Efficient Deployment of Police Forces in Vancouver Neighborhoods
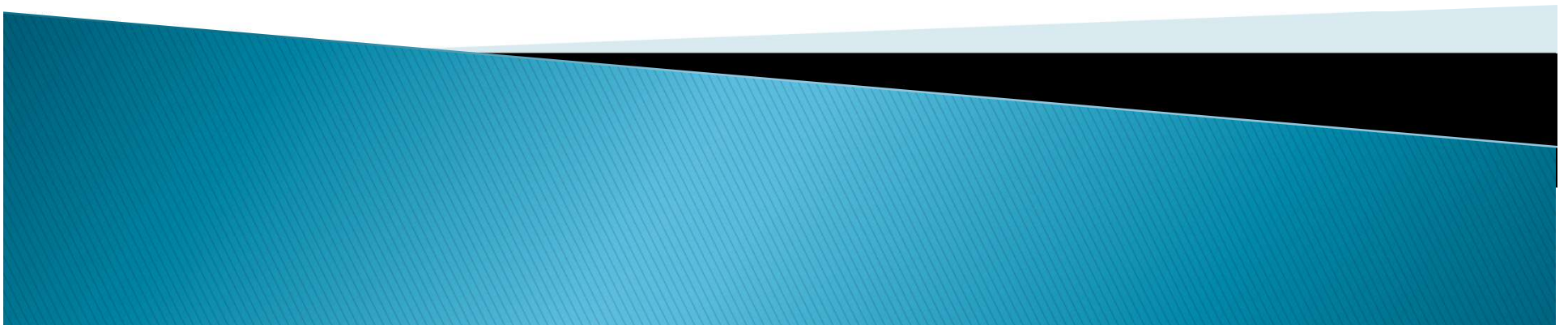
Importance of optimum Police allocation

▸ Helps in faster response

▸ Improves evidence collection and investigation

▸ Helps optimize public costs

▸ Makes neighborhoods safe and secure.

Data Management and Filtering

▸ Data from Kaggle containing crime records from 2003-2019 used for the analsysis. A dataset containing the crime statistics of each neighborhood in Vancouver along with type of crime.

▸ Creating a new consolidated dataset of the Neighborhoods for the year 2019 crime records

▸ Neighborhood coordinates are fetched using OpenCage Geocoder.

▸ To explore the neighborhood crimes and applying Machine Learning algorithms to cluster the neighborhoods and portray the findings on Map using Folium.

Total Crime Count

Central Business District	10618
West End	2864
Mount Pleasant	2219
Strathcona	1928
Fairview	1827
Grandview-Woodland	1613
Renfrew-Collingwood	1503
Kitsilano	1426
Kensington-Cedar Cottage	1363
Hastings-Sunrise	1229
Sunset	893
Riley Park	828
Marpole	771
Victoria-Fraserview	530
Killarney	507
Oakridge	491
Kerrisdale	382
South Cambie	367
Dunbar-Southlands	329
West Point Grey	323
Shaughnessy	266
Arbutus Ridge	263
Stanley Park	167
Musqueam	10

Crimes in Boroughs

Crimes in Borough

```python
vnc_crime_cat = pd.pivot_table(vnc_boroughs_crime,
                               values=['Year'],
                               index=['Borough'],
                               columns=['Type'],
                               aggfunc=len,
                               fill_value=0,
                               margins=True)
vnc_crime_cat
```

Type	Year									All
	Break and Enter Commercial	Break and Enter Residential/Other	Mischief	Other Theft	Theft from Vehicle	Theft of Bicycle	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with Fatality)	Vehicle Collision or Pedestrian Struck (with Injury)	
Borough										
Central	774	192	2003	2473	7041	696	251	1	218	13649
East Side	749	881	1966	1492	4707	712	651	6	412	11576
South Vancouver	38	81	178	82	512	33	64	2	57	1047
West Side	403	800	842	819	2559	541	234	3	244	6445
All	1964	1954	4989	4866	14819	1982	1200	12	931	32717

