Exploring Neighborhoods of Toronto using K-Means Algorithm and Toronto Crime Data

Criteria in Creating an Itinerary

- Minimize travel time and costs.
- Explore unique neigbhorhoods and maximize stay in the neighborhoods.
- Crime incidence information

Data Sources, Acquisition and Cleaning
Toronto Postal Codes and Geo Coordinates

	Postal Code	Borough	Neighbourhood	Latitude	Longitude
0	M1B	Scarborough	Rouge, Malvern	43.806686	-79.194353
1	M1C	Scarborough	Highland Creek, Rouge Hill, Port Union	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

Postal Codes   : *https://en.wikipedia.org/wiki/List_of_postal_codes_of_Canada:_M*
Geo Coordinates *: https://cocl.us/Geospatial_data*

Data Sources, Acquisition and Cleaning
Toronto Postal Codes Data Cleaning

- Cells with assigned boroughs will only be processed and unassigned boroughs will be ignored.

- Postal codes with multiple assigned neighborhoods will be combined into one row with the assigned neighborhoods separated with a comma.

- Unassigned neighborhood of a borough will be assigned as the same as its corresponding borough name.

Data Sources, Acquisition and Cleaning
Neighborhood Venues, Toronto Major Crime Indicator (MCI) and MCI Data Cleaning

- Neighborhood Venues:

    Foursquare API

- Toronto Major Crime Indicator (MCI):
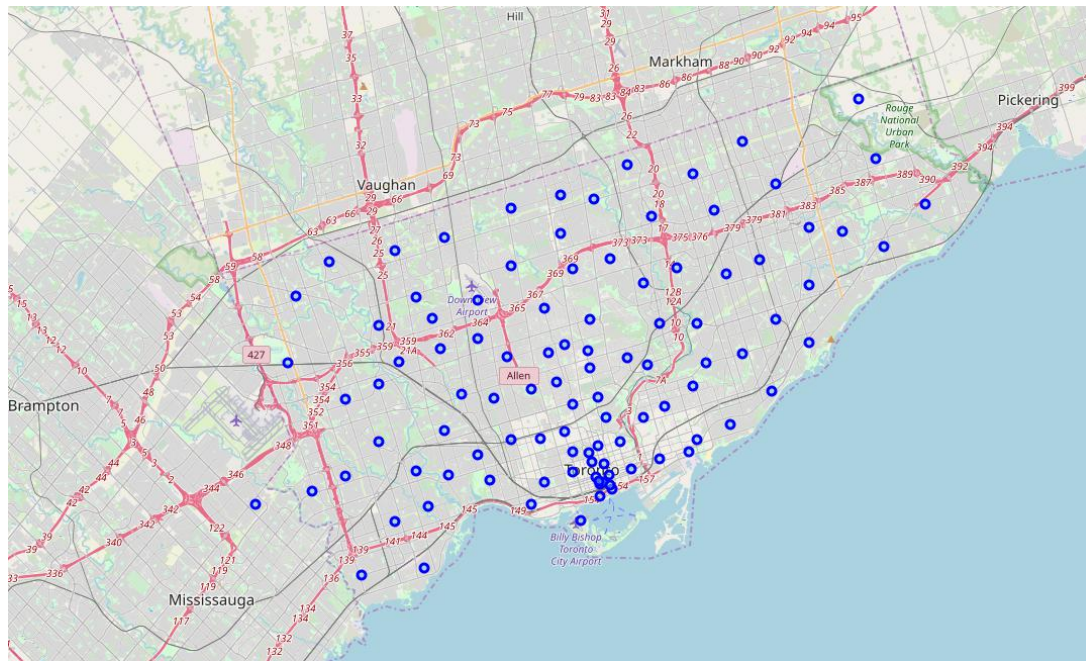
    Toronto Police Service Public Safety Data Portal

- MCI Data Cleaning:

