

# An EDA Case Study: Real Estate in Metro Vancouver, BC, Canada



VANCOUVER LOOKOUT AT HARBOUR CENTRE TOWER, Source: [<https://www.AAA.com>]

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## Section 1 Introduction

Nowadays, finding an affordable house in Canada is very difficult. Study of Google Trends data<sup>1</sup> shows that British Columbia, especially Metro Vancouver, BC got higher ranking in search **Vancouver real estate** keywords between searchers among all provinces in Canada [Picture 1].

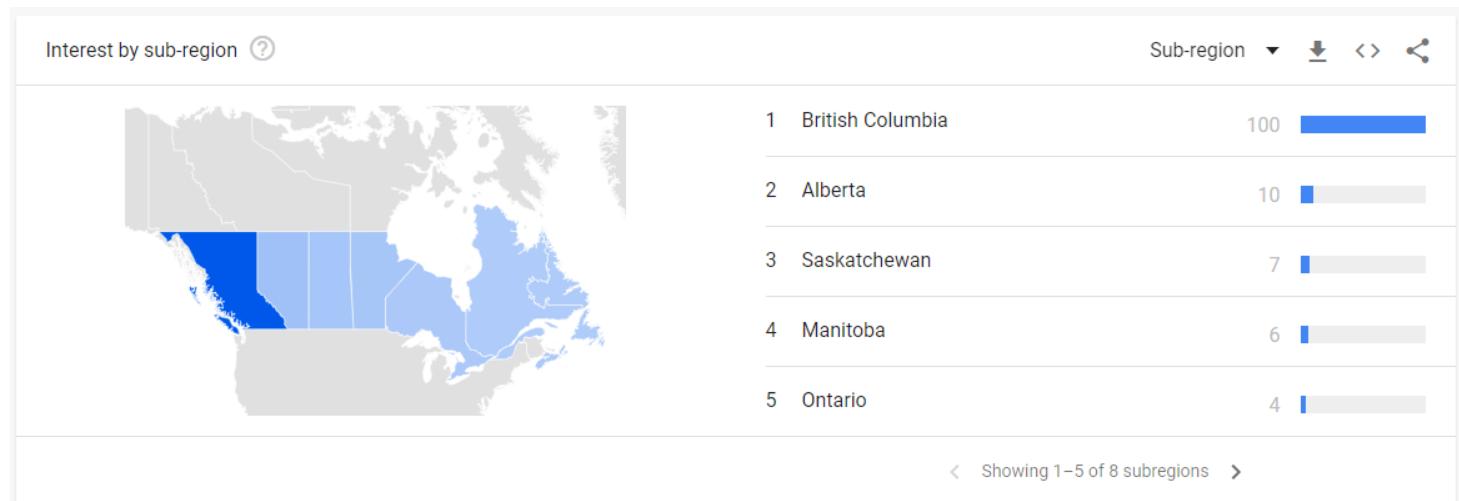


Figure 1 Google Trends output for “Vancouver real estate” comparison in Canada. (Screenshot by the author)

According to Statista<sup>2</sup>, Vancouver, BC is ranked seventh among the world's most expensive residential property markets in 2020, that making it difficult for buyers to find an affordable home. Consequently, this project was initiated to analyze the real estate market in Vancouver, British Columbia, Canada, by retrieving listing details from one of the available resources. The objective of this work is to analyze the housing market, visualize relevant statistics, and ultimately predict the sales price of a given listing using statistical data modeling.

## Section 2 Creating data source, data cleaning, missing values

The initial step in this project was to obtain data for analysis. There were two potential methods: linking to a government agency or real estate license, although this data was not up-to-date and did not contain the necessary information such as individual item prices; or scraping data. This article focuses on the latter approach. The next challenge was identifying the best resource from the existing options. To select the optimal choice, two factors were taken into consideration: the comprehensiveness of the data provided by a website, and the difficulty of accessing the data within the website.

After conducting a thorough study and taking the aforementioned factors into consideration, I observed that popular real estate listing websites like Zillow<sup>3</sup> and Realtor<sup>4</sup> only allow access to the first 800 records, which is not sufficient for our data modeling in the last step. So we decided to work with the [metrovancouverhomefinder.com](https://www.metrovancouverhomefinder.com)<sup>5</sup>.