Crimes in Neighborhood

Crimes in Neighborood

```python
vnc_crime_neigh = pd.pivot_table(vnc_boroughs_crime,
                        values=['Year'],
                        index=['Neighbourhood'],
                        columns=['Type'],
                        aggfunc=len,
                        fill_value=0,
                        margins=True)
vnc_crime_neigh.head()
```

Type	Year									
	Break and Enter Commercial	Break and Enter Residential/Other	Mischief	Other Theft	Theft from Vehicle	Theft of Bicycle	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with Fatality)	Vehicle Collision or Pedestrian Struck (with Injury)	All
Neighbourhood										
Arbutus Ridge	8	58	33	24	92	22	12	0	14	263
Central Business District	557	131	1579	1996	5507	524	158	1	165	10618
Dunbar-Southlands	10	51	47	23	150	22	11	0	15	329
Fairview	169	86	236	281	763	210	43	0	39	1827
Grandview-Woodland	110	131	317	183	608	115	108	1	40	1613

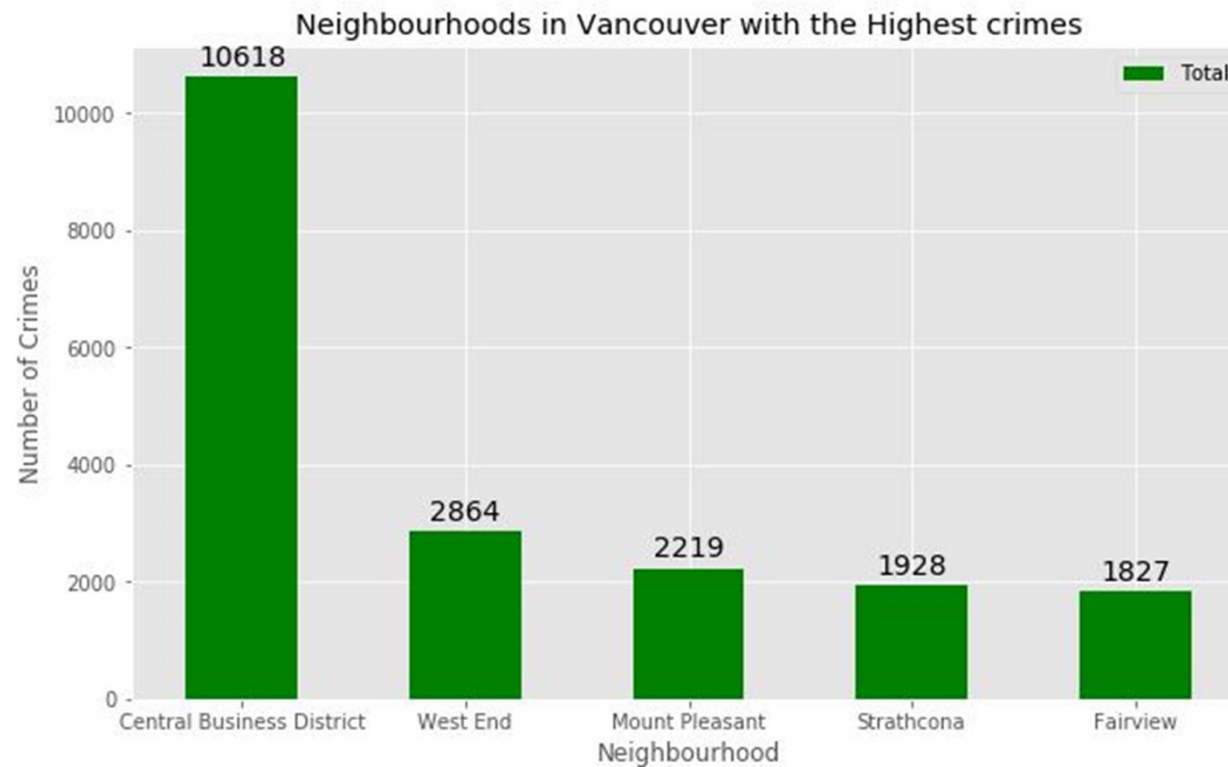# Crime prone Neighborhoods

Top 5 areas with top number of crimes

```
vnc_crime_neigh.sort_values(['Total'], ascending = False, axis = 0, inplace = True )

crime_neigh_top5 = vnc_crime_neigh.iloc[1:6]
crime_neigh_top5
```
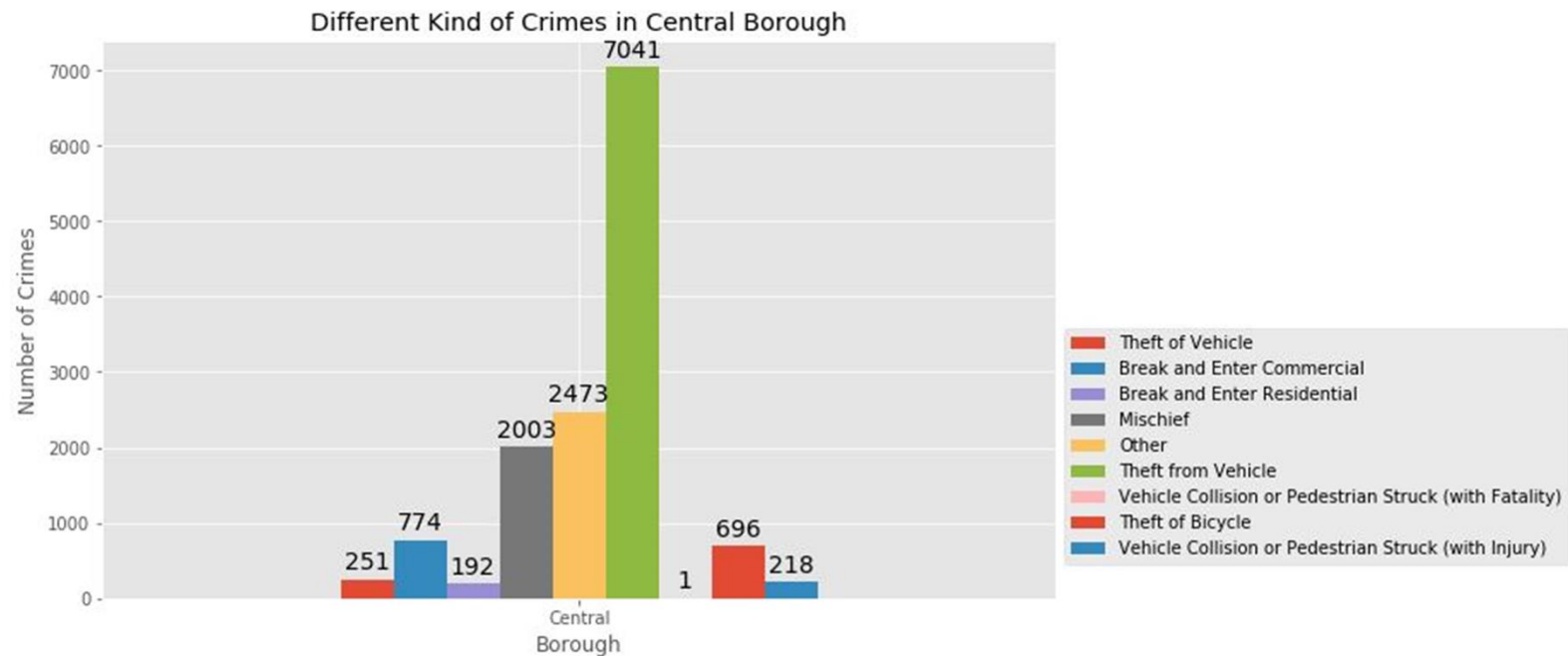
	Neighbourhood	YearBreak and Enter Commercial	YearBreak and Enter Residential/Other	YearMischief	YearOther Theft	YearTheft from Vehicle	YearTheft of Bicycle	YearTheft of Vehicle	YearVehicle Collision or Pedestrian Struck (with Fatality)	YearVehicle Collision or Pedestrian Struck (with Injury)	Total
1	Central Business District	557	131	1579	1996	5507	524	158	1	165	10618
22	West End	208	58	403	472	1428	159	90	0	46	2864
11	Mount Pleasant	200	121	286	467	769	217	103	0	56	2219
19	Strathcona	180	118	464	119	789	106	89	1	62	1928
3	Fairview	169	86	236	281	763	210	43	0	39	1827

