Segmenting and Exploring specific areas of the city of Vancouver

Final Capstone Project - The Battle of Neighborhoods

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1 Introduction

The city of Vancouver is part of the province of British Columbia and has the highest population density in Canada, with more than 5,400 people per square kilometer. It is one of the cities with the greatest ethnic and linguistic diversity in Canada, with 52% of the population speaking a first language other than English. With its panoramic views, mild climate and friendly people, Vancouver was one of the venues for famous international events such as the 2010 Winter Olympics and the 2010 Winter Paralympic Games.

2 Business Understanding

According to the official page of the city of Vancouver, the city consists of a number of smaller neighborhoods and communities, where these neighborhoods being divided into 22 distinct areas. We will focus only on these 22 neighborhoods.

Our client is interested in exploring the neighborhood with more different places and from there, exploring the best hotels and restaurants with the best reviews during their stay in Vancouver. We will also find Italian restaurant options in the region, in case he is interested.

Therefore, our main objective is to explore the neighborhoods of the city of Vancouver trying to find the most diverse and from there to explore the best places to visit. To do this, we will initially use the k-means clustering algorithm to segment neighborhoods according to the most common places, using the resources of the Foursquare API, to collect information from the various places located in Vancouver. We will use the map feature (folium) to better visualize the results.

3 Data Understanding / Preparation

First of all, let's manually get the coordinates of the 22 neighborhoods in the city of Vancouver since I couldn't find this information already in a table. For this, I collected the latitude and longitude of the 22 neighborhoods (Wikipedia) and consolidated it into a table, which we can obtain as shown below:

Table 1: Description of the 22 neighborhoods in the city of Vancouver.

Neighborhood	Latitude	Longitude
Arbutus Ridge	49.25710	-123.1662
Downtown	49.28417	-123.1211
Dunbar-Southlands	49.25000	-123.1850
Fairview	49.26400	-123.1300
Grandview-Woodland	49.27500	-123.0670
Hastings-Sunrise	49.28113	-123.0441
Kensington-Cedar Cottage	49.25000	-123.0667
Kerrisdale	49.21667	-123.1500
Killarney	49.22300	-123.0390
Kitsilano	49.26667	-123.1667
Marpole	49.21553	-123.1140
Mount Pleasant	49.26000	-123.1080
Oakridge	49.22500	-123.1167
Renfrew-Collingwood	49.24250	-123.0466
Riley Park	49.23940	-123.1035
Shaughnessy	49.24500	-123.1330
South Cambie	49.24600	-123.1220
Strathcona	49.27917	-123.0875
Sunset	49.22400	-123.0890
Victoria-Fraserview	49.21800	-123.0660
West End	49.28500	-123.1340
West Point Grey	49.26458	-123.1997

Now we're going to put all of these neighborhoods on a centralized map of Vancouver. We will use the Folium library to overlay the neighborhoods of Vancouver as points above the map. The result is in Figure 1.

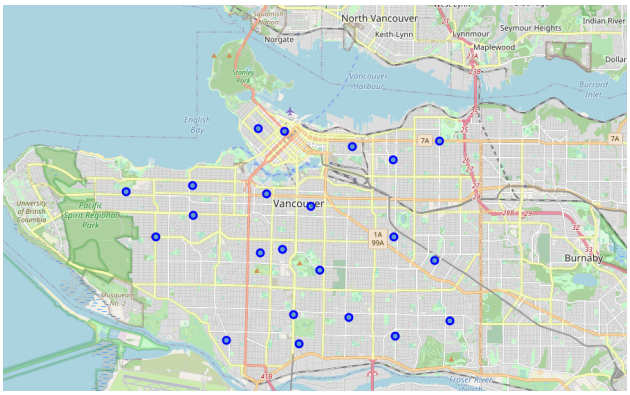

Figure 1: Neighborhoods of Vancouver

Now what we need is to collect information from each neighborhood to be able to understand and segment them into groups. We will use the Foursquare API tool and you need to have your credentials (CLIENT_ID and CLIENT_SECRET) to be able to make your calls. As I am using a free version, limits are imposed on the data collection. You can choose to register your credit card (as I did) in order to have better access to data.

After collect the most common places in each Vancouver neighborhood (limited within a radius of 600 meters) we can see the result dataframe in next table (first 12 rows):

Table 2: Common Places in Vancouver neighborhood classify by category

Neighborhood	Neighborhood Latitude	Neighborhood Longitude	Venue	Venue Latitude	Venue Longitude	Venue Category
Arbutus Ridge	49.25710	-123.1662	Sweet Obsession Cakes & Pastries	49.25776	-123.1653	Dessert Shop
Arbutus Ridge	49.25710	-123.1662	Yuwa Japanese Cuisine	49.25794	-123.1679	Japanese Restaurant
Arbutus Ridge	49.25710	-123.1662	Starbucks	49.25792	-123.1682	Coffee Shop
Arbutus Ridge	49.25710	-123.1662	Carnarvon Park	49.25768	-123.1715	Baseball Field
Arbutus Ridge	49.25710	-123.1662	Subway	49.25805	-123.1686	Sandwich Place
Arbutus Ridge	49.25710	-123.1662	Choices Markets	49.25784	-123.1658	Grocery Store
Arbutus Ridge	49.25710	-123.1662	La Glace	49.25797	-123.1679	Ice Cream Shop
Arbutus Ridge	49.25710	-123.1662	Yuwa Japanese Cuisine	49.25789	-123.1679	Japanese Restaurant
Arbutus Ridge	49.25710	-123.1662	WAX Hair Removal Bar	49.25780	-123.1687	Spa
Arbutus Ridge	49.25710	-123.1662	Bon Macaron	49.25795	-123.1694	Dessert Shop
Downtown	49.28417	-123.1211	Rosewood Hotel Georgia	49.28343	-123.1189	Hotel
Downtown	49.28417	-123.1211	Hyatt Regency Vancouver	49.28493	-123.1204	Hotel

Let's find out how many unique categories can be curated from all the returned venues.In Table 3 it seems that the Downtown neighborhood has the most distinct places, followed by West End and Kitsliano.