    Rows with missing entries will be deleted from the dataframe
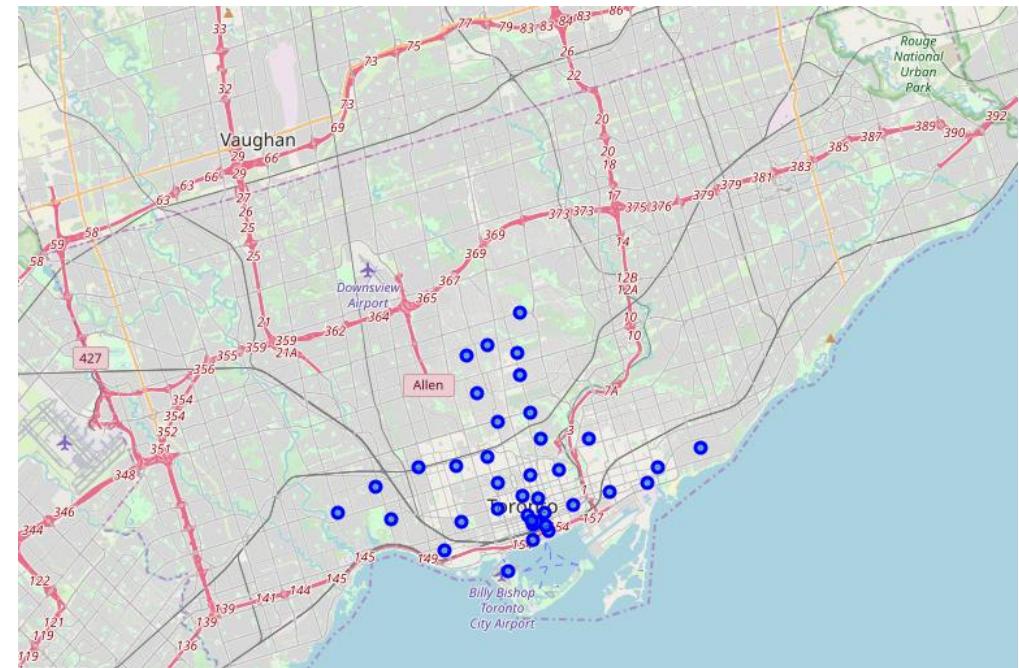
Exploratory Data Analysis
Exploring and Mapping Toronto Neighborhoods