Crime prone Neighborhoods– Graph

Neighbourhoods in Vancouver with the Highest crimes

Eg. of crime in a particular Borough

Different Kind of Crimes in Central Borough

Coordinates using OpenGeoCoder

Getting all the coordinates

```
]: Latitude = []
   Longitude = []
   Borough = []
   Neighbourhood = vnc_boroughs_crime['Neighbourhood'].unique()
   key= 'ae389a8e7afb4d64b107f88ed1f049a9'
   # Key has been hidden
   geocoder = OpenCageGeocode(key)

   for i in range(len(Neighbourhood)):
       address = '{}, Vancouver, BC, Canada'.format(Neighbourhood[i])
       location = geocoder.geocode(address)
       Latitude.append(location[0]['geometry']['lat'])
       Longitude.append(location[0]['geometry']['lng'])
       Borough.append('Borough')
   print(Latitude, Longitude)
```

```
[49.2641128, 49.2841308, 49.24966, 49.2705588, 49.2633296, 49.279554, 49.2195929, 49.2476321, 49.3019112, 49.2518626, 49.209223
3, 49.2184156, 49.2346728, 49.2694099, 49.2775935, 49.2474381, 49.2308288, 49.2644843, 49.2409677, 49.2420242, 49.2242738, 49.2
466847, 49.2534601, 49.2346005] [-123.1268352, -123.1317949, -123.11934, -123.0679417, -123.0965885, -123.0899788, -123.090238
6, -123.0842067, -123.1415405, -123.1380226, -123.1361495, -123.0732871, -123.1553893, -123.155267, -123.0439199, -123.1029664,
-123.1311342, -123.1854326, -123.1670008, -123.0576794, -123.0462504, -123.120915, -123.1850439, -123.183397]
```

Coordinates attached to all the areas

	Neighbourhood	Latitude	Longitude
0	Fairview	49.264113	-123.126835
1	West End	49.284131	-123.131795
2	Central Business District	49.249660	-123.119340
3	Grandview-Woodland	49.270559	-123.067942
4	Mount Pleasant	49.263330	-123.096588
5	Strathcona	49.279554	-123.089979
6	Sunset	49.219593	-123.090239
7	Kensington-Cedar Cottage	49.247632	-123.084207
8	Stanley Park	49.301911	-123.141541
9	Shaughnessy	49.251863	-123.138023
10	Marpole	49.209223	-123.136150
11	Victoria-Fraserview	49.218416	-123.073287
12	Kerrisdale	49.234673	-123.155389
13	Kitsilano	49.269410	-123.155267
14	Hastings-Sunrise	49.277594	-123.043920
15	Riley Park	49.247438	-123.102966
16	Oakridge	49.230829	-123.131134
17	West Point Grey	49.264484	-123.185433
18	Arbutus Ridge	49.240968	-123.167001
19	Renfrew-Collingwood	49.242024	-123.057679
20	Killarney	49.224274	-123.046250
21	South Cambie	49.246685	-123.120915
22	Dunbar-Southlands	49.253460	-123.185044
23	Musqueam	49.234600	-123.183397

