal code, boroughs and neighborhoods of Toronto city

Step 2: Geospatial data is used to obtain latitude and longitude details for each neighborhood and this data is merged to neighborhoods data from step 1

Step 3: Foursquare API is used to find all the venues in each neighborhood.

Step 4: Clustering the neighborhoods based on common venues to explore the best suited/recommended one using machine learning algorithm

Step 5: Filtering Indian restaurants from the venues list obtained from step 3. Exploring likes, ratings and tips of each Indian restaurant venue using Foursquare API and based on their counts assigning rank to each Indian restaurant

Step 6: Visualization of these restaurants in neighborhoods with ranking data using folium for decision making

3. Preprocessing and Data cleaning

At first all the python libraries that are required are imported and installed. Wiki data is converted into html and further into data frame using pandas. This data frame consists of borough and neighborhoods data with their respective postal codes in the city of Toronto. Further data is cleaned by removing not assigned borough and neighborhood cells. This is how data looks like

	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

Table 1. Toronto borough and neighborhoods data obtained from wiki post cleaning

Geo-spatial data is downloaded from CSV file and data frame is created using pandas and the above table 1 is merged with geo spatial data so as to get a consolidate data frame with names of borough, neighborhoods and their corresponding latitude and longitude coordinates as shown

below. Total size of this data frame is 103 rows and 4 columns. A map of Toronto neighborhoods is generated using this data as shown in figure 1.

	Borough	Neighborhood	Latitude	Longitude
0	North York	Parkwoods	43.753259	-79.329656
1	North York	Victoria Village	43.725882	-79.315572
2	Downtown Toronto	Regent Park, Harbourfront	43.654260	-79.360636
3	North York	Lawrence Manor, Lawrence Heights	43.718518	-79.464763
4	Downtown Toronto	Queen's Park, Ontario Provincial Government	43.662301	-79.389494
5	Etobicoke	Islington Avenue, Humber Valley Village	43.667856	-79.532242
6	Scarborough	Malvern, Rouge	43.806686	-79.194353
7	North York	Don Mills	43.745906	-79.352188
8	East York	Parkview Hill, Woodbine Gardens	43.706397	-79.309937
9	Downtown Toronto	Garden District, Ryerson	43.657162	-79.378937
10	North York	Glencairn	43.709577	-79.445073

