Optimized Deployment of Police Resources in Vancouver Neighbourhoods

Importance of Optimum Police Allocation

- Helps in faster police action
- Helps in better intelligence gathering
- Improves evidence collection and investigation
- Enables Police towards a surgical approach
- Helps optimize public costs
- Makes neighbourhoods safe and secure

Data acquisition and cleaning

•Using a real world data set from Kaggle containing the Vancouver Crimes from 2003 to 2019]: A dataset consisting of the crime statistics of each Neighbourhood in Vancouver along with type of crime, recorded year, month and hour.

•Gathering additional information of the list of officially categorized boroughs in Vancouver from [Wikipedia]. Borough information will be used to map the existing data where each neighbourhood can be assigned with the right borough.

•Creating a new consolidated dataset of the Neighborhoods, along with their boroughs, crime data and the respective Neighbourhood's co-ordinates (fetched using OpenCage Geocoder)

Data acquisition and cleaning

•Creating a new consolidated dataset of the Neighborhoods, boroughs, and the most common crimes and the respective Neighbourhood along with co-ordinates.

•To explore the neighbourhood crimes and to apply machine learning algorithm to cluster the neighbourhoods and present the findings by plotting it on maps using Folium.

Total Crime Count

```
vnc_crime_df['Neighbourhood'].value_counts()
```

```
Central Business District    10857
West End                      3031
Mount Pleasant                2396
Strathcona                    1987
Kitsilano                     1802
Fairview                      1795
Renfrew-Collingwood           1762
Grandview-Woodland            1761
Kensington-Cedar Cottage      1391
Hastings-Sunrise              1270
Sunset                         967
Riley Park                     866
Marpole                        828
Victoria-Fraserview            600
Killarney                      565
Oakridge                       499
Dunbar-Southlands              474
Kerrisdale                     417
Shaughnessy                    414
West Point Grey                372
Arbutus Ridge                  311
South Cambie                   292
Stanley Park                   154
Musqueam                        17
Name: Neighbourhood, dtype: int64
```

Pivot table (Crimes in boroughs)

```
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
```

	Year									
Type	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
Borough										
Central	787	198	2280	2489	6871	857	245	1	314	14042
East Side	786	1043	2192	1674	4754	678	605	8	660	12400
South Vancouver	49	156	187	88	483	36	71	1	111	1182
West Side	403	1000	1062	696	2838	588	225	3	389	7204
All	2025	2397	5721	4947	14946	2159	1146	13	1474	34828

Pivot table (Crimes in Neighbourhoods)

```
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()
```

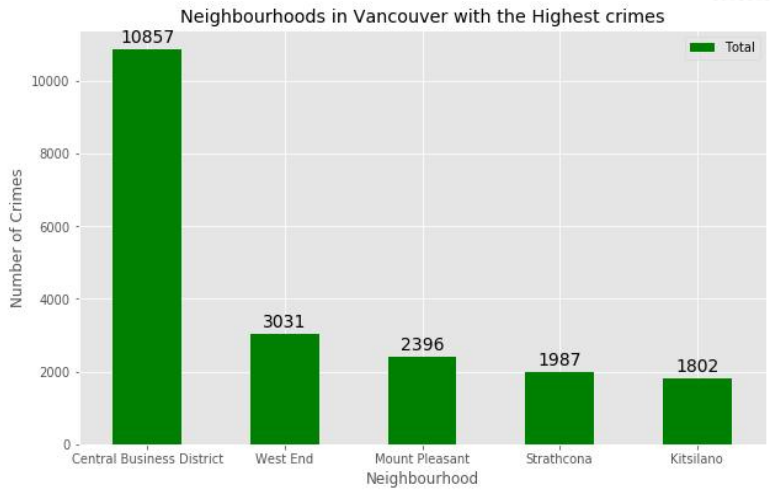
	Year									
Type	Break and Enter Commercial	Break and Enter Residential/Other	Mischief	Other Theft	Theft from Vehicle	Theft of Bicycle	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with Fatality)	Vehicle Collision or Pedestrian Struck (with Injury)	All
Neighbourhood										
Arbutus Ridge	12	78	49	18	111	12	12	1	18	311
Central Business District	551	124	1812	2034	5301	640	165	0	230	10857
Dunbar-Southlands	8	106	81	31	199	16	9	1	23	474
Fairview	138	73	233	297	692	245	55	0	62	1795
Grandview-Woodland	148	162	304	215	634	110	123	0	65	1761