<sup>1</sup> <https://trends.google.com>

<sup>2</sup> <https://www.statista.com/statistics/1040698/most-expensive-property-markets-worldwide>

<sup>3</sup> <https://Zillow.com>

<sup>4</sup> <https://www.realtor.ca>

<sup>5</sup> <https://www.metrovancouverhomefinder.com>

## 2-1 Web Scraping with Python

We made use of Google Colab, a free cloud-based platform for machine learning and data science experimentation. This platform allows users to write and run code, as well as share and collaborate on projects in a Jupyter notebook setting. Free access to GPU and TPU resources is provided, making it an attractive choice for deep learning model training and experimentation. Additionally, Colab integrates with popular libraries and frameworks such as TensorFlow, Keras, and PyTorch, and has the ability to easily import data from Google Drive or Github.

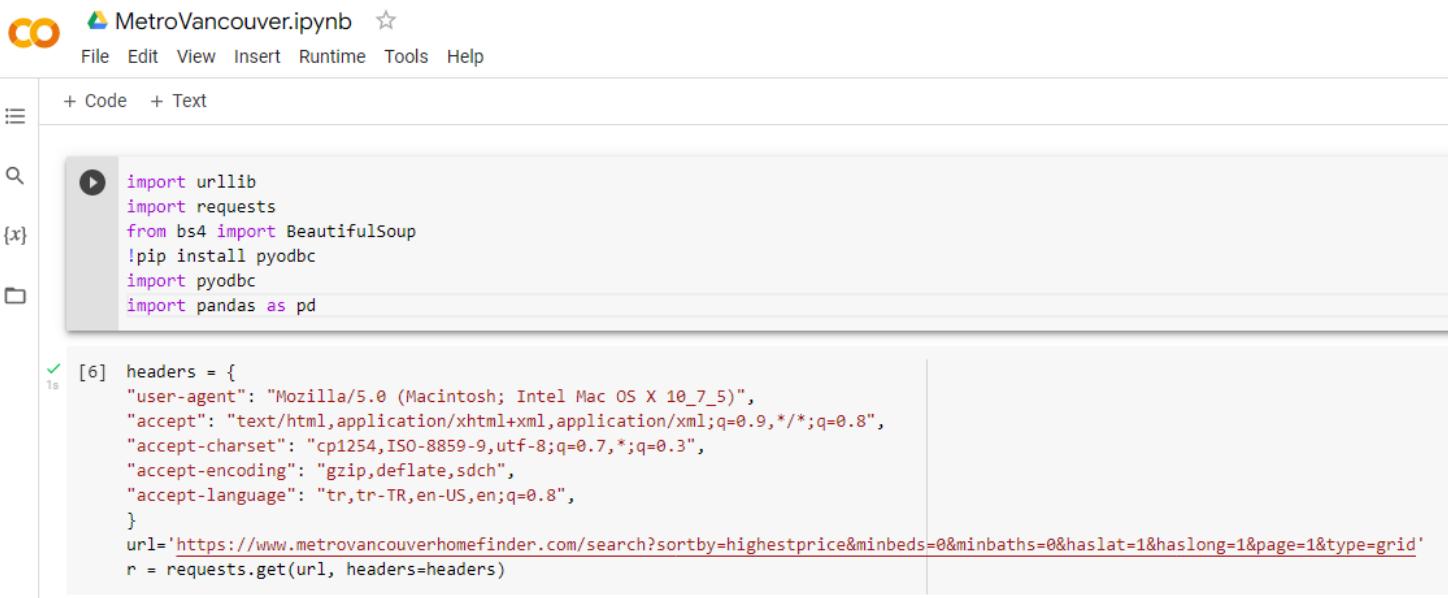
### Required Libraries

Python provides libraries, such as Scrapy and BeautifulSoup, which are specifically designed for web scraping. In this instance, I chose to use the first one due to its simplicity. To make the process easier, we can compile a list of all of the necessary libraries in a file called RequiredLibraries.txt, and then use the command 'pip install RequiredLibraries.txt' to install them.

```
import os
from bs4 import BeautifulSoup
from selenium import webdriver
from selenium.webdriver.common.keys import Keys
from selenium.webdriver.common.by import By
import warnings
import numpy as np
import pandas as pd
import lxml
from lxml.html.soupparser import fromstring
import prettify
import htmltext
import requests
import re
import json
```

### Web Headers

Metrovancouverhomefinder utilizes Captchas when attempting to execute a request.get(url) type of function. To bypass this, headers can be added to the request function, as demonstrated below.