Table 2. Sample cleaned data of Toronto neighborhoods with geo coordinates

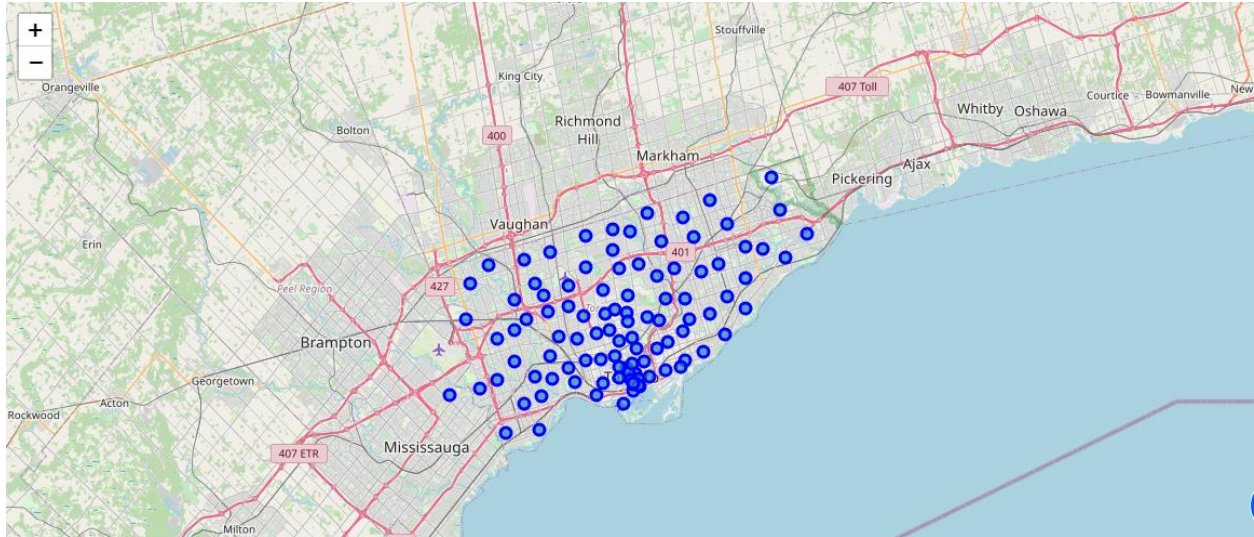


Figure 1. Map of Toronto Neighborhoods

4. Exploratory Data Analysis

Toronto geographical coordinates are used and generated a map as shown in figure 1. The geographical coordinate of Toronto City are 43.6534817, -79.3839347. Foursquare API is used to explore venues within and around 500m radius of each neighborhood. The number of venues are limited to 100. All the nearby venues are classified into various categories like parks, coffee shops, restaurants etc and a total of 2133 venues are explored in total. These are further grouped based on neighborhoods and a total of 273 unique categories are found by the end of this step.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	Parkwoods	43.753259	-79.329656	Brookbanks Park	43.751976	-79.332140	Park
1	Parkwoods	43.753259	-79.329656	TTC stop #8380	43.752672	-79.326351	Bus Stop
2	Parkwoods	43.753259	-79.329656	Variety Store	43.751974	-79.333114	Food & Drink Shop
3	Victoria Village	43.725882	-79.315572	Victoria Village Arena	43.723481	-79.315635	Hockey Arena
4	Victoria Village	43.725882	-79.315572	Tim Hortons	43.725517	-79.313103	Coffee Shop

Table 3. Toronto neighborhoods with geo coordinates and venues

Analysis of each neighborhood: All the venues are further analyzed and grouped based on neighborhoods into 93 using onehot encoding with 273 unique venue categories. 5 top venues grouped for each neighborhood looks like the table shown below.

----Agincourt----		
	venue	freq
0	Lounge	0.2
1	Breakfast Spot	0.2
2	Latin American Restaurant	0.2
3	Skating Rink	0.2
4	Clothing Store	0.2
----Alderwood, Long Branch----		
	venue	freq
0	Pizza Place	0.25
1	Sandwich Place	0.12
2	Coffee Shop	0.12
3	Pub	0.12
4	Dance Studio	0.12

Table 4. Top 5 venues of each neighborhood with frequency

A pandas data frame is created using top 10 most common venues for each neighborhood as shown below

	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	Agincourt	Latin American Restaurant	Skating Rink	Lounge	Clothing Store	Breakfast Spot	Doner Restaurant	Dim Sum Restaurant	Diner	Discount Store	Distribution Center
1	Alderwood, Long Branch	Pizza Place	Coffee Shop	Sandwich Place	Dance Studio	Pharmacy	Pub	Gym	Airport Service	Falafel Restaurant	Ethiopian Restaurant
2	Bathurst Manor, Wilson Heights, Downsview North	Bank	Coffee Shop	Park	Ice Cream Shop	Sushi Restaurant	Shopping Mall	Middle Eastern Restaurant	Restaurant	Mobile Phone Shop	Deli / Bodega
3	Bayview Village	Chinese Restaurant	Café	Bank	Japanese Restaurant	Women's Store	Diner	Discount Store	Distribution Center	Dog Run	Doner Restaurant
4	Bedford Park, Lawrence Manor East	Sandwich Place	Italian Restaurant	Restaurant	Coffee Shop	Sushi Restaurant	Pharmacy	Juice Bar	Liquor Store	Indian Restaurant	Butcher

Table 5. Top 10 most common venues

Clustering of Neighborhoods:

As part of first objective of the study, neighborhoods are clustered using k-mean algorithm. 5 clusters are chosen and the clusters looks like as shown below. Data frame is created for each cluster and every cluster is labeled starting from 0 to 4 as shown in table 6. Further, these clusters are examined and the results would be discussed in results section. Further these clusters are visualized using a map generation using folium.