Table 3: Unique categories venues for each Neighborhood, Vancouver,BC.

Neighborhood	Unique Categories Venues
Downtown	60
West End	43
Kitsilano	43
Grandview-Woodland	39
Mount Pleasant	34
Hastings-Sunrise	30
Fairview	26
Sunset	22
Dunbar-Southlands	17
Renfrew-Collingwood	16
Riley Park	16
Killarney	15
Strathcona	15
South Cambie	13
Kensington-Cedar Cottage	13
Marpole	12
West Point Grey	7
Oakridge	7
Victoria-Fraserview	6
Arbutus Ridge	6
Shaughnessy	5
Kerrisdale	3

Let's see (table 4) what places and quantities our search returned to the Downtown neighborhood (the top 30 places).

Table 4: Unique categories venues for each venues, Downtown, Vancouver.

Venue Categorie	Qt.
Hotel	9
Clothing Store	5
Dessert Shop	4
Cafe	4
Food Truck	4
Cosmetics Shop	3
Coffee Shop	3
Restaurant	3
Steakhouse	3
Concert Hall	3
Gym	2
Japanese Restaurant	2
Toy / Game Store	2
Seafood Restaurant	2
Burger Joint	2
Sandwich Place	2
French Restaurant	2
Italian Restaurant	2
Donut Shop	2
Bakery	1
Lebanese Restaurant	1
Miscellaneous Shop	1
Yoga Studio	1
Jewelry Store	1
Breakfast Spot	1
Optical Shop	1
Art Gallery	1
Hawaiian Restaurant	1
Movie Theater	1
Hot Dog Joint	1

4 Exploratory Data Analysis

4.1 First part: cluster Vancouver neighborhoods

Before specifically exploring the Downtown neighborhood, let's try to cluster Vancouver neighborhoods based each category present in each neighborhood. First we hot encoded each categories related to each neighborhood and grouped that by mean. We can see in the first lines in Figure 2.

	Neighborhood	American Restaurant	Amphitheater	Art Gallery	Arts & Crafts Store	Asian Restaurant	Athletics & Sports	BBQ Joint	Bagel Shop	Bakery	Bank	Bar	Baseball Field	Baseball Stadium	Bee Garde
0	Arbutus Ridge	0.00	0.0	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.000000	0.000000	0.0	0.166667	0.0	0.
1	Downtown	0.01	0.0	0.01	0.010000	0.000000	0.000000	0.000000	0.0	0.010000	0.000000	0.0	0.000000	0.0	0.
2	Dunbar-Southlands	0.00	0.0	0.00	0.000000	0.000000	0.000000	0.000000	0.0	0.055556	0.111111	0.0	0.000000	0.0	0.
3	Fairview	0.00	0.0	0.00	0.028571	0.057143	0.000000	0.028571	0.0	0.000000	0.028571	0.0	0.000000	0.0	0.
4	Grandview-Woodland	0.00	0.0	0.00	0.000000	0.016949	0.016949	0.016949	0.0	0.033898	0.000000	0.0	0.000000	0.0	0.

Figure 2: First lines of hot encoded categories

We will determine the ideal cluster number based on the visual method called KElbowVisualizer that implements the "elbow" method by selecting the ideal number of clusters by adjusting the K-Means model within a range of values for K. In the part where in our line graph if it looks like an arm, the "elbow" (the inflection point on the curve) is a good indication of an ideal cluster number (Figure 3).

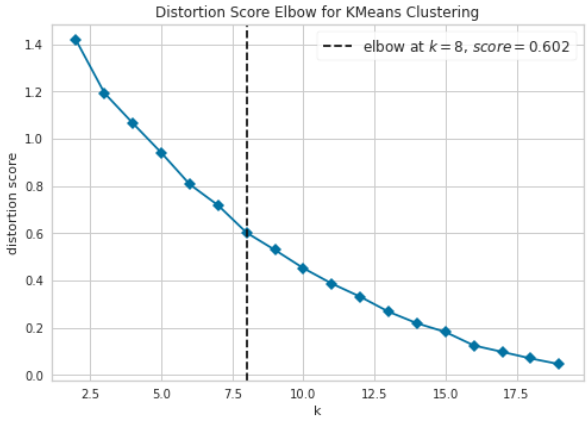

Figure 3: Distortion Score Elbow for kmeans Clustering

Let set our cluster number to 8 and create a new dataframe that includes the cluster as well as the top 10 venues for each neighborhood(Figure 4).

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
Arbutus Ridge	49.257100	-123.166200	3	Dessert Shop	Baseball Field	Japanese Restaurant	Coffee Shop	Sandwich Place	Grocery Store	Food	Flower Shop	Fish & Chips Shop	Field
Downtown	49.284167	-123.121111	1	Hotel	Clothing Store	Café	Food Truck	Dessert Shop	Steakhouse	Restaurant	Concert Hall	Coffee Shop	Cosmetics Shop
Dunbar-Southlands	49.250000	-123.185000	0	Bank	Diner	Grocery Store	Café	Chinese Restaurant	Sandwich Place	Mexican Restaurant	Restaurant	Coffee Shop	Sushi Restaurant
Fairview	49.264000	-123.130000	1	Coffee Shop	Park	Pharmacy	Japanese Restaurant	Asian Restaurant	Pet Store	Falafel Restaurant	Malay Restaurant	Camera Store	Restaurant
Grandview-Woodland	49.275000	-123.067000	1	Coffee Shop	Pizza Place	Italian Restaurant	Park	Indian Restaurant	Café	Bakery	Theater	Japanese Restaurant	Vegetarian / Vegan Restaurant

Figure 4: Top 10 venues for each neighborhood with respectives clusters (first five lines).

