

Crime Rate & Venues Data Analysis of Montreal

Sandra Lian

February 16, 2021

A. Introduction

A.1. Background Discussion

Montreal is the second most populous city in Canada, with close to two million residents in the urban agglomeration. It is often considered as "Canada's Cultural Capital", and remains as an important center of commerce, technology, education, art, culture and world affairs. The city has world-class universities, a lively cultural scene, a dynamic job market and the cost of living there is relatively low. As a result, it is often ranked the best city to be a university student in the world, and has become a popular destination for international students. According to Stats Can, the city is home to approximately 36,000 international university students. [1]

New to a foreign environment, it is important for international students to find suitable accommodations so they can focus on their academic pursuits. Although some students choose to live on campus, it is common for others to find homes in other parts of the city. This analysis aims to help international students to find the best accommodations that fit their needs.

There are two main criteria in evaluating the suitable accommodation in Montreal neighbourhoods:

- First, the neighbourhoods should provide good amenities and lively social scenes, such as restaurants, cafes, gyms, libraries etc.
- Second, the communities should offer a safe living environment with low reported crime rate.
- As part of the analysis, I will create a Choropleth map where the reported crime rate is placed in Montreal, and each city neighbourhood is clustered based on venue density.

A.2. Data Description

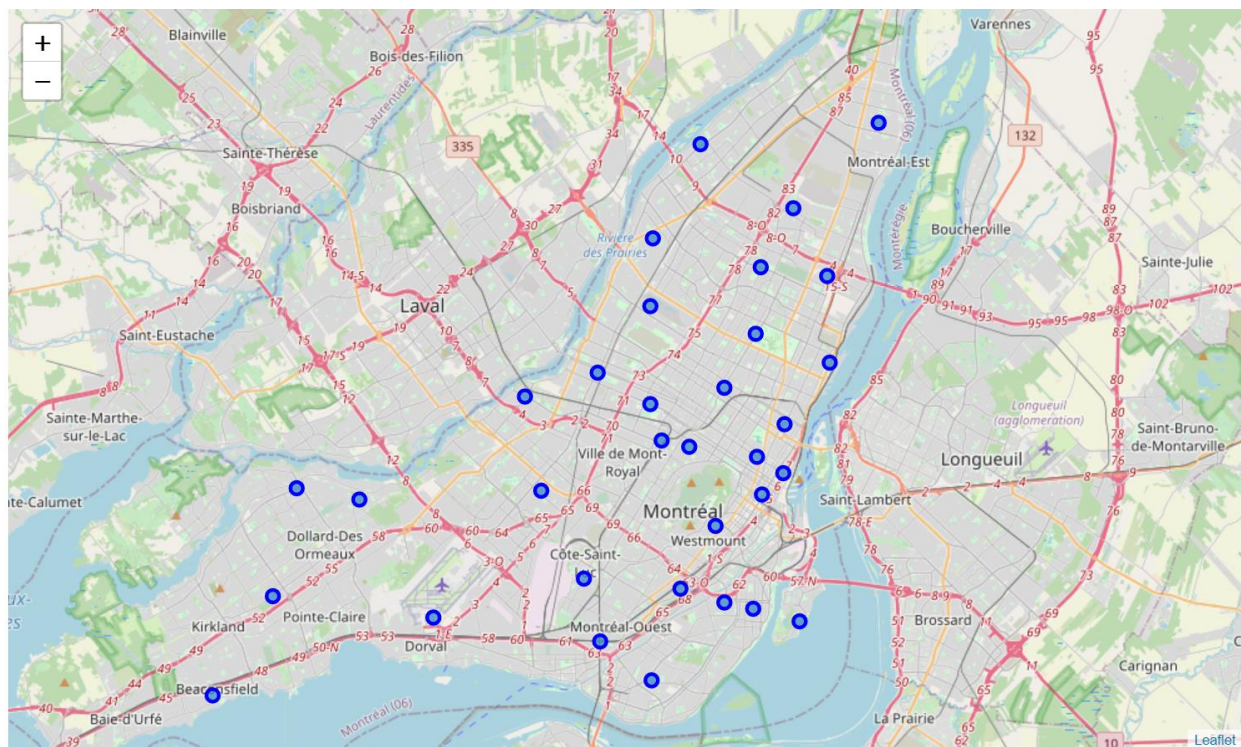
- "Data on the Limit of Police District Station Sectors" from the City of Montreal website: This is a .csv file which has the coordinates of Montreal based on the locations of the city's Police Department Quarters (PDQs). These Police Department Quarters (PDQs) are across the entire city and they provide a complete representation of the city coverage. Therefore, the analysis will use the provided coordinates to define Montreal's various neighbourhoods and create the map of the city. [2]
- "Montreal Crimes Data" from the City of Montreal website: This .csv file has the recorded crimes in Montreal since 2015. The crimes data is listed by each Police Department Quarters (PDQs), and has the following attributes: type of crimes, the number of crimes, times when specific crimes are committed and the coordinates of the PDQs where the crimes were committed. During the data cleaning process, I found there are some missing values in the recent years. To ensure the completeness of data and relevant presentation of the crime rates, I decided to use the data from the entire year of 2019. [3]
- With the combined info from "Data on the Limit of Police District Station Sectors" and "Montreal Crimes Data", I created a choropleth map of crime rates in Montreal.
- Foursquare API is used to get the most common venues of Montreal. [4]