Top 5 Crime-prone Neighbourhoods

```
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	551	124	1812	2034	5301	640	165	0	230	10857
22	West End	230	72	460	455	1461	203	77	1	72	3031
11	Mount Pleasant	205	124	353	493	822	232	67	0	100	2396
19	Strathcona	160	124	527	81	821	108	76	2	88	1987
9	Kitsilano	106	165	320	154	755	189	51	1	61	1802



Obtaining coordinates of all the neighbourhoods

```
Latitude = []
Longitude = []
Borough = []
Neighbourhood = vnc_boroughs_crime['Neighbourhood'].unique()

# 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)
```

```
[49.2841308, 49.24966, 49.2775935, 49.2705588, 49.2633296, 49.279554, 49.2518626, 49.2195929, 49.2641128, 49.2308288, 49.209223
3, 49.2476321, 49.2694099, 49.2184156, 49.2346728, 49.2644843, 49.2474381, 49.2409677, 49.2420242, 49.2242738, 49.2466847, 49.2
534601, 49.3019112, 49.2346005] [-123.1317949, -123.11934, -123.0439199, -123.0679417, -123.0965885, -123.0899788, -123.138022
6, -123.0902386, -123.1268352, -123.1311342, -123.1361495, -123.0842067, -123.155267, -123.0732871, -123.1553893, -123.1854326,
-123.1029664, -123.1670008, -123.0576794, -123.0462504, -123.120915, -123.1850439, -123.1415405, -123.183397]
```

Obtaining coordinates of all the neighbourhoods

```
CN_neig_geo
```

	Neighbourhood	Latitude	Longitude
0	West End	49.284131	-123.131795
1	Central Business District	49.249660	-123.119340
2	Hastings-Sunrise	49.277594	-123.043920
3	Grandview-Woodland	49.270559	-123.067942
4	Mount Pleasant	49.263330	-123.096588
5	Strathcona	49.279554	-123.089979
6	Shaughnessy	49.251863	-123.138023
7	Sunset	49.219593	-123.090239
8	Fairview	49.264113	-123.126835
9	Oakridge	49.230829	-123.131134
10	Marpole	49.209223	-123.136150
11	Kensington-Cedar Cottage	49.247632	-123.084207
12	Kitsilano	49.269410	-123.155267
13	Victoria-Fraserview	49.218416	-123.073287
14	Kerrisdale	49.234673	-123.155389
15	West Point Grey	49.264484	-123.185433
16	Riley Park	49.247429	-123.102966

Master table with all the neighbourhood information

NBD

	Neighbourhood	Type	Year	Month	Day	Hour	Borough	Latitude	Longitude
0	West End	Break and Enter Commercial	2018	3	2	6	Central	49.284131	-123.131795
1	West End	Break and Enter Commercial	2018	6	16	18	Central	49.284131	-123.131795
2	West End	Break and Enter Commercial	2018	12	12	0	Central	49.284131	-123.131795
3	West End	Break and Enter Commercial	2018	3	2	3	Central	49.284131	-123.131795
4	West End	Break and Enter Commercial	2018	3	17	11	Central	49.284131	-123.131795
...	...	...	...	...	...	...	...	...	...
34823	Musqueam	Theft of Bicycle	2018	7	15	15	South Vancouver	49.234600	-123.183397
34824	Musqueam	Theft of Vehicle	2018	8	17	23	South Vancouver	49.234600	-123.183397
34825	Musqueam	Theft of Vehicle	2018	6	3	6	South Vancouver	49.234600	-123.183397
34826	Musqueam	Vehicle Collision or Pedestrian Struck (with I...	2018	6	15	17	South Vancouver	49.234600	-123.183397
34827	Musqueam	Vehicle Collision or Pedestrian Struck (with I...	2018	2	4	12	South Vancouver	49.234600	-123.183397

Crime Probability