Finally, let's put this information on the map, specifying each cluster with a different color (Figure 5).

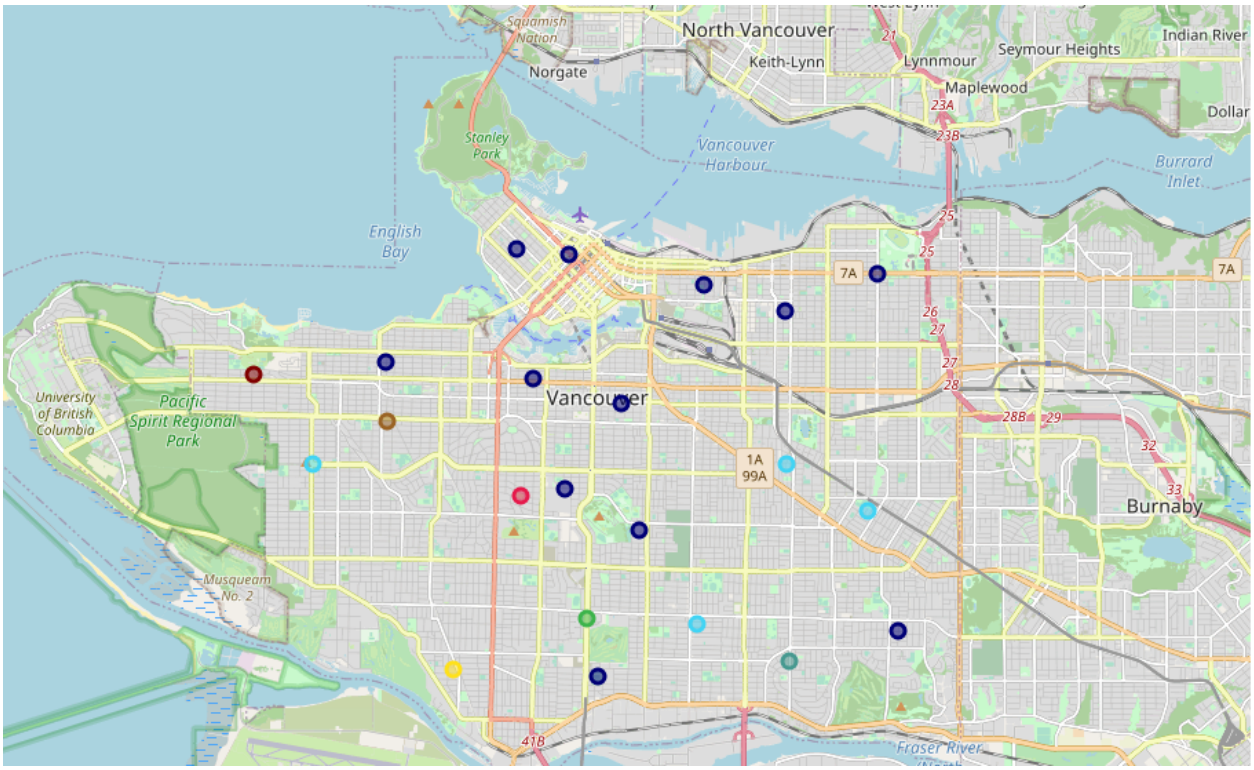

Figure 5: Map of neighboord of Vancouver classify by cluster (k = 8)

Let's explore the cluster where the Downtown neighborhood is located (cluster 1) and we can see that our model added in that cluster the neighborhoods with the most diversity of locations.(Figure 6)

	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	Downtown	Hotel	Clothing Store	Café	Food Truck	Dessert Shop	Steakhouse	Restaurant	Concert Hall	Coffee Shop	Cosmetics Shop
3	Fairview	Coffee Shop	Park	Pharmacy	Japanese Restaurant	Asian Restaurant	Pet Store	Falafel Restaurant	Malay Restaurant	Camera Store	Restaurant
4	Grandview-Woodland	Coffee Shop	Pizza Place	Italian Restaurant	Park	Indian Restaurant	Café	Bakery	Theater	Japanese Restaurant	Vegetarian / Vegan Restaurant
5	Hastings-Sunrise	Theme Park Ride / Attraction	Burger Joint	Vietnamese Restaurant	Beer Garden	Coffee Shop	Theater	Theme Park	Event Space	Park	Fair
8	Killarney	Pharmacy	Grocery Store	Fast Food Restaurant	Sandwich Place	Salon / Barbershop	Liquor Store	Gas Station	Chinese Restaurant	Sushi Restaurant	Farmers Market
9	Kitsilano	Coffee Shop	Café	Park	Yoga Studio	Indian Restaurant	Vegetarian / Vegan Restaurant	Pub	Donut Shop	Bus Stop	Chinese Restaurant
10	Marpole	Pharmacy	Bank	Park	Public Art	Residential Building (Apartment / Condo)	Fast Food Restaurant	Field	Bubble Tea Shop	Liquor Store	American Restaurant
11	Mount Pleasant	Coffee Shop	Chinese Restaurant	Indian Restaurant	Café	Taco Place	Sandwich Place	Brewery	Japanese Restaurant	Park	Pizza Place
14	Riley Park	Vietnamese Restaurant	Farmers Market	Ice Cream Shop	Gym	Playground	Chinese Restaurant	Cantonese Restaurant	Café	Skating Rink	Bus Stop
16	South Cambie	Coffee Shop	Bus Stop	Park	Light Rail Station	Gift Shop	Shopping Mall	Bank	Grocery Store	Furniture / Home Store	Bubble Tea Shop
17	Strathcona	Park	Sandwich Place	Brewery	Coffee Shop	Grocery Store	Café	Cheese Shop	Bus Station	Chinese Restaurant	Restaurant
20	West End	Coffee Shop	Sushi Restaurant	Ramen Restaurant	Bakery	Greek Restaurant	Vietnamese Restaurant	Dessert Shop	Japanese Restaurant	Grocery Store	Sandwich Place