Main Table

	index	Type	Year	Month	Day	Hour	Neighbourhood	Borough	Latitude	Longitude
0	0	Break and Enter Commercial	2019	3	7	2	Fairview	West Side	49.264113	-123.126835
1	1	Break and Enter Commercial	2019	4	21	16	Fairview	West Side	49.264113	-123.126835
2	2	Break and Enter Commercial	2019	10	26	0	Fairview	West Side	49.264113	-123.126835
3	3	Break and Enter Commercial	2019	3	27	8	Fairview	West Side	49.264113	-123.126835
4	4	Break and Enter Commercial	2019	7	13	1	Fairview	West Side	49.264113	-123.126835
5	5	Break and Enter Commercial	2019	4	18	8	Fairview	West Side	49.264113	-123.126835
6	6	Break and Enter Commercial	2019	4	14	5	Fairview	West Side	49.264113	-123.126835
7	7	Break and Enter Commercial	2019	9	10	20	Fairview	West Side	49.264113	-123.126835
8	8	Break and Enter Commercial	2019	10	10	0	Fairview	West Side	49.264113	-123.126835
9	9	Break and Enter Commercial	2019	1	16	3	Fairview	West Side	49.264113	-123.126835
10	10	Break and Enter Commercial	2019	5	17	8	Fairview	West Side	49.264113	-123.126835
11	11	Break and Enter Commercial	2019	1	19	3	Fairview	West Side	49.264113	-123.126835
12	12	Break and Enter Commercial	2019	7	24	4	Fairview	West Side	49.264113	-123.126835
13	13	Break and Enter Commercial	2019	10	18	4	Fairview	West Side	49.264113	-123.126835
14	14	Break and Enter Commercial	2019	10	12	9	Fairview	West Side	49.264113	-123.126835
15	15	Break and Enter Commercial	2019	4	5	20	Fairview	West Side	49.264113	-123.126835
16	16	Break and Enter Commercial	2019	6	20	10	Fairview	West Side	49.264113	-123.126835
17	17	Break and Enter Commercial	2019	7	31	18	Fairview	West Side	49.264113	-123.126835
18	18	Break and Enter Commercial	2019	5	17	0	Fairview	West Side	49.264113	-123.126835
19	19	Break and Enter Commercial	2019	7	4	19	Fairview	West Side	49.264113	-123.126835
20	20	Break and Enter Commercial	2019	4	3	18	Fairview	West Side	49.264113	-123.126835
21	21	Break and Enter Commercial	2019	9	9	23	Fairview	West Side	49.264113	-123.126835
22	22	Break and Enter Commercial	2019	5	16	8	Fairview	West Side	49.264113	-123.126835
23	23	Break and Enter Commercial	2019	7	8	9	Fairview	West Side	49.264113	-123.126835