```
NBD_onehot_grouped = NBD_onehot.groupby('Neighbourhood').mean().reset_index()
NBD_onehot_grouped.head()
```

	Neighbourhood	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)
0	Arbutus Ridge	0.038585	0.250804	0.157556	0.057878	0.356913	0.038585	0.038585	0.003215	0.057878
1	Central Business District	0.050751	0.011421	0.166897	0.187345	0.488256	0.058948	0.015198	0.000000	0.021184
2	Dunbar-Southlands	0.016878	0.223629	0.170886	0.065401	0.419831	0.033755	0.018987	0.002110	0.048523
3	Fairview	0.076880	0.040669	0.129805	0.165460	0.385515	0.136490	0.030641	0.000000	0.034540
4	Grandview-Woodland	0.084043	0.091993	0.172629	0.122090	0.360023	0.062465	0.069847	0.000000	0.036911

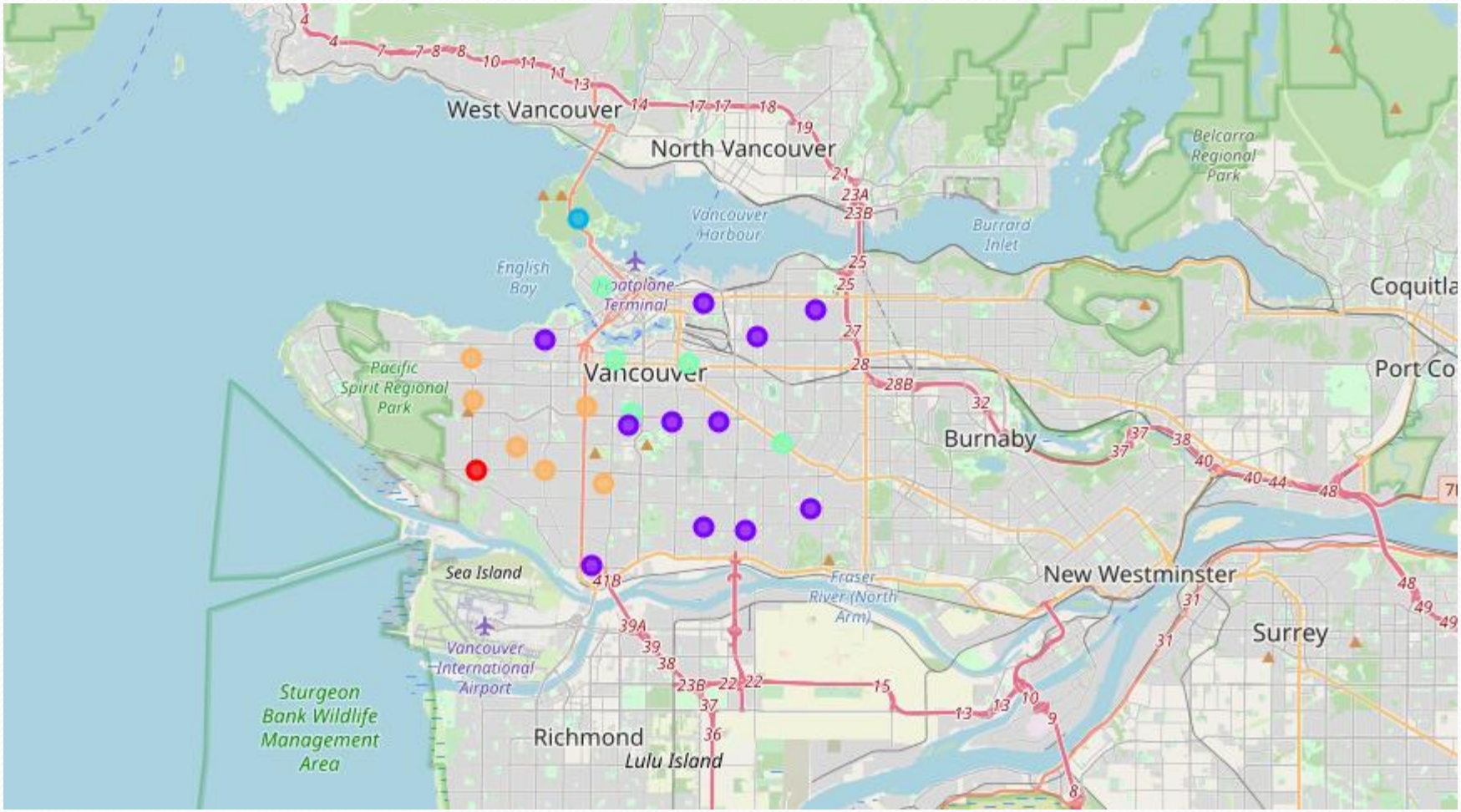
Most committed crimes

	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	Vehicle Collision or Pedestrian Struck (with I...	Other Theft	Theft of Vehicle	Theft of Bicycle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
1	Central Business District	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	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	Vehicle Collision or Pedestrian Struck (with I...	Theft of Bicycle	Theft of Vehicle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
3	Fairview	Theft from Vehicle	Other Theft	Theft of Bicycle	Mischief	Break and Enter Commercial	Break and Enter Residential/Other	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with F...
4	Grandview-Woodland	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Break and Enter Commercial	Theft of Vehicle	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Vehicle Collision or Pedestrian Struck (with F...

Formation of clusters

	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 Most Common Crime	No.8 M Common Cr
0	West End	49.284131	-123.131795	3	Theft from Vehicle	Mischief	Other Theft	Break and Enter Commercial	Theft of Bicycle	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Break and E Residential/C
1	Central Business District	49.249660	-123.119340	3	Theft from Vehicle	Other Theft	Mischief	Theft of Bicycle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with I...	Theft of Vehicle	Break and E Residential/C
2	Hastings-Sunrise	49.277594	-123.043920	1	Theft from Vehicle	Mischief	Break and Enter Residential/Other	Other Theft	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Bicycle	Break and E Comme
3	Grandview-Woodland	49.270559	-123.067942	1	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Break and Enter Commercial	Theft of Vehicle	Theft of Bicycle	Vehicle Colli or Pedes Struck (wit
					Theft				Break and		Vehicle Collision	

Depiction of Clusters



Individual analysis of clusters

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

	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
2	Hastings-Sunrise	Theft from Vehicle	Mischief	Break and Enter Residential/Other	Other Theft	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with I...	Theft of Bicycle	Break and Enter Commercial	Vehicle Collision or Pedestrian Struck (with F...