Figure 6: Neighborhood classifieds in cluster 1

4.2 Second part: Trends venues in Downtown Vancouver

As a second part of our study, we will explore the Downtown neighborhood. We will collect information related to the evaluations of each place in the space of 600 meters in radius according to our latest results. When collecting this information using Foursquare Api, it is only possible to obtain this information more quickly if you register your credit card. As I only made a premium call, I subsequently stored the results in a csv file, so as not to exceed my daily call limits and end up being charged to the credit card. Stay alert.

First, let's put in a dataframe the information of 100 venues in range of 650 meters in Downtown neighborhood. The first lines of dataframe is show in Figure 7.

	id	name	categories	lat	lng	distance	postalCode	cc	city	state	country
0	4d5ec8ce29ef236ae0cb9059	Rosewood Hotel Georgia	Hotel	49.283429	-123.118911	179	V6C 1P7	CA	Vancouver	BC	Canada
1	4aa7b152f964a520fa4c20e3	Hyatt Regency Vancouver	Hotel	49.284934	-123.120407	99	V6C 2R7	CA	Vancouver	BC	Canada
2	4d2cce46ae3a8cfa4067bf70	Hawksworth Restaurant	Lounge	49.283362	-123.119462	149	V6P 1C7	CA	Vancouver	BC	Canada
3	507f01b790e746e865f024c3	Victoria's Secret	Lingerie Store	49.283372	-123.122491	133	V6Z 1X5	CA	Vancouver	BC	Canada
4	4adbc696f964a5208f2a21e3	Rocky Mountain Chocolate Factory	Dessert Shop	49.283626	-123.123306	170	V6E 1A9	CA	Vancouver	BC	Canada

Figure 7: Venues in range of 650 meters in Downtown neighborhood.

Now for each place, we will collect information related to the variables "rating", "tips.count", "likes.count". The description of these variations can be seen below:

- rating: Numerical rating of the venue (0 through 10).
- tips.count : Contains the number of tips on the respective venue.
- likes.count: The count of users who have liked this venue.

we will collect the result of our api call from which we collect the characteristics of each place and join with our previous table. The result can be seen below (the first lines) (Figure 8).

	id	name	lat	lng	categories	rating	tips.count	likes.count
0	4d5ec8ce29ef236ae0cb9059	Rosewood Hotel Georgia	49.283429	-123.118911	Hotel	9.3	29	109
1	4aa7b152f964a520fa4c20e3	Hyatt Regency Vancouver	49.284934	-123.120407	Hotel	9.1	33	197
2	4d2cce46ae3a8cfa4067bf70	Hawksworth Restaurant	49.283362	-123.119462	Lounge	9.1	66	203
3	507f01b790e746e865f024c3	Victoria's Secret	49.283372	-123.122491	Lingerie Store	8.9	22	135
4	4adbc696f964a5208f2a21e3	Rocky Mountain Chocolate Factory	49.283626	-123.123306	Dessert Shop	8.9	17	45

Figure 8: Characteristics of each place with ratings, tips counts and likes count.

we are going to rearrange the data so that each category (row line) is one hot encoded and group them according to the id. This procedure is necessary to perform the necessary steps for our Kmeans cluster model.After that made this procedure, we merge the one hot encoded categories with “ratings”, “tips.count” and “likes.count”.The resulted dataframe is show in Figure 9 (first lines).

	id	name	American Restaurant	Art Gallery	Arts & Crafts Store	Bakery	Bookstore	Breakfast Spot	Building	Burger Joint	Café	Clothing Store	Coffee Shop	Concert Hall	...	rating	tips.count	likes.count
0	4aa17172f964a520904020e3	JOEY Burrard	0	0	0	0	0	0	0	0	0	0	0	0		8.2	69	181
1	4aa6f2c7f964a5209b4b20e3	Vancouver Art Gallery	0	1	0	0	0	0	0	0	0	0	0	0		8.7	92	432
2	4aa73016f964a520324c20e3	Scotiabank Theatres	0	0	0	0	0	0	0	0	0	0	0	0		8.3	102	672
3	4aa733fbf964a520444c20e3	Commodore Ballroom	0	0	0	0	0	0	0	0	0	0	0	1		8.8	33	259
4	4aa73bb9f964a5206b4c20e3	SEPHORA	0	0	0	0	0	0	0	0	0	0	0	0		8.8	11	57

Figure 9: Merged dataframe with One hot encoded categories.

The cluster number that we will use in our model is shown below, after visually looking through the KElbowVisualizer graph (Figure 10).