B. Methodology and Data Exploration

GitHub repository is used in performing and sharing this analysis. The master data has the components including Neighbourhood (defined by PDQs as mentioned above), Latitude and Longitude information of each neighbourhood, and the Total Number of Crimes in 2019 (listed under the column "Category").

	level_0	DATE	PDQ	LATITUDE	LONGITUDE	CATEGORIE
0	101574	2019	1.0	45.426522	-73.868164	275
1	87293	2019	3.0	45.505988	-73.821669	550
2	103087	2019	4.0	45.501623	-73.787537	318
3	102470	2019	5.0	45.464523	-73.835019	675
4	56565	2019	7.0	45.504832	-73.688365	1202

Python folium library is used to create the map of Montreal, with coordinates information provided by the data gathered:



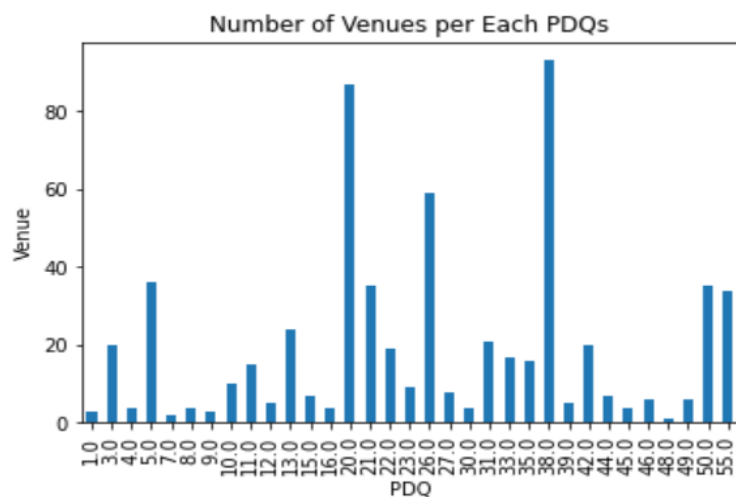
Foursquare API is used to analyze and cluster the different neighbourhoods in Montreal. The limit on venues is set at 100, and radius as 1000 meters for each neighbourhood from their geographic coordinates. Below is the example of the listed venues information from Foursquare API.

	name	categories	lat	lng
0	Arena Beaconsfield	Hockey Arena	45.425651	-73.866593
1	park city lane	Soccer Field	45.425301	-73.865801
2	Plaza Elm	Pizza Place	45.431739	-73.865350
3	Cugini's Pizza Cafe	Pizza Place	45.431706	-73.864628

There are a total of 623 venues returned by Foursquare. Below shows the combined information between various neighbourhoods (represented by PDQ numbers) and venues.

	Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
0	1.0	45.426522	-73.868164	Arena Beaconsfield	45.425651	-73.866593	Hockey Arena
1	1.0	45.426522	-73.868164	park city lane	45.425301	-73.865801	Soccer Field
2	1.0	45.426522	-73.868164	City Park	45.425026	-73.865735	Park
3	3.0	45.505988	-73.821669	Restaurant Bombay Choupati	45.508404	-73.820454	Indian Restaurant
4	3.0	45.505988	-73.821669	Aryana	45.504587	-73.817885	Middle Eastern Restaurant

Below we can see that the neighbourhoods near the Montreal Police Department Quarters (PDQ) 20 and 38 have the highest number of venues among the communities in Montreal, with close to 100 venues returned by Foursquare API. Followed by the area near PDQ 26 which has approximately 60 venues.



A summary that lists the top 10 venue categories for each Neighbourhood is created as a table 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	1.0	Soccer Field	Hockey Arena	Park	Convenience Store	Discount Store	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
1	3.0	Indian Restaurant	Pizza Place	Pharmacy	Coffee Shop	Pool Hall	Portuguese Restaurant	Middle Eastern Restaurant	Sandwich Place	Brazilian Restaurant	Market
2	4.0	Convenience Store	Pizza Place	Pharmacy	Train Station	Yoga Studio	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
3	5.0	Clothing Store	Electronics Store	Sporting Goods Shop	Restaurant	Café	Furniture / Home Store	Toy / Game Store	Fast Food Restaurant	Cosmetics Shop	Bank
4	7.0	Gym	Pharmacy	Park	Spa	Cocktail Bar	Coffee Shop	Discount Store	Diner	Dessert Shop	Department Store

There are some commonalities among different areas within Montreal. To explore their similarities, the unsupervised learning K-means algorithm is used to segment and cluster the neighbourhoods. The total neighborhoods are segmented into 6 clusters.

The table below shows the detailed information of the clustered neighbourhood:

	level_0	DATE	PDQ	LATITUDE	LONGITUDE	Cluster Label	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	101574	2019	1.0	45.426522	-73.868164	1	Soccer Field	Hockey Arena	Park	Convenience Store	Discount Store	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
1	87293	2019	3.0	45.505988	-73.821669	2	Indian Restaurant	Pizza Place	Pharmacy	Coffee Shop	Pool Hall	Portuguese Restaurant	Middle Eastern Restaurant	Sandwich Place	Brazilian Restaurant	Market
2	103087	2019	4.0	45.501623	-73.787537	2	Convenience Store	Pizza Place	Pharmacy	Train Station	Yoga Studio	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
3	102470	2019	5.0	45.464523	-73.835019	2	Clothing Store	Electronics Store	Sporting Goods Shop	Restaurant	Café	Furniture / Home Store	Toy / Game Store	Fast Food Restaurant	Cosmetics Shop	Bank
4	56565	2019	7.0	45.504832	-73.688365	1	Gym	Pharmacy	Park	Spa	Cocktail Bar	Coffee Shop	Discount Store	Diner	Dessert Shop	Department Store

Next, we will closely examine the six clustered areas within Montreal:

Cluster 1:

	DATE	Cluster Label	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
12	2019	0	Park	Convenience Store	Mediterranean Restaurant	Cosmetics Shop	Discount Store	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio

Cluster 2:

	DATE	Cluster Label	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	2019	1	Soccer Field	Hockey Arena	Park	Convenience Store	Discount Store	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
4	2019	1	Gym	Pharmacy	Park	Spa	Cocktail Bar	Coffee Shop	Discount Store	Diner	Dessert Shop	Department Store
6	2019	1	Pool	Skating Rink	Park	Convenience Store	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio	Cupcake Shop
15	2019	1	Park	Performing Arts Venue	Sandwich Place	Grocery Store	Ice Cream Shop	Bakery	Restaurant	Fast Food Restaurant	Mexican Restaurant	Boxing Gym
16	2019	1	Park	Pharmacy	Supermarket	Restaurant	Theater	French Restaurant	Ice Cream Shop	Hardware Store	Coffee Shop	Cocktail Bar
24	2019	1	Grocery Store	Pharmacy	Gas Station	Park	Italian Restaurant	Yoga Studio	Convenience Store	Diner	Dessert Shop	Department Store
26	2019	1	Chinese Restaurant	Convenience Store	Grocery Store	Pharmacy	Park	Scenic Lookout	Nature Preserve	Dessert Shop	Department Store	Deli / Bodega