	Borough	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	9th Most Common Venue	10th Most Common Venue
0	North York	Parkwoods	43.753259	-79.329656	3.0	Park	Bus Stop	Food & Drink Shop	Distribution Center	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Dog Run	Event Space
1	North York	Victoria Village	43.725882	-79.315572	1.0	Portuguese Restaurant	Coffee Shop	Pizza Place	Intersection	French Restaurant	Hockey Arena	Distribution Center	Department Store	Dessert Shop	Dim Sum Restaurant
2	Downtown Toronto	Regent Park, Harbourfront	43.654260	-79.360636	1.0	Coffee Shop	Pub	Bakery	Park	Theater	Restaurant	Breakfast Spot	Café	Event Space	Performing Arts Venue
3	North York	Lawrence Manor, Lawrence Heights	43.718518	-79.464763	1.0	Furniture / Home Store	Accessories Store	Clothing Store	Coffee Shop	Boutique	Miscellaneous Shop	Event Space	Women's Store	Vietnamese Restaurant	Construction & Landscaping
4	Downtown Toronto	Queen's Park, Ontario Provincial Government	43.662301	-79.389494	1.0	Coffee Shop	Sushi Restaurant	Music Venue	Beer Bar	Smoothie Shop	Sandwich Place	Burger Joint	Burrito Place	Restaurant	Café

Table 6. Neighborhood clustering showing geo coordinates and top 10 most common venues

Exploring Indian Restaurants: Now, as part of second objective of this study, Indian Restaurants are explored using Foursquare API. List of Indian restaurants corresponding to the neighborhoods and borough is explored. A total of 12 restaurants are found as shown in below table.

	Borough	Neighborhood	ID	Name
0	Downtown Toronto	Central Bay Street	57c07e5f498ed3724a049dc1	Colaba Junction
1	East York	Thornccliffe Park	4daf08e66e81e2dffdd4fe40	Iqbal Kebab & Sweet Centre
2	East York	Thornccliffe Park	4bed9f2fbac3c9b6ad93fee9	Hakka Garden
3	Downtown Toronto	Harbourfront East, Union Station, Toronto Islands	50b79b94e4b0a577af25a83f	Indian Roti House
4	East Toronto	The Danforth West, Riverdale	4c1d5337eac020a1cb1048c2	Sher-E-Punjab
5	North York	Bedford Park, Lawrence Manor East	4d796616542ab1f75eb87c41	The Copper Chimney
6	Scarborough	Dorset Park, Wexford Heights, Scarborough Town...	5226562611d2cd49d83ef03b	Kairali
7	Scarborough	Dorset Park, Wexford Heights, Scarborough Town...	4bf96c435317a593a23a017f	Karaikudi Chettinad South Indian Restaurant
8	Central Toronto	The Annex, North Midtown, Yorkville	4c62c59ce1621b8dd0332453	Roti Cuisine of India
9	Central Toronto	Davisville	5169d445e4b07de190b5c3d6	Marigold Indian Bistro
10	Downtown Toronto	St. James Town, Cabbagetown	4c8c21dfd0ce236ab28e15ef	Butter Chicken Factory
11	Downtown Toronto	Church and Wellesley	4bedf8b5e24d20a17b567214	Kothur Indian Cuisine

Table 7. List of Indian restaurants with their names and neighborhoods

Each Indian restaurant has been analyzed based on likes, tips and ratings. Number of likes, tips and ratings are counted and tabulated as below