The screenshot shows a Google Colab notebook titled "MetroVancouver.ipynb". The code cell contains imports for urllib, requests, BeautifulSoup, pyodbc, and pandas. The output cell [6] shows the creation of a dictionary 'headers' with various user-agent and accept-related keys, followed by a URL assignment and a call to requests.get() with the headers parameter.

```
import urllib
import requests
from bs4 import BeautifulSoup
!pip install pyodbc
import pyodbc
import pandas as pd

[6]: headers = {
    "user-agent": "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_7_5)",
    "accept": "text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8",
    "accept-charset": "cp1254,ISO-8859-9,utf-8;q=0.7,*;q=0.3",
    "accept-encoding": "gzip,deflate,sdch",
    "accept-language": "tr,tr-TR,en-US,en;q=0.8",
}
url='https://www.metrovancouverhomefinder.com/search?sortby=highestprice&minbeds=0&minbaths=0&haslat=1&haslong=1&page=1&type=grid'
r = requests.get(url, headers=headers)
```

Furthermore, following step is done to complete job:

- Parse data from urls in looping through pages
- Create and append Data Frames
- Export Data frame to csv file

Here is complete code and result:

```

if r.status_code != 200:
    print("request denied")
else:
    result = r.content
    addlist = []
    arealist = []
    soup = BeautifulSoup(result)
    add_list = [i.text.strip() for i in soup.find_all('div', {'class': 'property-address'})]
    i=0
    while i < len(add_list):
        addlist.append(add_list[i])
        i = i+1
        arealist.append(add_list[i])
        i= i+1
    pricelist = [i.text.strip() for i in soup.find_all('div', {'class': 'property-price'})]
    bdbalist = [i.text.strip() for i in soup.find_all('div', {'class': 'text-right property-bdba'})]
    brokerlist = [i.text.strip() for i in soup.find_all('div', {'class': "flex2 property-mls"})]
    property_list = pd.DataFrame({
        'address': addlist,
        'area': arealist,
        'price': pricelist,
        'bdba': bdbalist,
        'broker': brokerlist
    })

property_list.head()

```

	address	area	price	bdba	broker
0	34687 Ferndale Avenue, Mission, BC V2V 7C8	-- SqFt	\$90,000,000	-- Beds   -- Baths	Listing Provided By Royalty Group Realty Inc.
1	4838 Belmont Avenue, Vancouver, BC V6T 1A9	12,410 SqFt	\$59,800,000	5 Beds   8 Baths	Listing Provided By Macdonald Realty
2	5462 Stonebridge Drive, Whistler, BC V8E 0V9	8,700 SqFt	\$39,000,000	6 Beds   10 Baths	Listing Provided By Engel & Volkers Whistler
3	730 Fairmile Road, West Vancouver, BC V7S 1R2	14,759 SqFt	\$36,968,000	8 Beds   11 Baths	Listing Provided By Rennie & Associates Realty...
4	4788 Belmont Avenue, Vancouver, BC V6T 1A9	10,548 SqFt	\$33,888,000	7 Beds   11 Baths	Listing Provided By Sutton Group-West Coast Re...

```

[ ] import csv
from google.colab import drive
import pandas as pd
import time

#time.sleep(10) # Delay for 10 seconds.
drive.mount('drive', force_remount=True)

property_list.to_csv('metrovan.csv', mode='a', header=False)
!cp metrovan.csv "drive/My Drive/"

```

Mounted at drive

**Result:** raw data includes 5 columns e.g. address, area, price, bdba and broker and **4000** rows.

#### Note:

It is important to bear in mind that the website makes use of anti-scraping techniques such as captchas, IP blocking, and honeypot traps in order to protect its data from scraping. It is likely that our IP/device has been blacklisted at this point, but we have successfully completed the first step.

## 2-2 Data Cleaning and Preprocessing

Data cleaning involves the identification and rectification of any errors or inconsistencies in the data, such as missing values, duplicated records, or incorrect data types. This is a critical step, as it helps to guarantee that the data is complete and accurate, which is essential for constructing dependable models. To this end, we have divided the address attribute into three fields: address, city, and zip code; additionally, we have split the bdba field into two fields: bed and bath, which respectively represent the number of beds and baths; furthermore, we have updated the original data frame by using the *Geopy* library to locate the coordinates of the zip code by adding two new columns: latitude and longitude. We also converted the string types of *price* and *area* to *float* so that we could perform statistical functions on them later.