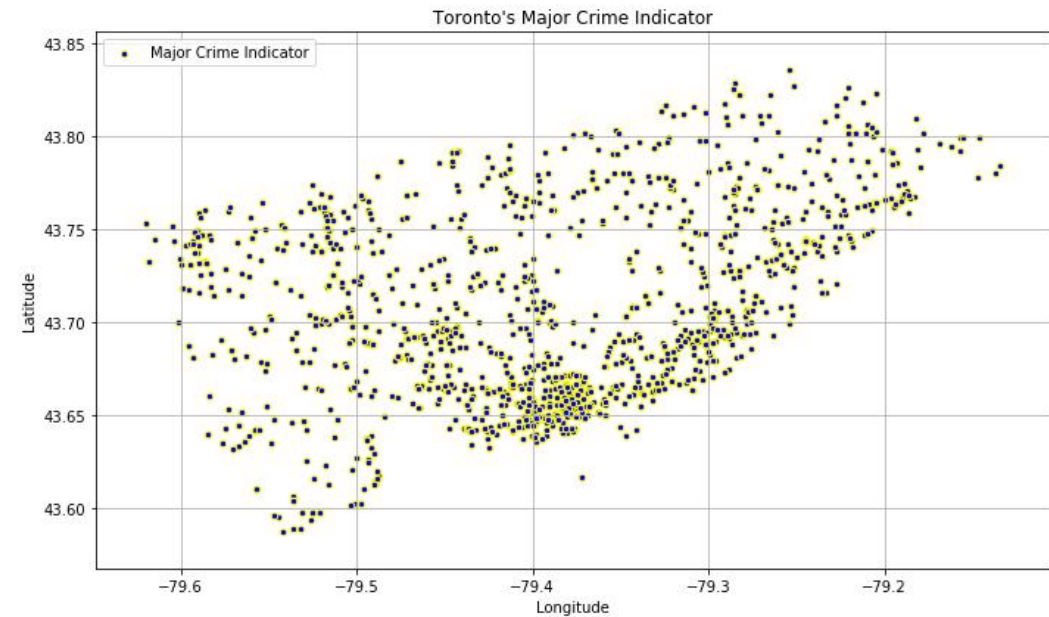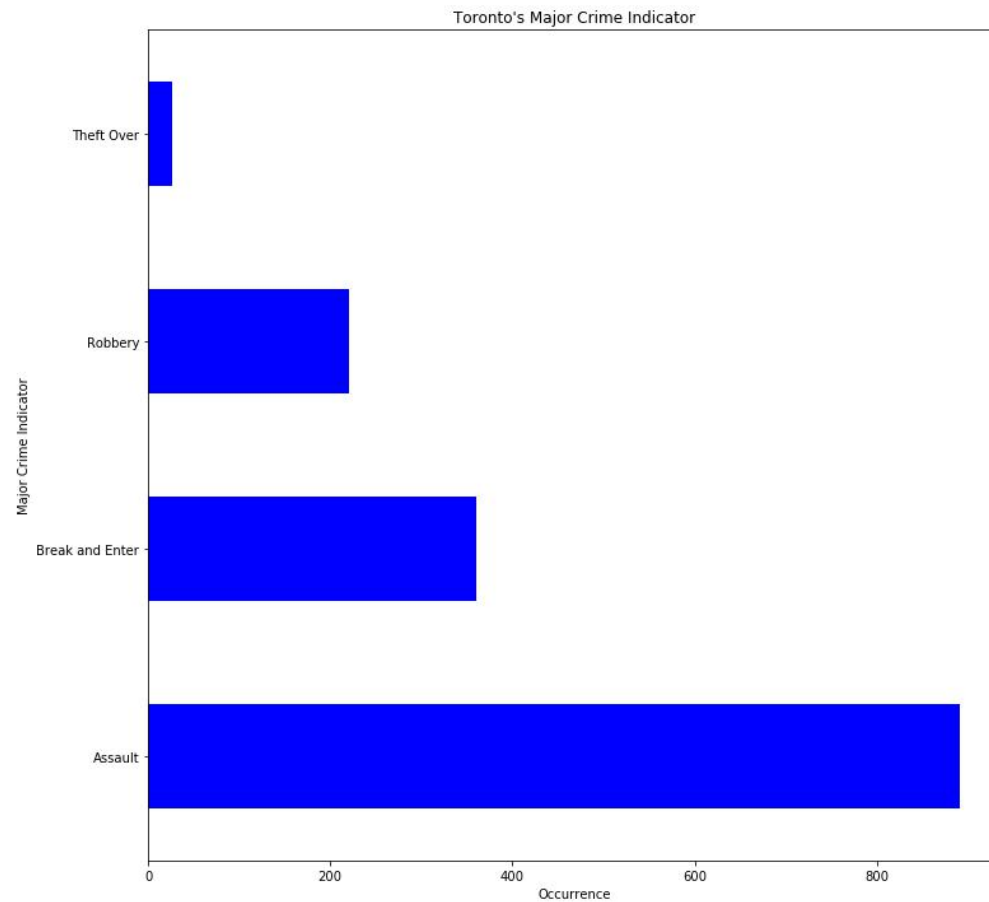**Map of Toronto with Neighborhoods Superimposed on Top**