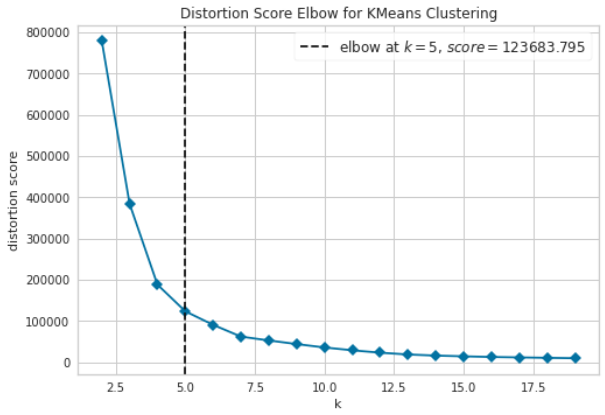

Figure 10: Distortion Score Elbow for kmeans Clustering.

Our choice was k = 5, and now we can proceed with Kmeans cluster modeling and Re-inserting in our database to which each cluster belongs to each respective id.(Figure 11)

	id	name	lat	lng	categories	rating	tips.count	likes.count	Cluster Labels
0	4d5ec8ce29ef236ae0cb9059	Rosewood Hotel Georgia	49.283429	-123.118911	Hotel	9.3	29	109	4
1	4aa7b152f964a520fa4c20e3	Hyatt Regency Vancouver	49.284934	-123.120407	Hotel	9.1	33	197	1
2	4d2cce46ae3a8cfa4067bf70	Hawksworth Restaurant	49.283362	-123.119462	Lounge	9.1	66	203	3
3	507f01b790e746e865f024c3	Victoria's Secret	49.283372	-123.122491	Lingerie Store	8.9	22	135	4
4	4adbc696f964a5208f2a21e3	Rocky Mountain Chocolate Factory	49.283626	-123.123306	Dessert Shop	8.9	17	45	0

Figure 11: Merged Data with respective Clusters (first rows).

We will now see on the map, how each cluster aggregates the places along the Downtown neighborhood.

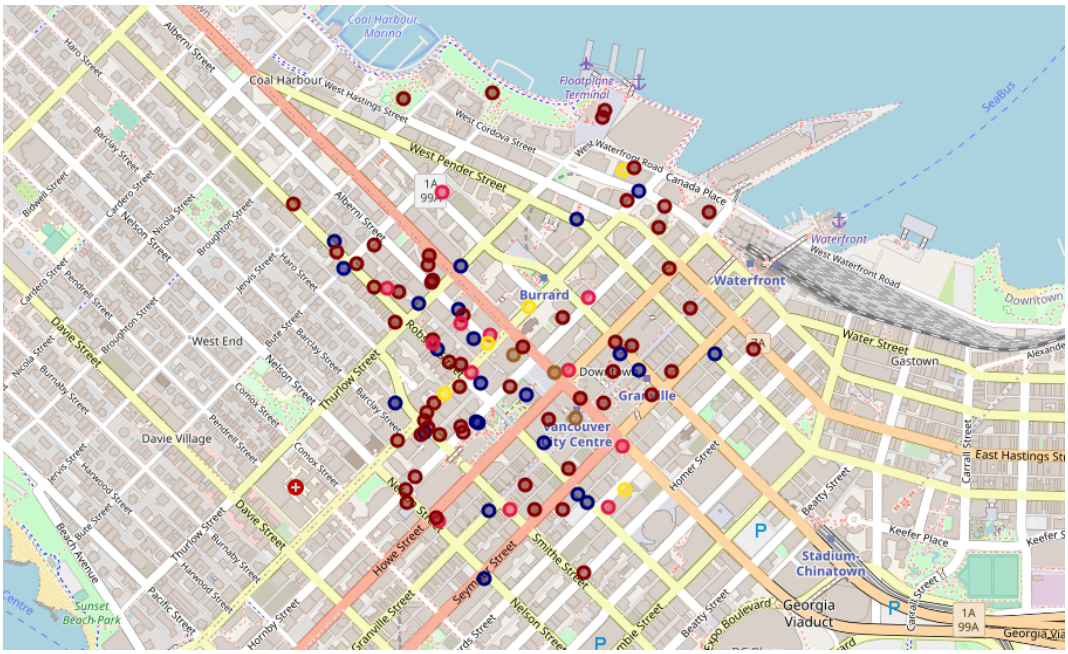

Figure 12: Map of venues of Downtown neighboord classify by cluster (k = 5).

Here (Figure 13) we can see the graph with the distribution of the clusters.

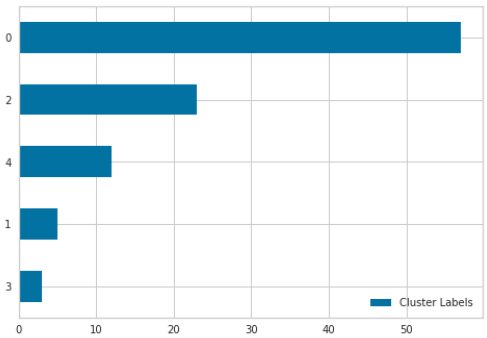

Figure 13: Distribution of Clusters.

We may also want to check which places belong to each cluster. For example, for cluster 1 the following places have been added:(Figure 14)

	name	categories	rating	tips.count	likes.count	Cluster Labels
1	Hyatt Regency Vancouver	Hotel	9.1	33	197	1
29	JOEY Burrard	New American Restaurant	8.2	69	181	1
51	Salam Bombay	Indian Restaurant	7.8	23	45	1
56	Fairmont Pacific Rim	Hotel	9.4	69	232	1
62	Medina Café	Breakfast Spot	8.8	303	790	1

Figure 14: Aggregated categories within cluster 1.