3	Grandview-Woodland	Theft from Vehicle	Mischief	Other Theft	Break and Enter Residential/Other	Break and Enter Commercial	Theft of Vehicle	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Vehicle Collision or Pedestrian Struck (with F...
5	Strathcona	Theft from Vehicle	Mischief	Break and Enter Commercial	Break and Enter Residential/Other	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with I...	Other Theft	Theft of Vehicle	Vehicle Collision or Pedestrian Struck (with F...
7	Sunset	Theft from Vehicle	Mischief	Other Theft	Vehicle Collision or Pedestrian Struck (with I...	Break and Enter Residential/Other	Theft of Vehicle	Break and Enter Commercial	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with F...
10	Marpole	Theft from Vehicle	Mischief	Break and Enter Residential/Other	Vehicle Collision or Pedestrian Struck (with I...	Other Theft	Break and Enter Commercial	Theft of Vehicle	Theft of Bicycle	Vehicle Collision or Pedestrian Struck (with F...

Modelling

To help stakeholders choose the right neighborhood within a borough we will be clustering similar neighborhoods using K - means clustering which is a form of unsupervised machine learning algorithm that clusters data based on predefined cluster size.
We will use K-Means clustering to address this problem so as to group data based on existing crimes which will help in the decision making process.

- Defining a function to fetch top 10 crimes around a given neighborhood
- Data frame containing crimes for each neighborhood
- crime Count per neighborhood
- One Hot Encoding to Analyze Each Neighborhood
- Top 5 most frequent crimes across neighborhoods
- Creation of a new dataframe which displays the top 10 crimes for each neighborhood
- Clustering neighborhoods

Results

- Cluster 1 with Musqueam faces the problem of Theft from Vehicle and Break and Enter Residential/Other. Police deployment should be made accordingly

- Cluster 2 has neighbourhood such as 'Hastings-Sunrise', 'Grandview-Woodland', 'Strathcona', 'Sunset', 'Marpole', 'Kensington-Cedar Cottage', 'Kitsilano', 'Victoria-Fraserview', 'Riley Park', '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

- Stanley Park is a separate cluster 3 and faces the crimes of Vehicle and Bicycle theft as also Vehicle Collision or Pedestrian Struck

- Cluster 4 comprises 'West End', 'Central Business District', 'Mount Pleasant', 'Fairview', 'Renfrew-Collingwood'. They bear the issues like Theft from vehicle, other thefts, Michiefs, etc. This area thus needs continuous Police patrolling.

Conclusion

We have explored the crime data to understand different types of crimes in all neighborhoods of Vancouver and later categorized them into different neighborhoods, which helped us group the neighborhoods into clusters and deploy police depending upon the frequency of crimes in that particular cluster.