Map of East, West and Central Toronto with Neighborhoods Superimposed on Top
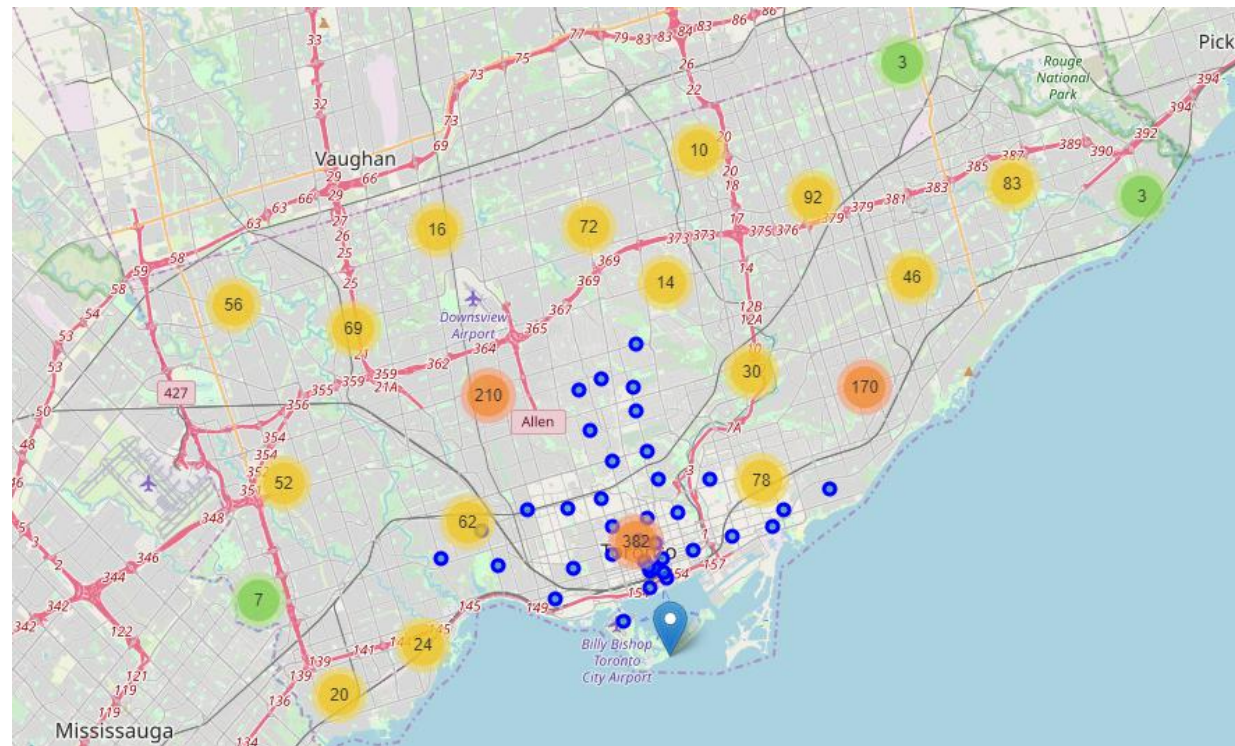
Exploratory Data Analysis
Mapping Toronto Crime Indicator

Exploratory Data Analysis
Mapping Toronto Crime Indicator

Folium Cluster Map of Toronto's Major Crime Indicator (*Sample Size = 1,500*)

Clustering Neighborhoods
K-Means Algorithm (Cluster = 0)

	Postal Code	Borough	Neighbourhood	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	M4E	East Toronto	The Beaches	43.676357	-79.293031	0	Other Great Outdoors	Coffee Shop	Health Food Store	Trail	Pub	Neighborhood	Deli / Bodega	Eastern European Restaurant	Dumpling Restaurant	Donut Shop
1	M4K	East Toronto	The Danforth West, Riverdale	43.679557	-79.352188	0	Greek Restaurant	Ice Cream Shop	Italian Restaurant	Yoga Studio	Cosmetics Shop	Coffee Shop	Pizza Place	Dessert Shop	Diner	Pub
2	M4L	East Toronto	The Beaches West, India Bazaar	43.668999	-79.315572	0	Sandwich Place	Gym	Food & Drink Shop	Burger Joint	Burrito Place	Liquor Store	Italian Restaurant	Fast Food Restaurant	Fish & Chips Shop	Steakhouse
3	M4M	East Toronto	Studio District	43.659526	-79.340923	0	Café	Coffee Shop	Italian Restaurant	American Restaurant	Bakery	Yoga Studio	Seafood Restaurant	Fish Market	Ice Cream Shop	Neighborhood
4	M4N	Central Toronto	Lawrence Park	43.728020	-79.388790	0	Park	Bus Line	Swim School	Dim Sum Restaurant	Convenience Store	Cosmetics Shop	Event Space	Ethiopian Restaurant	Eastern European Restaurant	Dumpling Restaurant