We can go deeper, and want to find out which Italian restaurants are in the area. For this, a simple filter in our database returns the following table:

	id	name	lat	lng	categories	rating	tips.count	likes.count	Cluster Labels
44	4aa801e0f964a520ab4e20e3	CinCin	49.285402	-123.126035	Italian Restaurant	8.7	31	71	0
49	4aa82e4bf964a520de4f20e3	Pacifico Pizzeria Ristorante	49.282068	-123.124079	Italian Restaurant	8.2	36	72	0

Figure 15: Italian restaurants and their respective clusters.

We note that the two restaurants have a rating above 8 and have been aggregated in the same cluster. How would the map of these restaurants look in relation to other places in the same cluster. This we can check on the following map:

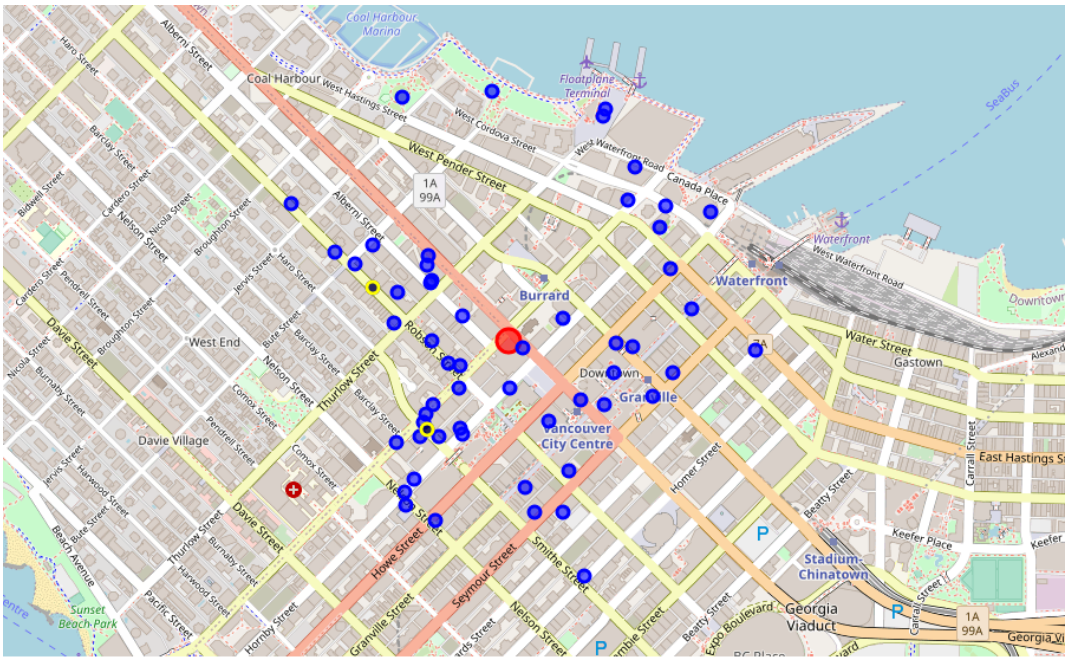

Figure 16: Map of venues (cluster = 0) and italian restaurants(yellow points) of Downtown neighboord. .The red dot is the center point of search.

Going the same way, we are now interested in discovering all the restaurants in the Downtown area with ratings above 8.5 and placing them on a map. We see below:(Figure 17 and Figure 18)

	id	name	lat	lng	categories	rating	tips.count	likes.count	Cluster Labels
12	4ab59f7cf964a520a97520e3	Joe Fortes Seafood & Chop House	49.285017	-123.124410	Seafood Restaurant	8.9	118	385	2
20	4aaec434f964a520346320e3	Le Crocodile Restaurant	49.282658	-123.125287	French Restaurant	9.2	31	63	2
31	5170656ae4b029a050dd8a49	The Keg Steakhouse + Bar - Dunsmuir	49.283438	-123.116363	Restaurant	8.8	33	158	2
44	4aa801e0f964a520ab4e20e3	CinCin	49.285402	-123.126035	Italian Restaurant	8.7	31	71	0
50	4b4be83af964a520fdaa26e3	Shizen Ya	49.280880	-123.124552	Japanese Restaurant	8.6	57	148	0
91	5646ab13498e460c732920e8	Ramen Danbo	49.287406	-123.129028	Ramen Restaurant	9.1	37	134	0
95	4d320c5498336dcb18401ff0	Cactus Club Cafe	49.289468	-123.117671	American Restaurant	8.6	98	466	0
97	51a7a349454a2b1f0e2449f8	Homer St. Cafe and Bar	49.278591	-123.118385	Restaurant	8.6	46	130	0

Figure 17: Distribution of restaurants in Downtown area with ratings above 8.5.