	Borough	Neighborhood	ID	Name	Likes	Rating	Tips
0	Downtown Toronto	Central Bay Street	57c07e5f498ed3724a049dc1	Colaba Junction	11	7.1	5
1	East York	Thornccliffe Park	4daf08e66e81e2dffdd4fe40	Iqbal Kebab & Sweet Centre	13	7.6	6
2	East York	Thornccliffe Park	4bed9f2fbac3c9b6ad93fee9	Hakka Garden	10	6.4	12
3	Downtown Toronto	Harbourfront East, Union Station, Toronto Islands	50b79b94e4b0a577af25a83f	Indian Roti House	38	7.1	14
4	East Toronto	The Danforth West, Riverdale	4c1d5337eac020a1cb1048c2	Sher-E-Punjab	10	7.0	8
5	North York	Bedford Park, Lawrence Manor East	4d796616542ab1f75eb87c41	The Copper Chimney	14	7.4	15
6	Scarborough	Dorset Park, Wexford Heights, Scarborough Town...	5226562611d2cd49d83ef03b	Kairali	9	7.2	6
7	Scarborough	Dorset Park, Wexford Heights, Scarborough Town...	4bf96c435317a593a23a017f	Karaikudi Chettinad South Indian Restaurant	27	6.5	23
8	Central Toronto	The Annex, North Midtown, Yorkville	4c62c59ce1621b8dd0332453	Roti Cuisine of India	40	8.8	19
9	Central Toronto	Davisville	5169d445e4b07de190b5c3d6	Marigold Indian Bistro	11	8.1	11
10	Downtown Toronto	St. James Town, Cabbagetown	4c8c21dfd0ce236ab28e15ef	Butter Chicken Factory	18	8.4	10
11	Downtown Toronto	Church and Wellesley	4bedf8b5e24d20a17b567214	Kothur Indian Cuisine	16	8.1	19

Table 8. Number of likes, ratings and tips of Indian restaurants

Average ratings are calculated for each restaurant based on neighborhood and borough and the results are shown below. Ratings and the final outcomes of the analysis would be discussed in results and discussion section

	Neighborhood	Average Rating
7	The Annex, North Midtown, Yorkville	8.80
6	St. James Town, Cabbagetown	8.40
2	Church and Wellesley	8.10
3	Davisville	8.10
0	Bedford Park, Lawrence Manor East	7.40
1	Central Bay Street	7.10
5	Harbourfront East, Union Station, Toronto Islands	7.10
8	The Danforth West, Riverdale	7.00
9	Thorncliffe Park	7.00
4	Dorset Park, Wexford Heights, Scarborough Town...	6.85

	Borough	Average Rating
0	Central Toronto	8.450
1	Downtown Toronto	7.675
4	North York	7.400
2	East Toronto	7.000
3	East York	7.000
5	Scarborough	6.850

Table 9. Average ratings of restaurants corresponding to their neighborhoods and boroughs

5. Results

First objective is to cluster the neighborhood so as to understand the most common venues in and around the neighborhoods which helps in decision making. As mentioned above, all the neighborhoods have been clustered into 5 each labeled from 0 to 4. The following are the snapshots of the results of neighborhood clustering.

	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
51	Cliffside, Cliffcrest, Scarborough Village West	American Restaurant	Motel	Deli / Bodega	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Women's Store

Cluster 1 with one 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	10th Most Common Venue
1	Victoria Village	Portuguese Restaurant	Coffee Shop	Pizza Place	Intersection	French Restaurant	Hockey Arena	Distribution Center	Department Store	Dessert Shop	Dim Sum Restaurant
2	Regent Park, Harbourfront	Coffee Shop	Pub	Bakery	Park	Theater	Restaurant	Breakfast Spot	Café	Event Space	Performing Arts Venue
3	Lawrence Manor, Lawrence Heights	Furniture / Home Store	Accessories Store	Clothing Store	Coffee Shop	Boutique	Miscellaneous Shop	Event Space	Women's Store	Vietnamese Restaurant	Construction & Landscaping
4	Queen's Park, Ontario Provincial Government	Coffee Shop	Sushi Restaurant	Music Venue	Beer Bar	Smoothie Shop	Sandwich Place	Burger Joint	Burrito Place	Restaurant	Café
7	Don Mills	Coffee Shop	Restaurant	Gym	Japanese Restaurant	Beer Store	Asian Restaurant	Sporting Goods Shop	Bike Shop	Shopping Mall	Sandwich Place
8	Parkview Hill, Woodbine Gardens	Pizza Place	Gym / Fitness Center	Athletics & Sports	Intersection	Fast Food Restaurant	Gastropub	Pharmacy	Pet Store	Bank	Dumpling Restaurant

Cluster 2 with 83 neighborhoods

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
6 Malvern, Rouge	Fast Food Restaurant	Doner Restaurant	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Donut Shop	Falafel Restaurant