Clustering Neighborhoods *(continued...)*
K-Means Algorithm (Cluster = 0)

	Postal Code	Borough	Neighbourhood	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
5	M4P	Central Toronto	Davisville North	43.712751	-79.390197	0	Gym	Hotel	Clothing Store	Sandwich Place	Breakfast Spot	Food & Drink Shop	Park	Gastropub	Deli / Bodega	Dumpling Restaurant
6	M4R	Central Toronto	North Toronto West	43.715383	-79.405678	0	Clothing Store	Coffee Shop	Sporting Goods Shop	Chinese Restaurant	Burger Joint	Salon / Barbershop	Restaurant	Rental Car Location	Café	Park
7	M4S	Central Toronto	Davisville	43.704324	-79.388790	0	Dessert Shop	Sandwich Place	Sushi Restaurant	Café	Pizza Place	Coffee Shop	Gym	Italian Restaurant	Diner	Farmers Market
8	M4T	Central Toronto	Moore Park, Summerhill East	43.689574	-79.383160	0	Gym	Playground	Trail	Dessert Shop	Event Space	Ethiopian Restaurant	Eastern European Restaurant	Dumpling Restaurant	Donut Shop	Dog Run
9	M4V	Central Toronto	Deer Park, Forest Hill SE, Rathnelly, South Hi...	43.686412	-79.400049	0	Coffee Shop	Pub	Supermarket	Vietnamese Restaurant	Sushi Restaurant	Light Rail Station	Liquor Store	American Restaurant	Restaurant	Pizza Place
10	M4W	Downtown Toronto	Rosedale	43.679563	-79.377529	0	Park	Playground	Trail	Deli / Bodega	Ethiopian Restaurant	Eastern European Restaurant	Dumpling Restaurant	Donut Shop	Dog Run	Discount Store
11	M4X	Downtown Toronto	Cabbagetown, St. James Town	43.667967	-79.367675	0	Italian Restaurant	Bakery	Restaurant	Café	Beer Store	Japanese Restaurant	Sandwich Place	Jewelry Store	Butcher	Pub
12	M4Y	Downtown Toronto	Church and Wellesley	43.665860	-79.383160	0	Gay Bar	Burger Joint	General Entertainment	Ramen Restaurant	Bookstore	Breakfast Spot	Japanese Restaurant	Bubble Tea Shop	Salon / Barbershop	Restaurant
13	M5A	Downtown Toronto	Harbourfront, Regent Park	43.654260	-79.360636	0	Coffee Shop	Park	Bakery	Pub	Breakfast Spot	Café	Mexican Restaurant	French Restaurant	Event Space	Spa
14	M5B	Downtown Toronto	Ryerson, Garden District	43.657162	-79.378937	0	Clothing Store	Coffee Shop	Café	Plaza	Sporting Goods Shop	Fast Food Restaurant	Hotel	Pizza Place	Beer Bar	Steakhouse
15	M5C	Downtown Toronto	St. James Town	43.651494	-79.375418	0	Coffee Shop	Italian Restaurant	Gastropub	Café	Restaurant	Hotel	Hostel	Cosmetics Shop	Creperie	Church

Clustering Neighborhoods *(continued...)*
K-Means Algorithm (Cluster = 0)