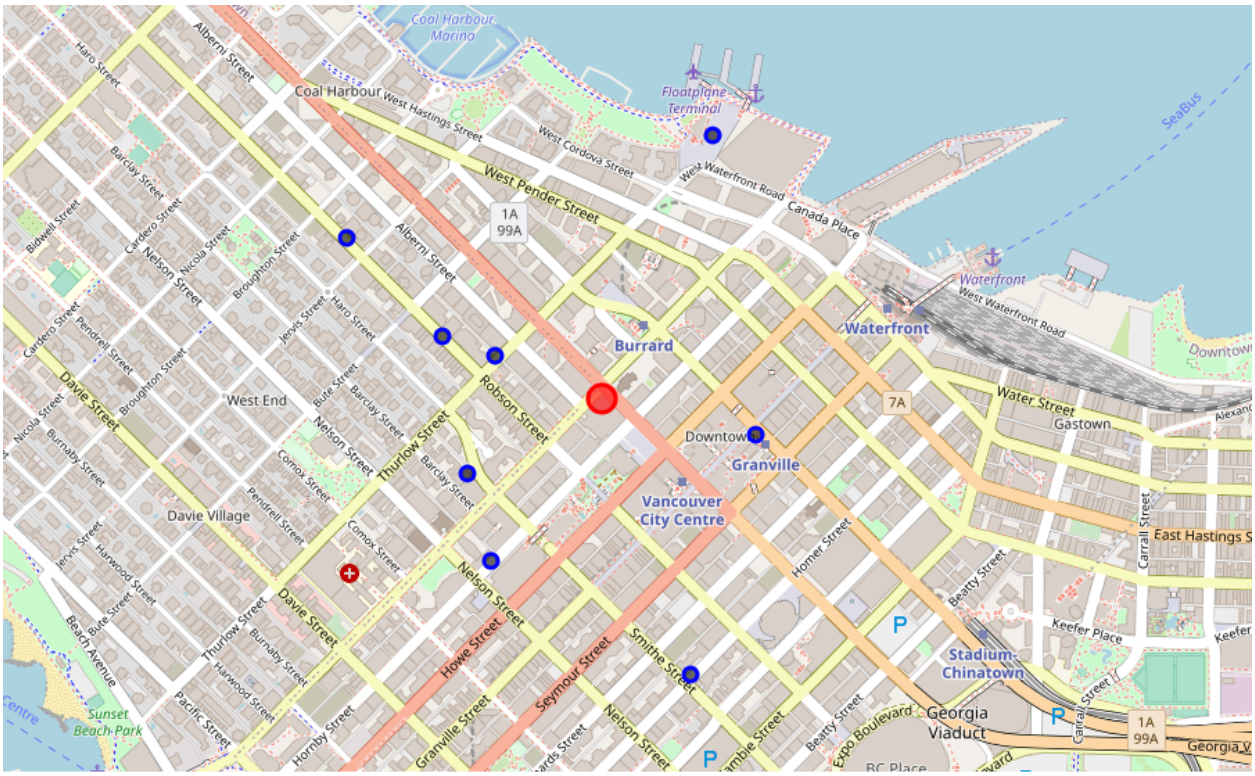

Figure 18: Map of restaurants in Downtown area with ratings above 8.5.The red dot is the center point of search.

and finally, following the same recipe, we will find all hotels with a rating above 8.5 and distribute them on a map.

	id	name	lat	lng	categories	rating	tips.count	likes.count	Cluster Labels
0	4d5ec8ce29ef236ae0cb9059	Rosewood Hotel Georgia	49.283429	-123.118911	Hotel	9.3	29	109	4
1	4aa7b152f964a520fa4c20e3	Hyatt Regency Vancouver	49.284934	-123.120407	Hotel	9.1	33	197	1
7	4ba59d68f964a520bd1639e3	Wedgewood Hotel	49.282163	-123.122237	Hotel	9.0	7	17	2
11	4af0f4e4f964a5204ae021e3	The Fairmont Hotel Vancouver	49.283805	-123.120944	Hotel	8.6	64	198	3
21	4acd3910f964a5207dcb20e3	Shangri-La Hotel	49.285934	-123.124081	Hotel	8.7	28	83	0
42	4b18a7acf964a52002d523e3	Loden Hotel	49.287690	-123.123574	Hotel	9.1	20	54	4
54	4b7235fef964a52010742de3	L'Hermitage	49.280139	-123.117480	Hotel	9.3	16	37	4
56	4bbcbcf88ec3d13ab0261b28	Fairmont Pacific Rim	49.288227	-123.116932	Hotel	9.4	69	232	1

Figure 19: Distribution of hotels in Downtown area with ratings above 8.5.