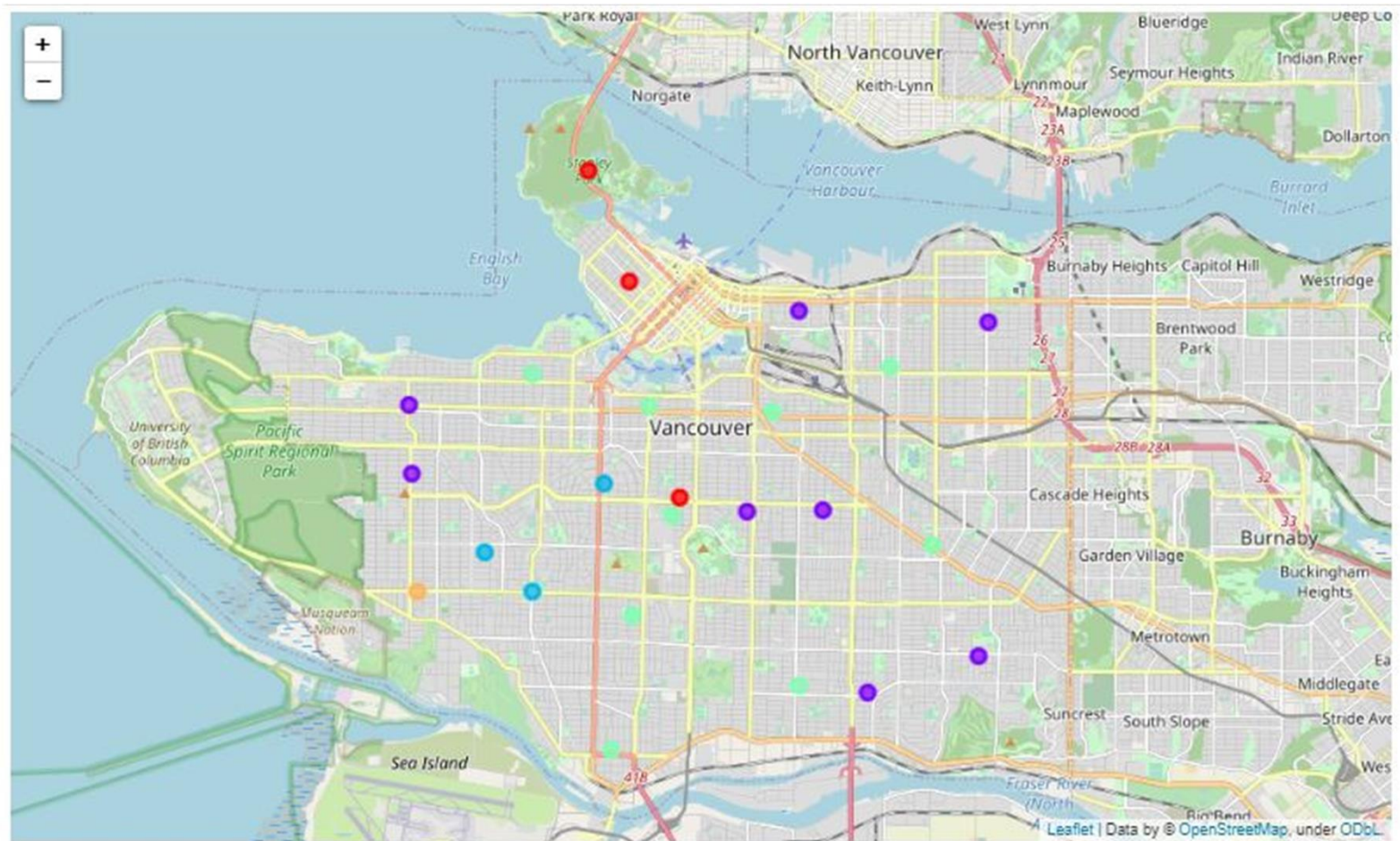| 32706 | 32706 | Vehicle Collision or Pedestrian Struck (with I... | 2019 | 6 | 23 | 14 | Dunbar-Southlands | West Side | 49.253460 | -123.185044 |
32707	32707	Break and Enter Residential/Other	2019	4	28	16	Musqueam	South Vancouver	49.234600	-123.183397
32708	32708	Mischief	2019	9	2	21	Musqueam	South Vancouver	49.234600	-123.183397
32709	32709	Mischief	2019	6	15	2	Musqueam	South Vancouver	49.234600	-123.183397
32710	32710	Mischief	2019	10	19	0	Musqueam	South Vancouver	49.234600	-123.183397
32711	32711	Theft from Vehicle	2019	1	28	18	Musqueam	South Vancouver	49.234600	-123.183397
32712	32712	Theft from Vehicle	2019	4	11	20	Musqueam	South Vancouver	49.234600	-123.183397
32713	32713	Theft from Vehicle	2019	1	1	0	Musqueam	South Vancouver	49.234600	-123.183397
32714	32714	Theft from Vehicle	2019	6	2	1	Musqueam	South Vancouver	49.234600	-123.183397
32715	32715	Theft of Vehicle	2019	6	5	22	Musqueam	South Vancouver	49.234600	-123.183397
32716	32716	Vehicle Collision or Pedestrian Struck (with I...	2019	5	8	19	Musqueam	South Vancouver	49.234600	-123.183397