	Postal Code	Borough	Neighbourhood	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
16	M5E	Downtown Toronto	Berczy Park	43.644771	-79.373306	0	Cocktail Bar	Café	Bakery	Coffee Shop	Farmers Market	Beer Bar	Seafood Restaurant	French Restaurant	Fish Market	Liquor Store
18	M5H	Downtown Toronto	Adelaide, King, Richmond	43.650571	-79.384568	0	Steakhouse	Hotel	Coffee Shop	Café	Asian Restaurant	Concert Hall	Seafood Restaurant	Bar	Pizza Place	Lounge
19	M5J	Downtown Toronto	Harbourfront East, Toronto Islands, Union Station	43.640816	-79.381752	0	Plaza	Hotel	Café	Park	Deli / Bodega	IT Services	Skating Rink	Sporting Goods Shop	Sports Bar	Basketball Stadium
20	M5K	Downtown Toronto	Design Exchange, Toronto Dominion Centre	43.647177	-79.381576	0	Coffee Shop	Café	Restaurant	Japanese Restaurant	Deli / Bodega	Gym	Steakhouse	Gastropub	Gym / Fitness Center	Hotel
21	M5L	Downtown Toronto	Commerce Court, Victoria Hotel	43.648198	-79.379817	0	Café	Coffee Shop	Restaurant	Gastropub	Japanese Restaurant	Deli / Bodega	Gym	Bakery	Gym / Fitness Center	Ice Cream Shop
23	M5P	Central Toronto	Forest Hill North, Forest Hill West	43.696948	-79.411307	0	Jewelry Store	Trail	Sushi Restaurant	Bus Line	Yoga Studio	Diner	Event Space	Ethiopian Restaurant	Eastern European Restaurant	Dumpling Restaurant
25	M5S	Downtown Toronto	Harbord, University of Toronto	43.662696	-79.400049	0	Café	Bookstore	Restaurant	Sandwich Place	Japanese Restaurant	Italian Restaurant	Bar	Bakery	Sushi Restaurant	Comfort Food Restaurant
26	M5T	Downtown Toronto	Chinatown, Grange Park, Kensington Market	43.653206	-79.400049	0	Café	Vietnamese Restaurant	Bakery	Mexican Restaurant	Gourmet Shop	Cocktail Bar	Dumpling Restaurant	Farmers Market	Donut Shop	Fish Market
29	M5X	Downtown Toronto	First Canadian Place, Underground city	43.648429	-79.382280	0	Café	Coffee Shop	Steakhouse	Deli / Bodega	Restaurant	Gym	Seafood Restaurant	Japanese Restaurant	Pub	Pizza Place
30	M6G	Downtown Toronto	Christie	43.669542	-79.422564	0	Grocery Store	Café	Park	Diner	Convenience Store	Nightclub	Coffee Shop	Athletics & Sports	Baby Store	Restaurant

Clustering Neighborhoods *(continued...)*
K-Means Algorithm (Cluster = 0)

	Postal Code	Borough	Neighbourhood	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
31	M6H	West Toronto	Dovercourt Village, Dufferin	43.669005	-79.442259	0	Supermarket	Bakery	Pharmacy	Smoke Shop	Furniture / Home Store	Café	Recording Studio	Bar	Bank	Middle Eastern Restaurant
32	M6J	West Toronto	Little Portugal, Trinity	43.647927	-79.419750	0	Bar	Asian Restaurant	Vietnamese Restaurant	Pizza Place	New American Restaurant	Beer Store	Boutique	Brewery	Record Shop	Yoga Studio
33	M6K	West Toronto	Brockton, Exhibition Place, Parkdale Village	43.636847	-79.428191	0	Café	Coffee Shop	Breakfast Spot	Furniture / Home Store	Pet Store	Performing Arts Venue	Italian Restaurant	Intersection	Grocery Store	Yoga Studio
34	M6P	West Toronto	High Park, The Junction South	43.661608	-79.464763	0	Thai Restaurant	Grocery Store	Mexican Restaurant	Café	Bar	Fast Food Restaurant	Diner	Speakeasy	Bakery	Discount Store
35	M6R	West Toronto	Parkdale, Roncesvalles	43.648960	-79.456325	0	Gift Shop	Bookstore	Italian Restaurant	Coffee Shop	Eastern European Restaurant	Cuban Restaurant	Dog Run	Dessert Shop	Movie Theater	Breakfast Spot
36	M6S	West Toronto	Runnymede, Swansea	43.651571	-79.484450	0	Café	Pizza Place	Coffee Shop	Sushi Restaurant	Italian Restaurant	Food	Indie Movie Theater	Dessert Shop	Bar	Fish & Chips Shop
37	M7Y	East Toronto	Business Reply Mail Processing Centre 969 Eastern	43.662744	-79.321558	0	Light Rail Station	Yoga Studio	Fast Food Restaurant	Park	Pizza Place	Butcher	Restaurant	Burrito Place	Brewery	Skate Park