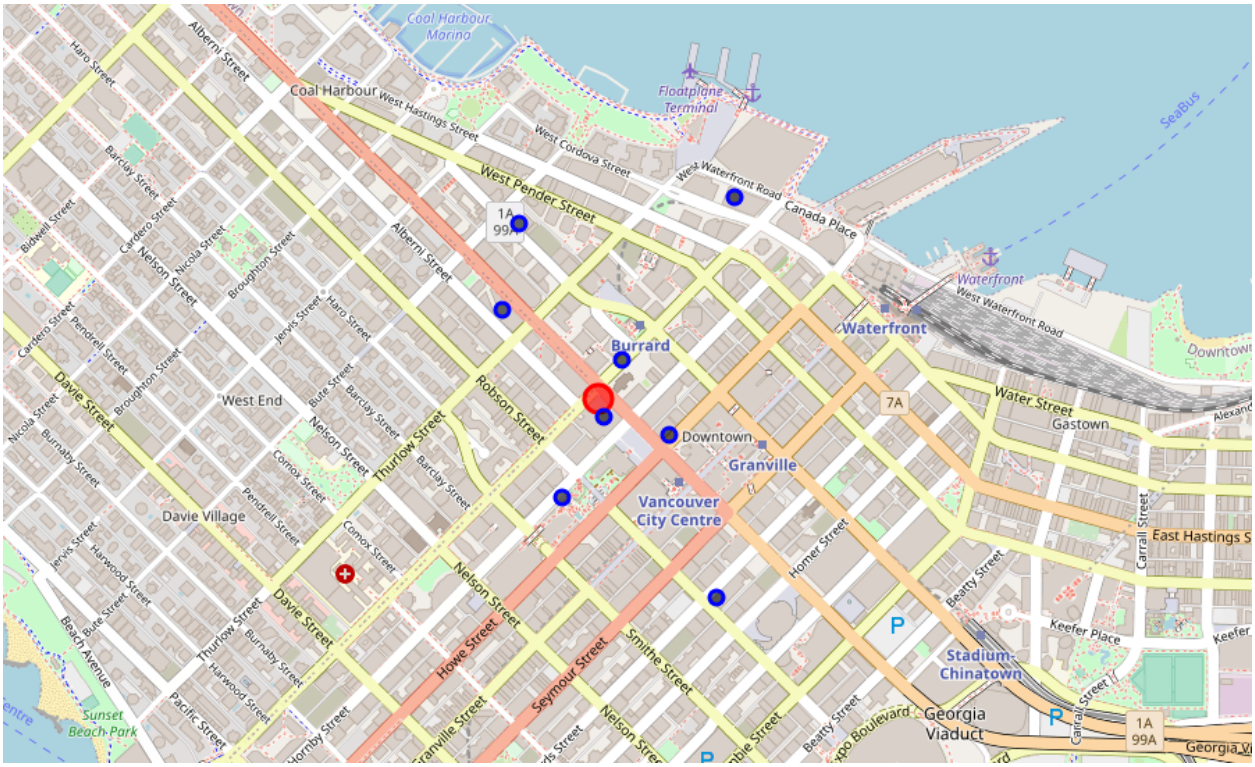

Figure 20: Map of hotels in Downtown area with ratings above 8.5.The red dot is the center point of search.

If we already found these three possibilities, we will put them all on a map, so we can show our customer the location of the best hotels, the best restaurants and the Italian restaurants present in the region.

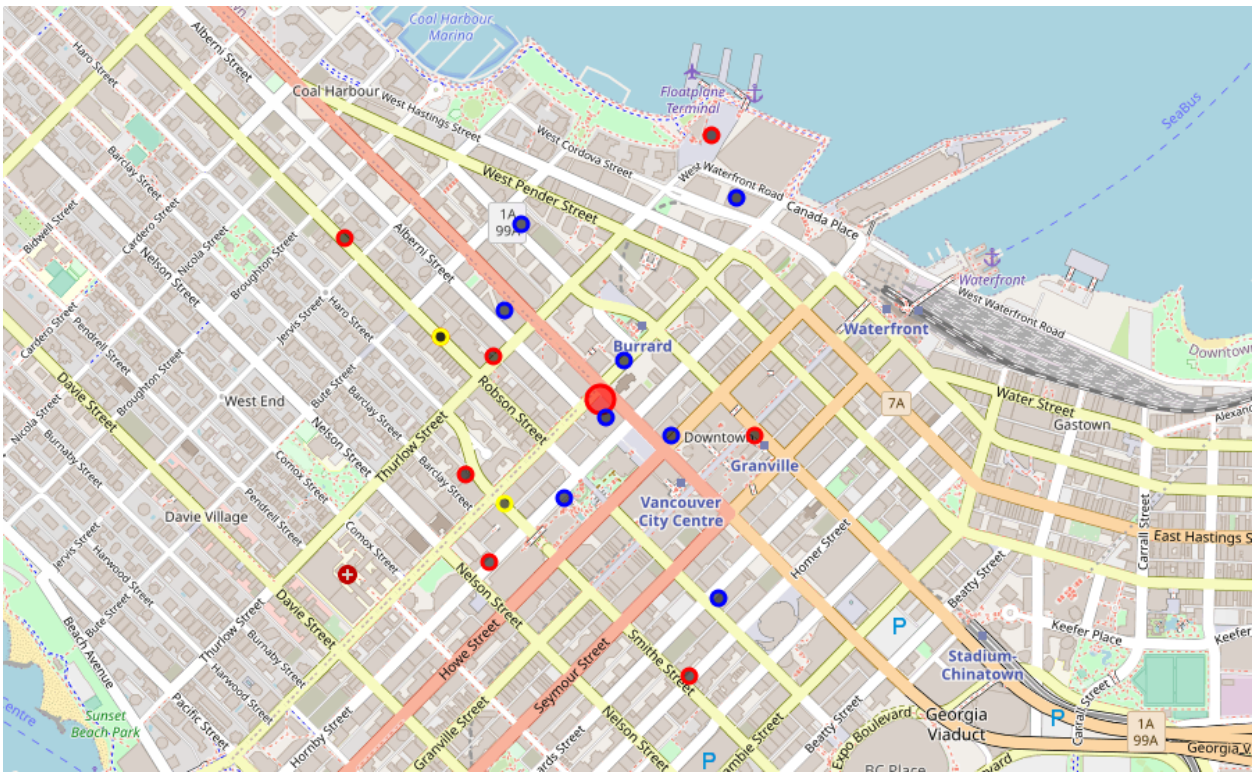

Figure 21: Map of hotels (blue dots),restaurants(little red dots) and italian restaurants (yellow dots), in Downtown area with ratings above 8.5.The big red dot is the center point of search.

5 Conclusion

In conclusion, this study aimed to find the best places to go using the Foursquare API as a tool. We can see how easy it is to find and map your searches to your needs. For example, we can place another neighborhood in Vancouver and easily find the best places from a central point.

One point to clarify is that not all calls in the Foursquare API are free, so be careful not to spend a lot of money when making a call within a for loop, for example.

As future changes in this research, we could use a different type of data cluster model different from Kmeans cluster, such as: density-based clustering algorithms like DBSCAN or HDBSCAN.

6 References

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