Cluster 3 with 1 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	10th Most Common Venue
0	Parkwoods	Park	Bus Stop	Food & Drink Shop	Distribution Center	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Dog Run	Event Space
21	Caledonia-Fairbanks	Park	Pool	Women's Store	Gourmet Shop	Curling Ice	Eastern European Restaurant	Dumpling Restaurant	Drugstore	Donut Shop	Doner Restaurant
35	East Toronto, Broadview North (Old East York)	Park	Convenience Store	Doner Restaurant	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Women's Store
61	Lawrence Park	Park	Swim School	Bus Line	Dog Run	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Doner Restaurant	Department Store
64	Weston	Convenience Store	Park	Doner Restaurant	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Women's Store
66	York Mills West	Convenience Store	Park	Doner Restaurant	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Women's Store
83	Moore Park, Summerhill East	Restaurant	Trail	Park	College Stadium	Colombian Restaurant	Electronics Store	Eastern European Restaurant	Dumpling Restaurant	Drugstore	Donut Shop
85	Milliken, Agincourt North, Steeles East, L'Amoreaux	Park	Asian Restaurant	Playground	Dog Run	Dessert Shop	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Doner Restaurant

Cluster 4 with 10 neighborhoods

	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
57	Humberlea, Emery	Baseball Field	Women's Store	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Doner Restaurant	Donut Shop	Farmers Market
101	Old Mill South, King's Mill Park, Sunnylea, Hurontario	Business Service	Baseball Field	Doner Restaurant	Dim Sum Restaurant	Diner	Discount Store	Distribution Center	Dog Run	Women's Store	Dessert Shop

Cluster 5 with 2 neighborhood

Table 10. Clustered neighborhoods

Further moving into second objective of finding out Indian restaurants that have best average rating and their corresponding neighborhoods, analysis has been done using the following results. Bar charts are used as visualization tool for this exercise to analyze the count of neighborhoods and the number of Indian restaurants around them. From the below chart, it can be seen that maximum number of neighborhoods are in North York borough

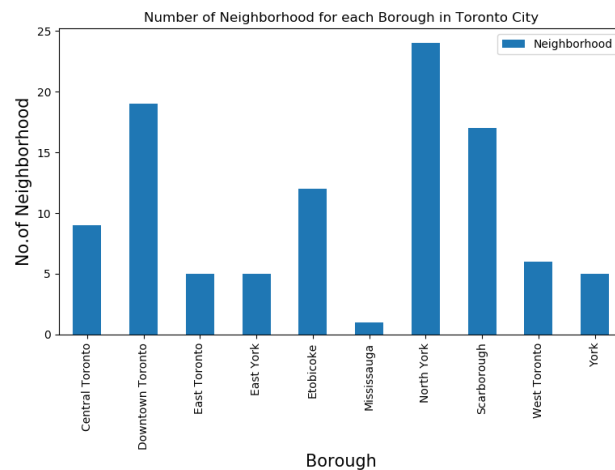


Figure 2. Number of neighborhoods for each borough in Toronto city

Total number of Indian restaurants are plotted with respect to each borough and as it can be seen a maximum of 4 restaurants are found in Downtown Toronto whereas an average being 2 in other three boroughs and one each in other two boroughs.