Cluster 3:

	DATE	Cluster Label	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	2019	2	Indian Restaurant	Pizza Place	Pharmacy	Coffee Shop	Pool Hall	Portuguese Restaurant	Middle Eastern Restaurant	Sandwich Place	Brazilian Restaurant	Market
2	2019	2	Convenience Store	Pizza Place	Pharmacy	Train Station	Yoga Studio	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
3	2019	2	Clothing Store	Electronics Store	Sporting Goods Shop	Restaurant	Café	Furniture / Home Store	Toy / Game Store	Fast Food Restaurant	Cosmetics Shop	Bank
7	2019	2	Pharmacy	Gas Station	Discount Store	Bank	Sandwich Place	Asian Restaurant	Shopping Mall	Comedy Club	Cycle Studio	Clothing Store
8	2019	2	Persian Restaurant	Café	Restaurant	Park	Pizza Place	Grocery Store	Discount Store	Korean Restaurant	Japanese Restaurant	Breakfast Spot
9	2019	2	Gym	Coffee Shop	Shoe Store	Italian Restaurant	Playground	Café	College Gym	Discount Store	Diner	Dessert Shop
10	2019	2	Pharmacy	Fast Food Restaurant	Coffee Shop	Pet Store	Italian Restaurant	Bank	Café	Convenience Store	Middle Eastern Restaurant	Sandwich Place
11	2019	2	Video Store	Playground	Tunnel	Pool	Business Service	Bus Station	Breakfast Spot	Yoga Studio	Convenience Store	Dessert Shop
13	2019	2	Coffee Shop	Hotel	Restaurant	French Restaurant	Café	Sandwich Place	Sushi Restaurant	Liquor Store	Gastropub	Cocktail Bar
14	2019	2	Hotel	Vietnamese Restaurant	Café	Convenience Store	Italian Restaurant	Plaza	French Restaurant	Coffee Shop	Seafood Restaurant	Library
17	2019	2	Greek Restaurant	Restaurant	Café	Italian Restaurant	Bookstore	Bakery	Theater	Mediterranean Restaurant	Park	Pizza Place
18	2019	2	Pizza Place	Pharmacy	Sandwich Place	Baseball Field	Bar	Metro Station	Convenience Store	Video Store	College Gym	Comedy Club
19	2019	2	ATM	Breakfast Spot	Pizza Place	Pharmacy	Peruvian Restaurant	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio
20	2019	2	Café	Pharmacy	Gym	Sporting Goods Shop	Convenience Store	Fast Food Restaurant	Brewery	Arts & Entertainment	Spanish Restaurant	Portuguese Restaurant
21	2019	2	Indian Restaurant	Greek Restaurant	Coffee Shop	Park	Café	North Indian Restaurant	Middle Eastern Restaurant	Cosmetics Shop	Bank	Supermarket
22	2019	2	Grocery Store	Pharmacy	Italian Restaurant	Coffee Shop	Deli / Bodega	Brewery	Diner	Lounge	Liquor Store	Bike Rental / Bike Share
23	2019	2	Bar	French Restaurant	Hotel	Indian Restaurant	Restaurant	Ice Cream Shop	Hostel	Sushi Restaurant	Brewery	Bakery
25	2019	2	Grocery Store	Fast Food Restaurant	Sushi Restaurant	Pharmacy	Pizza Place	Park	Paper / Office Supplies Store	Coffee Shop	Movie Theater	Breakfast Spot
28	2019	2	Convenience Store	Soccer Field	American Restaurant	Drugstore	Pizza Place	Gourmet Shop	Gym	Diner	Dessert Shop	Department Store
30	2019	2	Pharmacy	Baseball Stadium	Coffee Shop	Discount Store	Supermarket	Fast Food Restaurant	Yoga Studio	Cycle Studio	Diner	Dessert Shop
31	2019	2	Grocery Store	Bakery	Sandwich Place	Breakfast Spot	Café	Indian Restaurant	Pizza Place	Cheese Shop	Restaurant	Peruvian Restaurant
32	2019	2	Coffee Shop	Café	Airport	Airport Lounge	Airport Service	Gastropub	Rental Car Location	Pizza Place	Lounge	Burger Joint