Here is complete code and result:

The screenshot shows a Jupyter Notebook interface with the following details:

- Title:** zipcodeToLoc.ipynb
- File Menu:** File, Edit, View, Insert, Runtime, Tools, Help
- Status Bar:** All changes saved
- Code Cells:**
  - [12]: `!pip install geopy  
!pip install geopandas`
  - [4]: `import csv  
import geopy  
from geopy.geocoders import Nominatim  
import csv  
from google.colab import drive  
import pandas as pd  
import time`
  - [14]: `locator = Nominatim(user_agent="myGeocoder")  
drive.mount('drive', force_remount=True)  
df = pd.read_csv('drive/My Drive/metrovan.csv')`
  - [15]: `from geopy.extra.rate_limiter import RateLimiter  
  
geocode = RateLimiter(locator.geocode, min_delay_seconds=1)  
  
df['location'] = df['Zipcode'].apply(geocode)  
df['point'] = df['location'].apply(lambda loc: tuple(loc.point) if loc else None)  
df[['latitude', 'longitude', 'altitude']] = pd.DataFrame(df['point'].tolist(), index=df.index)`
  - A cell starting with [16] is partially visible, containing code related to mounting a drive and saving files.
- Output:** A message "Mounted at drive" is displayed below the code cells.

## 2-3 Missing Values

It is essential to substitute missing information with NaN (Not a Number) in order to facilitate the identification of absent values in our data and permit the implementation of appropriate measures expeditiously. Here, the missing values in the columns Town, ZipCode, Broker, Beds, Area, Price, Baths, Latitude and Longitude are addressed by filling it with NaN values.

After data cleaning, shape of data is like result:

```

drive.mount('drive', force_remount=True)
df = pd.read_csv('drive/My Drive/metrovan1.csv')

Mounted at drive
   index      Address     Town Zipcode  Latitude  Longitude    Area  Price  Beds  Baths  Broker
0     1  111 32085 George Ferguson Way Abbotsford    V2T 2K7  49.055312 -122.336344  1000  449000    2      2  RE/MAX Westcoast
1     2        20617 102b Avenue Langley    V1M 3H3  49.190194 -122.651115  1000 3000000    2      1 Homelife Advantage Realty (central Valley) Ltd.
2     3       211 E 38th Avenue Vancouver    V5W 1H3  49.236586 -123.100463  1000 7100000    3      1 Sutton Group-West Coast Realty
3     4      209 1802 Duthie Avenue Burnaby    V5A 2R8  49.267361 -122.951989  1001  549900    2      2  RE/MAX Crest Realty
4     5  302 2151 151a Street Surrey    V4A 7C6  49.040312 -122.802964  1002  655000    2      2      Oakwyn Realty Ltd.

[8] df.head(5)
print(f"Number of samples: {df.shape[0]}")
print(f"Number of features in dataset: {df.shape[1]}")
print("Features:")
print(df.dtypes)

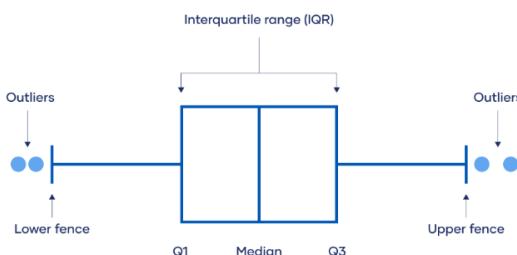
Number of samples: 3802
Number of features in dataset: 11
Features:
index      int64
Address     object
Town        object
Zipcode    object
Latitude   float64
Longitude  float64
Area       int64
Price      int64
Beds       int64
Baths      int64
Broker     object
dtype: object

```

## 2-4 Outliers

Outliers are values that are exceptionally distinct from the majority of the data points in a dataset. They can drastically alter the results of any statistical analyses and influence the results of any hypothesis tests. In this work, we utilize the interquartile range (IQR) to identify the range of the middle half of the dataset based on the *price* attribute. Additionally, we use the IQR to create *fences* around our data and define outliers as any values that lie outside these boundaries.