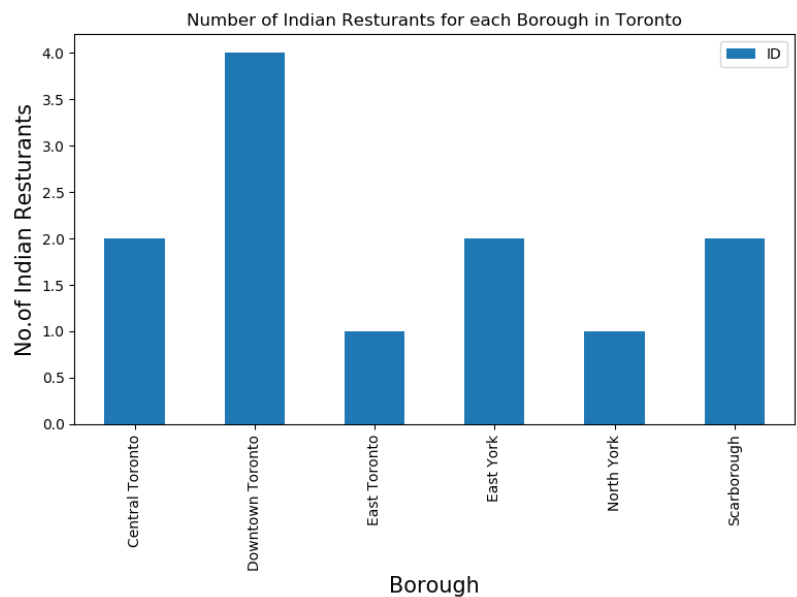


Figure 3. Number of Indian Restaurants for each borough in Toronto

Also when analyzed with respect to neighborhoods, a maximum of 2 in two neighborhoods is found and rest having one each as can be seen in the below plot.

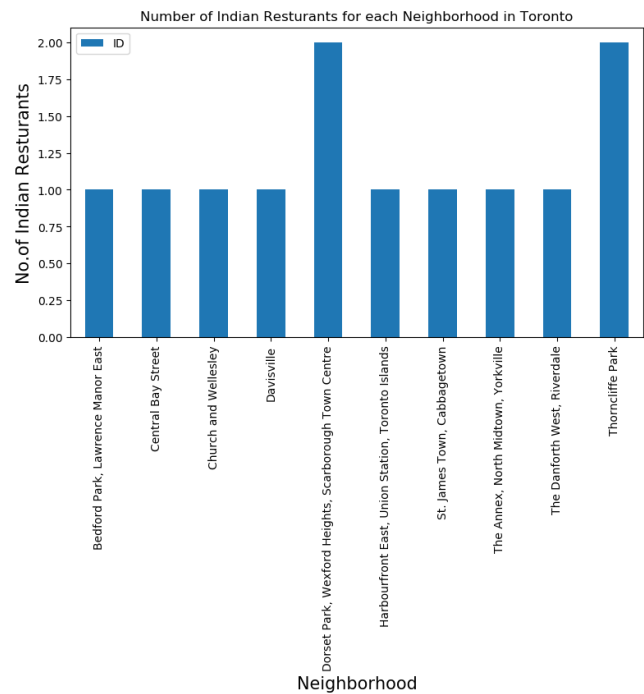


Figure 4. Number of Indian restaurants for each neighborhood in Toronto

Now, average rating of each restaurant is plotted with respect to boroughs. To be observed that ratings range between 6.85 and 8.8 for neighborhoods as shown in the below table.

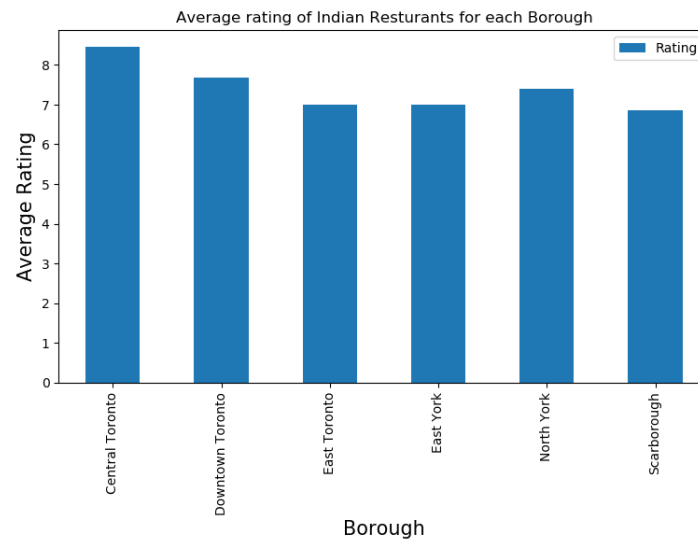


Figure 5. Average rating of Indian restaurants for each borough

	Neighborhood	Average Rating
7	The Annex, North Midtown, Yorkville	8.80
6	St. James Town, Cabbagetown	8.40
2	Church and Wellesley	8.10
3	Davisville	8.10
0	Bedford Park, Lawrence Manor East	7.40
1	Central Bay Street	7.10
5	Harbourfront East, Union Station, Toronto Islands	7.10
8	The Danforth West, Riverdale	7.00
9	Thorncliffe Park	7.00
4	Dorset Park, Wexford Heights, Scarborough Town...	6.85