Cluster 4:

	DATE	Cluster Label	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
27	2019	3	Bus Stop	Yoga Studio	Cosmetics Shop	Dive Bar	Discount Store	Diner	Dessert Shop	Department Store	Deli / Bodega	Cycle Studio

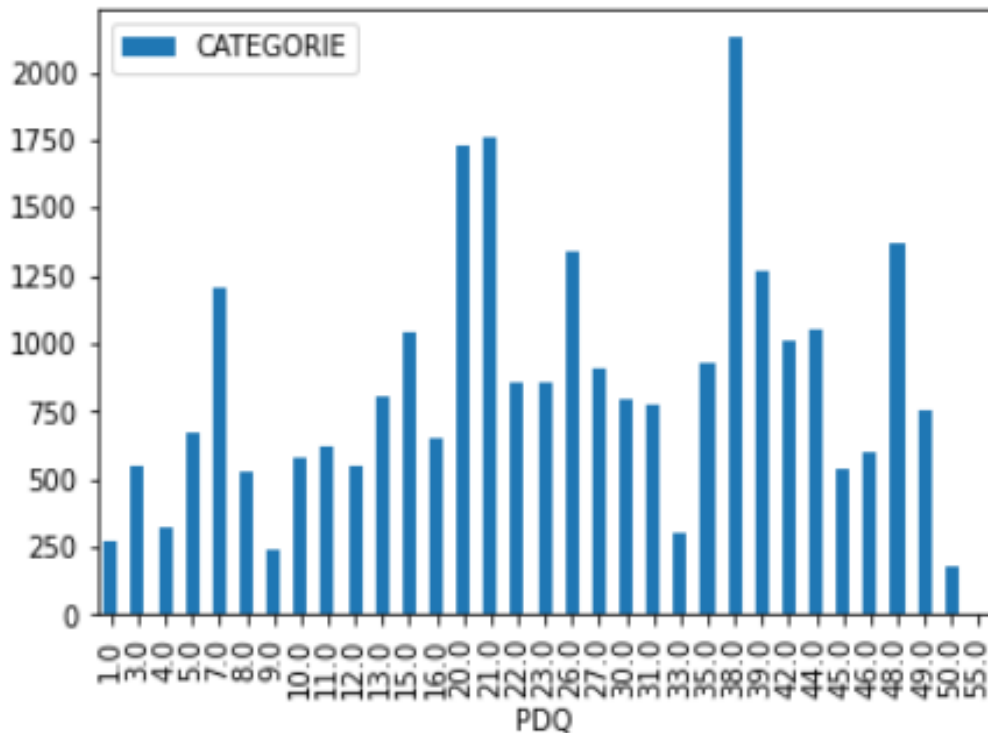
Cluster 5:

DATE	Cluster Label	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	
29	2019	4	Candy Store	Bar	Diner	Yoga Studio	Cupcake Shop	Dive Bar	Discount Store	Dessert Shop	Department Store	Deli / Bodega

Cluster 6:

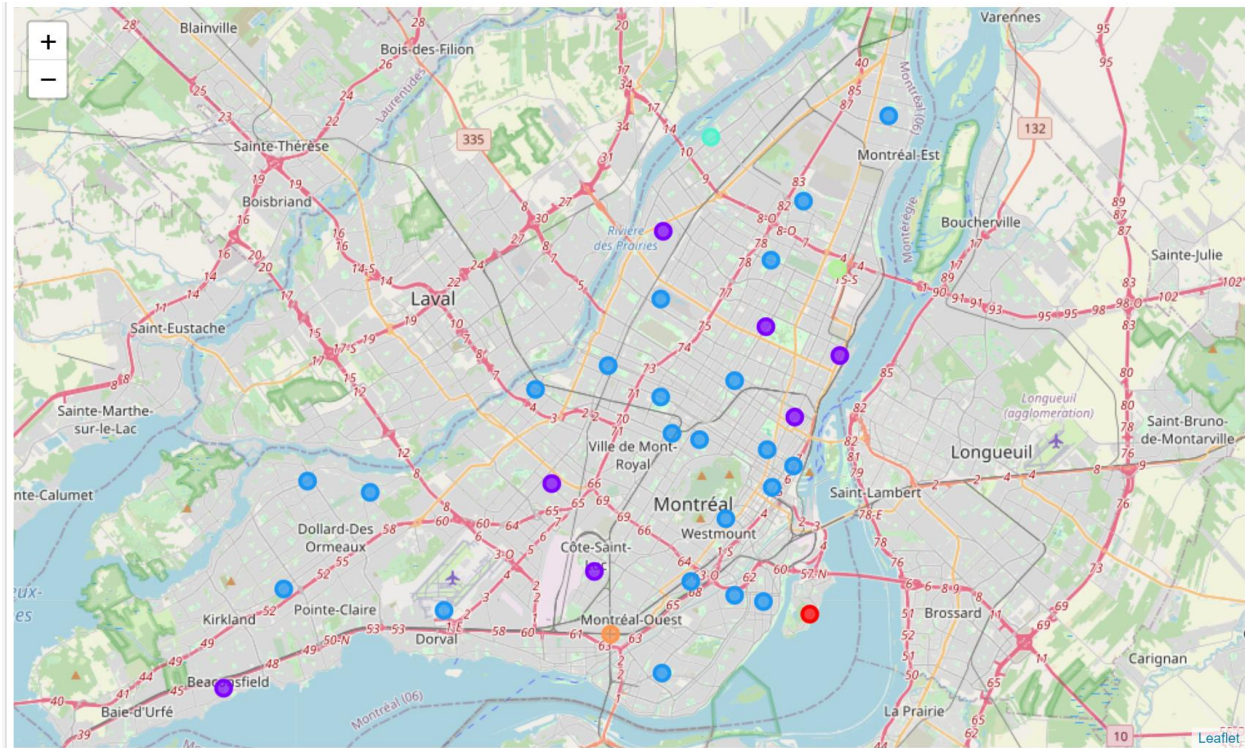
DATE	Cluster Label	1st Most Common Venue	2nd Most Common Venue	3rd Most Common Venue	4th Most Common Venue	5th Most Common Venue	6th Most Common Venue	7th Most Common Venue	8th Most Common Venue	9th Most Common Venue	10th Most Common Venue	
5	2019	5	Electronics Store	Shipping Store	Antique Shop	Skating Rink	Yoga Studio	Cupcake Shop	Discount Store	Diner	Dessert Shop	Department Store

Following that, we can now evaluate the number of crimes per each neighbourhood as reported by various PDQs. As we can see below, the neighbourhoods close to Montreal Police Department Quarters (PDQs) 20, 21 and 38 reported a much higher number of crimes than the other parts of the city in 2019. These PDQs coordinate with the PDQs with higher venue density. It would make sense, with higher venue and population density, the crime rate would also likely to be higher. Therefore, when choosing accommodations, the audience should pay close attention to these neighbourhoods and achieve a balance between a desired lively social scene and a safe living environment:

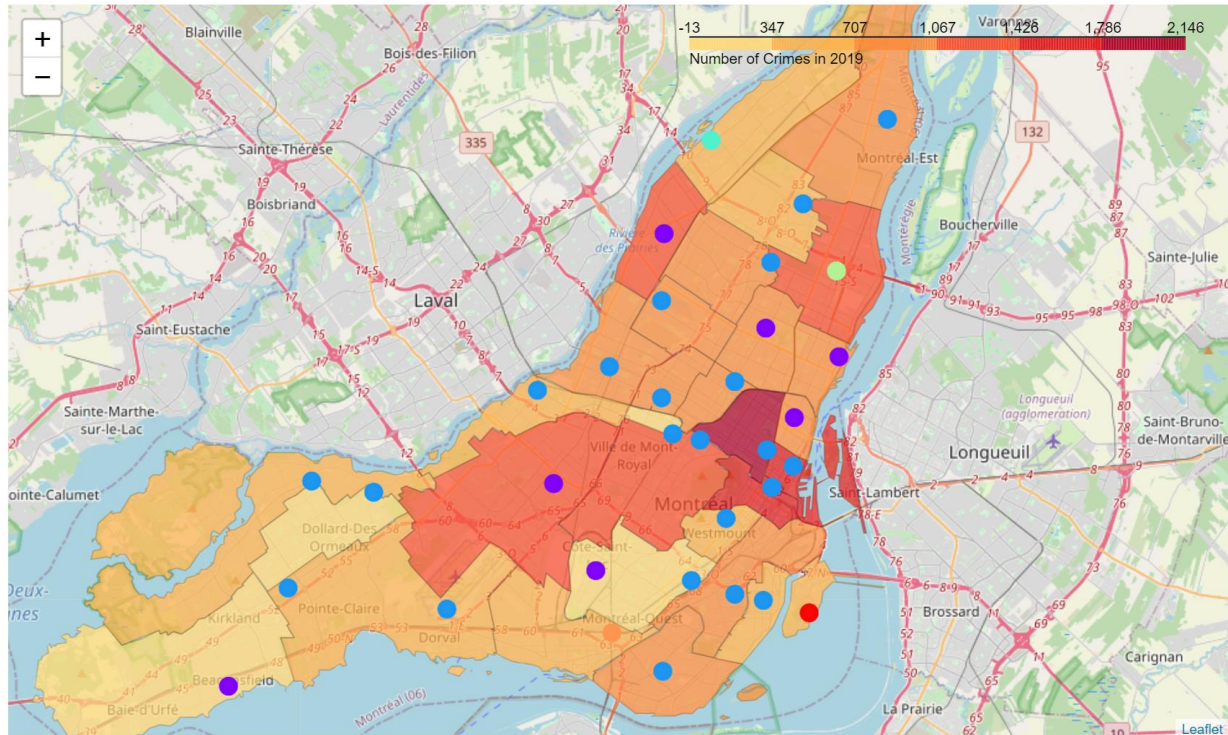


C. Results

With all data cleaned, explored and analyzed, we can now create a clustered neighbourhood map for the city of Montreal. Please see below:



As one of the goals for this analysis is to demonstrate the Crime Rates in Montreal so we can easily identify the safe vs. dangerous neighbourhoods, I created the choropleth map below that shows the number of crimes committed in 2019. At last, the neighbourhood clusters were layered upon the Crime Rate Choropleth map, which shows the social scenes of various neighborhoods and their reported crimes.



D. Discussion

Montreal is an important Canadian city with various population and venue density across the city. Each neighbourhood has its own charms in terms of social scenes and natural environment. Although largely being a very safe place, different part of the city demonstrates variable levels of reported crimes. With such complexity, several methodologies can be used in evaluating and clustering the neighbourhoods. It is important to note that different approaches can often lead to somewhat different yet still reasonable results.

The K-means algorithm approach is used here to analyze the clusters, with k value set to 6. Given the PDQ coordinates provided by the City of Montreal, 32 district coordinates were used. The analysis, just like any other products, has room for continuous improvement if further data and details can be provided including more detailed streets information, demographic data, unemployment rate and so on.

A large part of this analysis includes data exploration. This report and notebook are stored on GitHub, so it can be easily shared with others and consistently updated with new information.

In the end, the Choropleth map was created which provided us with a high level view on the safety of the city's environment, along with the clustered neighbourhoods with different social dynamics.

E. Conclusion

This analysis can be used by international students to analyze the Montreal neighbourhoods, and to help them find ideal accommodations that suit their needs. It can also be shared with any newcomers, such as new immigrants and tourists for a better understanding of the city of Montreal. Lastly, it may also provide value to the city officials, such as Justice and City Planning departments, for better city planning in the future.

F. References

- [1] Montreal: <https://en.wikipedia.org/wiki/Montreal>
- [2] Neighborhood police stations on the island of Montreal Data: <https://donnees.montreal.ca/ville-de-montreal/carte-postes-quartier>
- [3] Montreal Crimes Data: <https://donnees.montreal.ca/ville-de-montreal/actes-criminels>
- [4] Foursquare API