Clustering Neighborhoods
K-Means Algorithm (Cluster = 1)

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toronto_merged[toronto_merged['Cluster Labels'] ==1]
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	Postal Code	Borough	Neighbourhood	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
28	M5W	Downtown Toronto	Stn A PO Boxes 25 The Esplanade	43.646435	-79.374846	1	Farmers Market	Cocktail Bar	Café	Seafood Restaurant	Beer Bar	Food Truck	Museum	Clothing Store	Pub	Jazz Club

Clustering Neighborhoods
K-Means Algorithm (Cluster = 2)

	Postal Code	Borough	Neighbourhood	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
22	M5N	Central Toronto	Roselawn	43.711695	-79.416936	2	Garden	Yoga Studio	Dim Sum Restaurant	Falafel Restaurant	Event Space	Ethiopian Restaurant	Eastern European Restaurant	Dumpling Restaurant	Donut Shop	Dog Run

Clustering Neighborhoods
K-Means Algorithm (Cluster = 3)

	Postal Code	Borough	Neighbourhood	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
24	M5R	Central Toronto	The Annex, North Midtown, Yorkville	43.672710	-79.405678	3	Sandwich Place	Café	Coffee Shop	Burger Joint	Pizza Place	Pub	Middle Eastern Restaurant	BBQ Joint	History Museum	Liquor Store
27	M5V	Downtown Toronto	CN Tower, Bathurst Quay, Island airport, Harbo...	43.628947	-79.394420	3	Airport Lounge	Airport Service	Airport	Harbor / Marina	Rental Car Location	Boat or Ferry	Boutique	Sculpture Garden	Airport Terminal	Airport Food Court

Clustering Neighborhoods
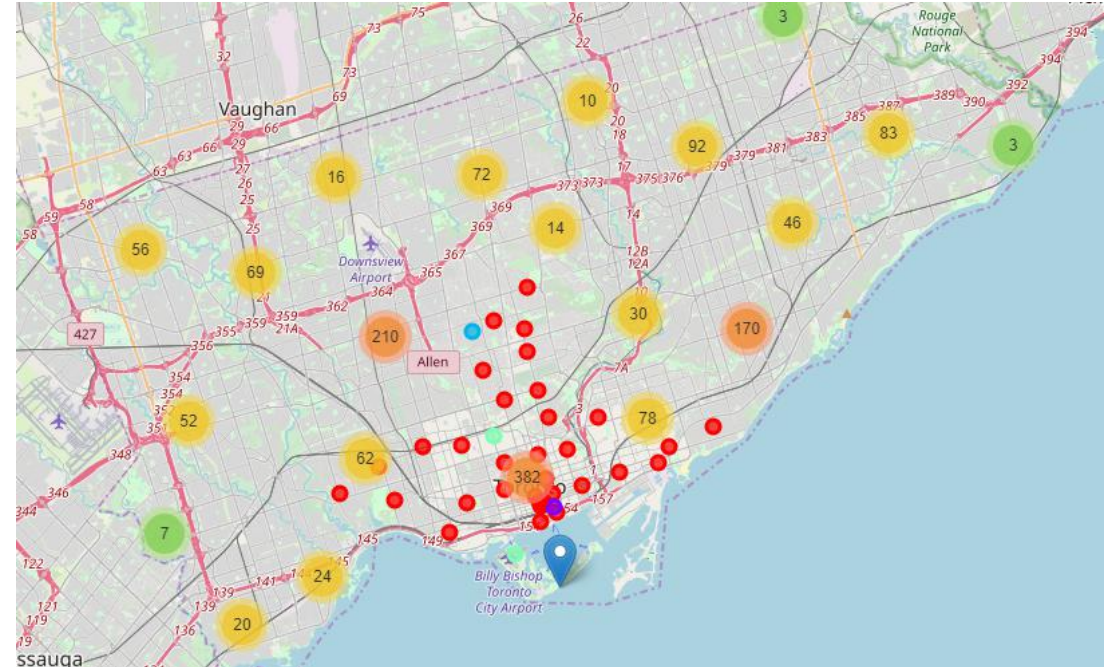## K-Means Algorithm (Cluster = 4)