Table 11. Average rating of Indian restaurant for each neighborhood in Toronto

Location results are shown using visualization tool by generating the map as shown below

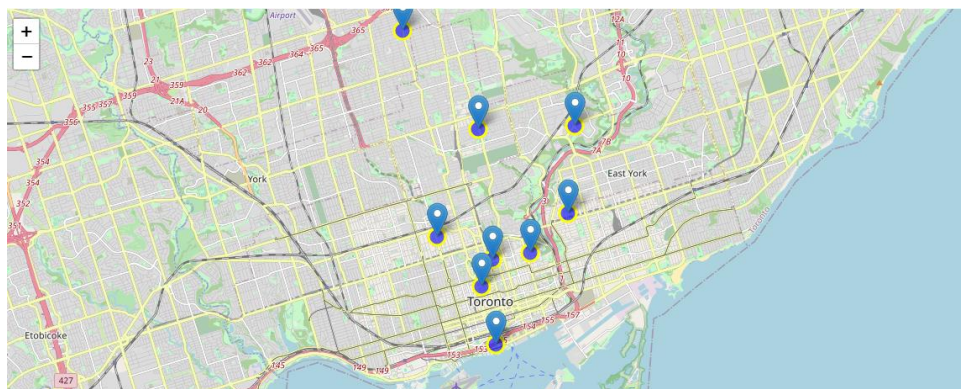


Figure 6. Visualization of restaurant locations using geographical map

6. Discussion

At first, number of neighborhoods are analyzed in each borough. In the first segment of analysis, various neighborhoods are segmented for 10 most common venues. Further, these neighborhoods are clustered using k-means algorithm. All the neighborhoods are clustered into 5 and each cluster is examined with respect to first 10 most common venues. Cluster 2 labeled as 1 seems to have major amenities like coffee shops, pubs, restaurants and services however cluster 3 labeled as 2 also seems to have all the possible amenities.

In the second segment, all the neighborhoods of each borough are analyzed for Indian Restaurants. Number of Indian restaurants in each borough and each neighborhood is analyzed. Downtown Toronto borough has maximum of 4 Indian restaurants. Further, based on likes, tips and ratings, average rating of each restaurant is analyzed and 12 restaurants are found to be given ratings. They are found to have ratings between 6.85 and 8.8 out of 10. Indian restaurant in central Toronto has highest rating followed by downtown Toronto borough. Maximum of 2 number of restaurants are observed to be in Thorncliffe Park and Dorset Park, Wexford Heights, Scarborough Town neighborhoods.

Thus comparing the second segment results with first segment results, most of these neighborhoods fall under cluster 2 and thus cluster 2 would be the better choice for an individual to reside with all the considered top 10 most common venues and high rated Indian restaurants

7. Conclusions

The following are the highest rated and highest number of restaurants with respect to Boroughs and Neighborhoods in city of Toronto

Insight 1:

- Highest average rating of Indian Restaurant: 8.8
- Borough: Central Toronto
- Neighborhood: The Annex, North Midtown, Yorkville
- Name of Indian Restaurant: Roti Cuisine of India

Insight 2:

- Highest number of Indian restaurants:4
- Borough: Down Toronto, Scarborough

Insight 3:

- Highest number of Indian restaurants:2
- Neighborhood: Thorncliffe Park -Iqbal kabab and sweet center
- Neighborhood: Park, Wexford Heights, Scarborough Town - Kairali

Insight 4:

More number of top 10 most common venues with all amenities like coffee shops, women stores, parks, restaurants, auto shops etc

Final Decision:

Comparing all the choices, Cluster 2 is the most appropriate cluster to choose to reside in with 10 more top common venues available around in addition to Indian restaurants

8. Further scope

Number of cluster k in k -means algorithm used here can be improved much to model it much better. Also, since the ranking is clearly based on the ratings provided, accuracy of the results depends on the data obtained by Foursquare

9. References

1. https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M
2. https://cocl.us/Geospatial_data