In continue we remove any erroneous data while keeping genuine extreme values. It involves deleting anomalous values from a dataset before conducting our statistical analysis. The majority of outliers are located above the upper fence, which is attributed to records related to *land* real estate.



```

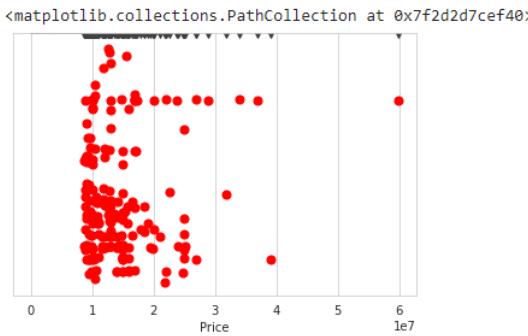
# Calculate first and third quartile
first_quartile = df['Price'].quantile(0.25)
third_quartile = df['Price'].quantile(0.75)
# Find interquartile range
IQR = third_quartile - first_quartile
# Find lower and upper bound
lower_bound = first_quartile - (1.5 * IQR)
upper_bound = third_quartile + (1.5 * IQR)

# filtering dataframe
data_outlier = df[(df.Price < lower_bound) | (df.Price > upper_bound)]

# plotting boxplot
sns.boxplot(x=df.Price)

# plotting outliers
plt.scatter(data_outlier.Price, data_outlier.index, color='red', s=50)

```



```

plt.rcParams.update({'figure.figsize':(5,7), 'figure.dpi':100})
plt.boxplot(df['Price'], notch=True)
plt.title('Outliers boxplot')
plt.xlabel('Price')
plt.ylabel('Property')
plt.show()

```

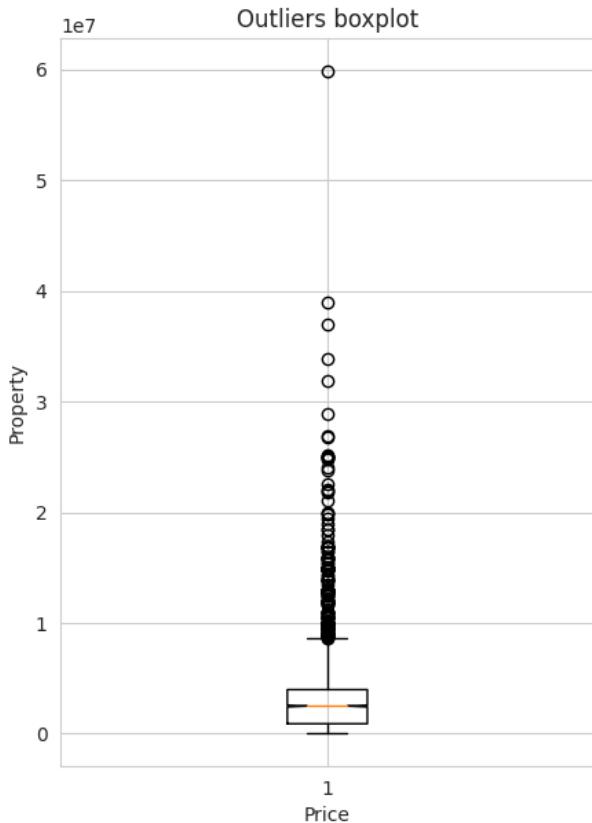


Figure 2 Outliers based on price of real estate in metro Vancouver, BC. (Image by the author)

## Section 3 Data visualization

We conducted two forms of data visualization:

- 1- Data visualization with Python libraries
- 2- Data visualization with Tableau

### 3-1 Data visualization with Python libraries

Here we did some coding to create a shape of data and histogram. First of all we convert towns as category attribute to numerical attribute.

```
# Converting Town as a category attribute to numbers
df.Town = pd.Categorical(df.Town)
df['Towncode'] = df.Town.cat.codes

sns.pairplot(df, height=2)
plt.tight_layout()
```