Most Committed Crimes

	Neighbourhood	No.1 Most Common Crime	No.2 Most Common Crime	No.3 Most Common Crime	No.4 Most Common Crime	No.5 Most Common Crime	No.6 Most Common Crime	No.7 Most Common Crime	No.8 Most Common Crime	No.9 Most Common Crime
0	Arbutus Ridge	Theft from Vehicle	Break and Enter Residential/Other	Mischief	Other Theft	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
1	Central Business District	Theft from Vehicle	Other Theft	Mischief	Break and Enter Commercial	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and Enter Residential/Other	Vehicle Collision or Pedestrian Struck (with F...
2	Dunbar-Southlands	Theft from Vehicle	Break and Enter Residential/Other	Mischief	Other Theft	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
3	Fairview	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	Break and Enter Residential/Other	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Vehicle Collision or Pedestrian Struck (with F...
4	Grandview-Woodland	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Theft of Bicycle	Break and Enter Commercial	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Vehicle Collision or Pedestrian Struck (with F...

Cluster formation

	Neighbourhood	Latitude	Longitude	Cluster Labels	No.1 Most Common Crime	No.2 Most Common Crime	No.3 Most Common Crime	No.4 Most Common Crime	No.5 Most Common Crime	No.6 Most Common Crime	No.7 Mo Common Crin
0	Fairview	49.264113	-123.126835	3	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	Break and Enter Residential/Other	Theft of Vehicle
1	West End	49.284131	-123.131795	0	Theft from Vehicle	Other Theft	Mischief	Break and Enter Commercial	Theft of Bicycle	Theft of Vehicle	Break and Ente Residential/Oth
2	Central Business District	49.249660	-123.119340	0	Theft from Vehicle	Other Theft	Mischief	Break and Enter Commercial	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle
3	Grandview-Woodland	49.270559	-123.067942	3	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Theft of Bicycle	Break and Enter Commercial	Theft of Vehicle
4	Mount Pleasant	49.263330	-123.096588	3	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	Break and Enter Residential/Other	Theft of Vehicle

Cluster Depiction

Analysis of different Clusters

Cluster 1

```
vancouver_merged.loc[vancouver_merged['Cluster Labels'] == 0, vancouver_merged.columns[[0]] + list(range(4, vancouver_merged.shape[1]))]]
```

	Neighbourhood	No.1 Most Common Crime	No.2 Most Common Crime	No.3 Most Common Crime	No.4 Most Common Crime	No.5 Most Common Crime	No.6 Most Common Crime	No.7 Most Common Crime	No.8 Most Common Crime	No.9 Most Common Crime
1	West End	Theft from Vehicle	Other Theft	Mischief	Break and Enter Commercial	Theft of Bicycle	Theft of Vehicle	Break and Enter Residential/Other	Vehicle Collision or Pedestrian Struck (with I...	Vehicle Collision or Pedestrian Struck (with F...
2	Central Business District	Theft from Vehicle	Other Theft	Mischief	Break and Enter Commercial	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and Enter Residential/Other	Vehicle Collision or Pedestrian Struck (with F...
8	Stanley Park	Theft from Vehicle	Mischief	Theft of Bicycle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with I...	Other Theft	Theft of Vehicle	Break and Enter Residential/Other	Vehicle Collision or Pedestrian Struck (with F...

Cluster 2

```
vancouver_merged.loc[vancouver_merged['Cluster Labels'] == 1, vancouver_merged.columns[[0]] + list(range(4, vancouver_merged.shape[1]))]]
```

	Neighbourhood	No.1 Most Common Crime	No.2 Most Common Crime	No.3 Most Common Crime	No.4 Most Common Crime	No.5 Most Common Crime	No.6 Most Common Crime	No.7 Most Common Crime	No.8 Most Common Crime	No.9 Most Common Crime
5	Strathcona	Theft from Vehicle	Mischief	Break and Enter Commercial	Other Theft	Break and Enter Residential/Other	Theft of Bicycle	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Vehicle Collision or Pedestrian Struck (with F...
7	Kensington-Cedar Cottage	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Theft of Bicycle	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
11	Victoria-Fraserview	Theft from Vehicle	Mischief	Break and Enter Residential/Other	Other Theft	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Theft of Bicycle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
14	Hastings-Sunrise	Theft from Vehicle	Mischief	Break and Enter Residential/Other	Theft of Vehicle	Other Theft	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Break and Enter Commercial	Vehicle Collision...