	Postal Code	Borough	Neighbourhood	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
17	M5G	Downtown Toronto	Central Bay Street	43.657952	-79.387383	4	Coffee Shop	Café	Chinese Restaurant	Italian Restaurant	Bubble Tea Shop	Sandwich Place	Ice Cream Shop	Spa	Japanese Restaurant	Seafood Restaurant

Visualizing Clustered Neighborhoods using K-Means Algorithm

Clustered Neighborhoods

Clustered Neighborhoods with Crime Data

Proposed Itinerary

Itinerary	Cluster Group	Borough	Neighbourhood	Criminal Activity	Most Common Value Ranking	Venue
Day 1 - 3	1	Downtown Toronto	Stn A PO Boxes 25 The Esplanade	High	1	Farmers Market
					2	Cocktail Bar
					3	CafÃ©
					4	Seafood Restaurant
					5	Beer Bar
					6	Food Truck
					7	Museum
					8	Clothing Store
					9	Pub
					10	Jazz Club
Day 4 - 6	4	Downtown Toronto	Central Bay Street	High	1	Coffee Shop
					2	CafÃ©
					3	Chinese Restaurant
					4	Italian Restaurant
					5	Bubble Tea Shop
					6	Sandwich Place
					7	Ice Cream Shop
					8	Spa
					9	Japanese Restaurant
					10	Seafood Restaurant

Proposed Itinerary (*continued...*)

Itinerary	Cluster Group	Borough	Neighbourhood	Criminal Activity	Most Common Value Ranking	Venue
Day 7 - 9	3	Central Toronto	The Annex, North Midtown, Yorkville	Low	1	Sandwich Place
					2	CafÃ©
					3	Coffee Shop
					4	Burger Joint
					5	Pizza Place
					6	Pub
					7	Middle Eastern Restaurant
					8	BBQ Joint
					9	History Museum
					10	Liquor Store
Day 10 - 12	0	Central Toronto	Forest Hill North, Forest Hill West	Low	1	Jewelry Store
					2	Trail
					3	Sushi Restaurant
					4	Bus Line
					5	Yoga Studio
					6	Diner
					7	Event Space
					8	Ethiopian Restaurant
					9	Eastern European Restaurant
					10	Dumpling Restaurant
Day 13 - 15	2	Central Toronto	Roselawn	Low	1	Garden
					2	Yoga Studio
					3	Dim Sum Restaurant
					4	Falafel Restaurant
					5	Event Space
					6	Ethiopian Restaurant
					7	Eastern European Restaurant
					8	Dumpling Restaurant
					9	Donut Shop
					10	Dog Run

Conclusion and Recommendation

- We were able to generate proposed itinerary with the following criteria:
  - Uniqueness of the neighborhood
  - Proximity distance of each unique neighborhoods
- We have also included the crime data in order for us to be aware of our safety when visiting the neighborhood
- It is suggested to include the crime data in the cluster analysis for better results

Thank You