Cluster 3

```
vancouver_merged.loc[vancouver_merged['Cluster Labels'] ==2, vancouver_merged.columns[[0]] + list(range(4, vancouver_merged.shape[1]))]]
```

	Neighbourhood	No.1 Most Common Crime	No.2 Most Common Crime	No.3 Most Common Crime	No.4 Most Common Crime	No.5 Most Common Crime	No.6 Most Common Crime	No.7 Most Common Crime	No.8 Most Common Crime	No.9 Most Common Crime
9	Shaughnessy	Theft from Vehicle	Break and Enter Residential/Other	Mischief	Vehicle Collision or Pedestrian Struck (with I...	Break and Enter Commercial	Theft of Bicycle	Theft of Vehicle	Other Theft	Vehicle Collision or Pedestrian Struck (with F...
12	Kerrisdale	Theft from Vehicle	Break and Enter Residential/Other	Mischief	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Break and Enter Commercial	Theft of Bicycle	Other Theft	Vehicle Collision or Pedestrian Struck (with F...
18	Arbutus Ridge	Theft from Vehicle	Break and Enter Residential/Other	Mischief	Other Theft	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...

Cluster 4

```
vancouver_merged.loc[vancouver_merged['Cluster Labels'] == 3, vancouver_merged.columns[[0]] + list(range(4, vancouver_merged.shape[1]))]]
```

	Neighbourhood	No.1 Most Common Crime	No.2 Most Common Crime	No.3 Most Common Crime	No.4 Most Common Crime	No.5 Most Common Crime	No.6 Most Common Crime	No.7 Most Common Crime	No.8 Most Common Crime
0	Fairview	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	Break and Enter Residential/Other	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...
3	Grandview-Woodland	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Theft of Bicycle	Break and Enter Commercial	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...
4	Mount Pleasant	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	Break and Enter Residential/Other	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...
6	Sunset	Theft from Vehicle	Other Theft	Mischief	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and Enter Residential/Other	Theft of Bicycle
10	Marpole	Theft from ...	Other Theft	Break and Enter...	Mischief	Break and Enter...	Vehicle Collision or Pedestrian...	Theft of Bicycle	Theft of...

Modeling

To choose the right areas/neighborhoods, clustering is required which is done using K- means clustering. It is form of unsupervised machine learning algorithm that clusters predefined data.

This method will be used to address the problem of finding the areas with most frequent crimes as per 2019 data.

- Defining a function to fetch top crimes in the area
- Clustering neighborhoods
- Crime count per neighborhood
- Probability of the same crimes happening again
- Top 5 most frequent crimes

Results

- Cluster 1 with West End , Central Business District And Stanlrey Park faces the problem of Theft from Vehicle , Other Theft , break and enter Residential/Other. Police deployment should be made accordingly

- Cluster 2 has neighborhood such as Hastings – Sunrise, Grandview–Woodland, Strathcona, Sunset, Marpole, Kensington–Cedar Cottage, Kitsilano, Victoria–Fraserview, RileyPark , Killarney, South Cambie and these areas mostly face the problems of Theft from Vehicle, Mischief and Break and Enter Residential/Other . Police should work accordingly in this cluster.

Results

- Cluster 3 comprises of Shaughnessy ,Kerrisdale, Arbutus Ridge and faces the crimes of Vehicle and Bicycle theft and also Break and enter.

- Cluster 4 comprises Sunset, Marpole , South Cambie, Mount Pleasant,, Fairview , Renview- Collingwood. Theft from Vehicle , Mischiefs are common issues here. This area requires continuous patrolling.

Conclusion

- We have discussed all the major areas with their crime record. We have distributed the areas as clusters for the ease of mobilizing and arranging personnel in these areas as required depending upon the frequency of crimes in that particular cluster