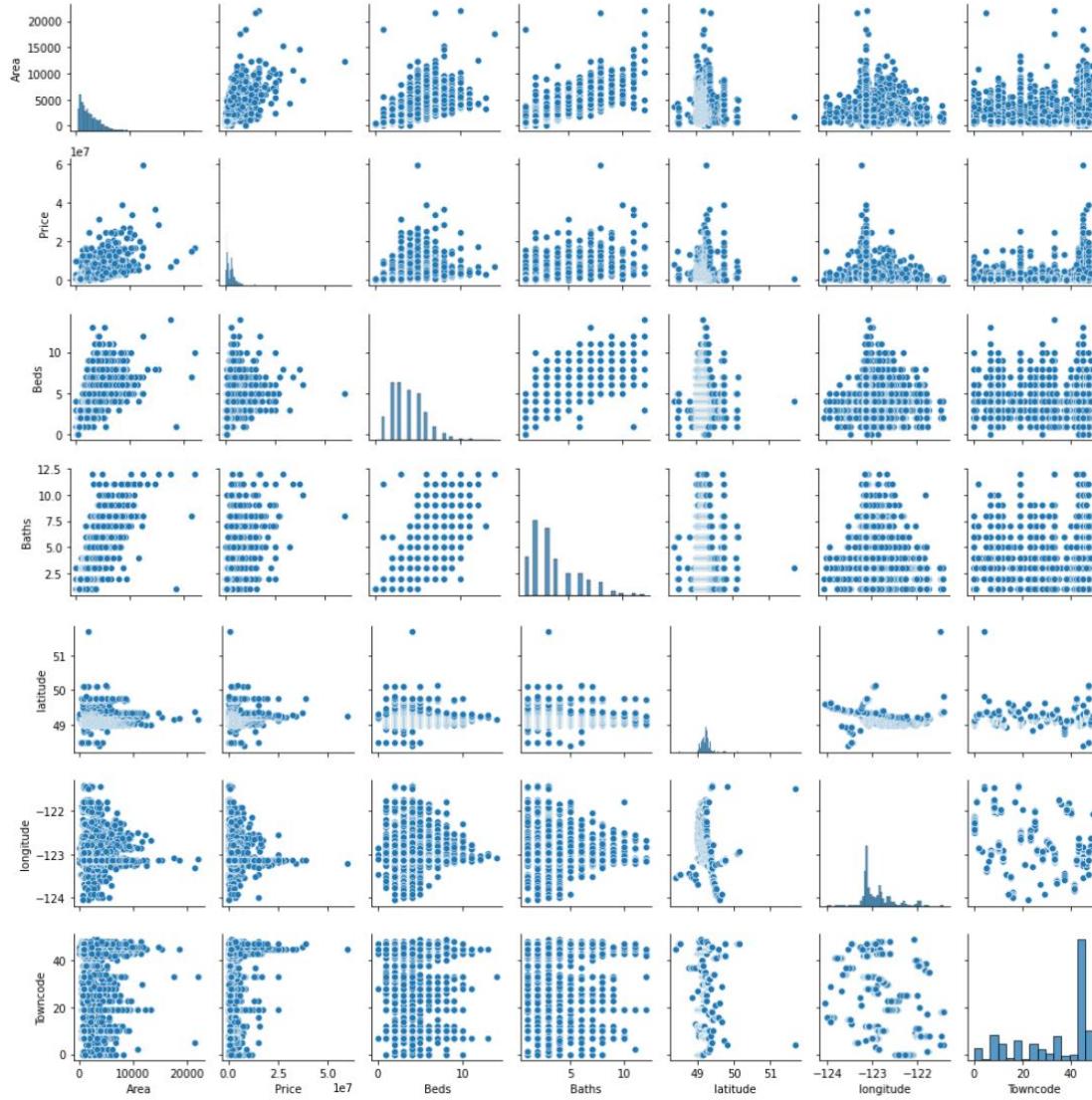


Figure 3 Pairplot of dataset (Image by the author)

Consequently, we draw most important statistics feature i.e. Histogram, extracted by following code, result in [Figure 4]

```
✓ 2s import matplotlib.ticker as tkr

#sns.set_theme()
plt.figure(figsize=(26,9)) # figure ration 16:9
sns.set()
# Modify histogram with bins
graph = sns.displot(data=df, x="Price", kde=True, kind='hist', rug=True, log_scale=True, bins=55, height=8.27, aspect=11.7/8.27)
graph.set(title="Histogram of Sale Price")
for ax in graph.axes.flat:
    ax.xaxis.set_major_formatter(tkr.FuncFormatter(lambda x, p: format(int(x), ',')))
plt.xticks(rotation=30)
plt.show()
```

Result:

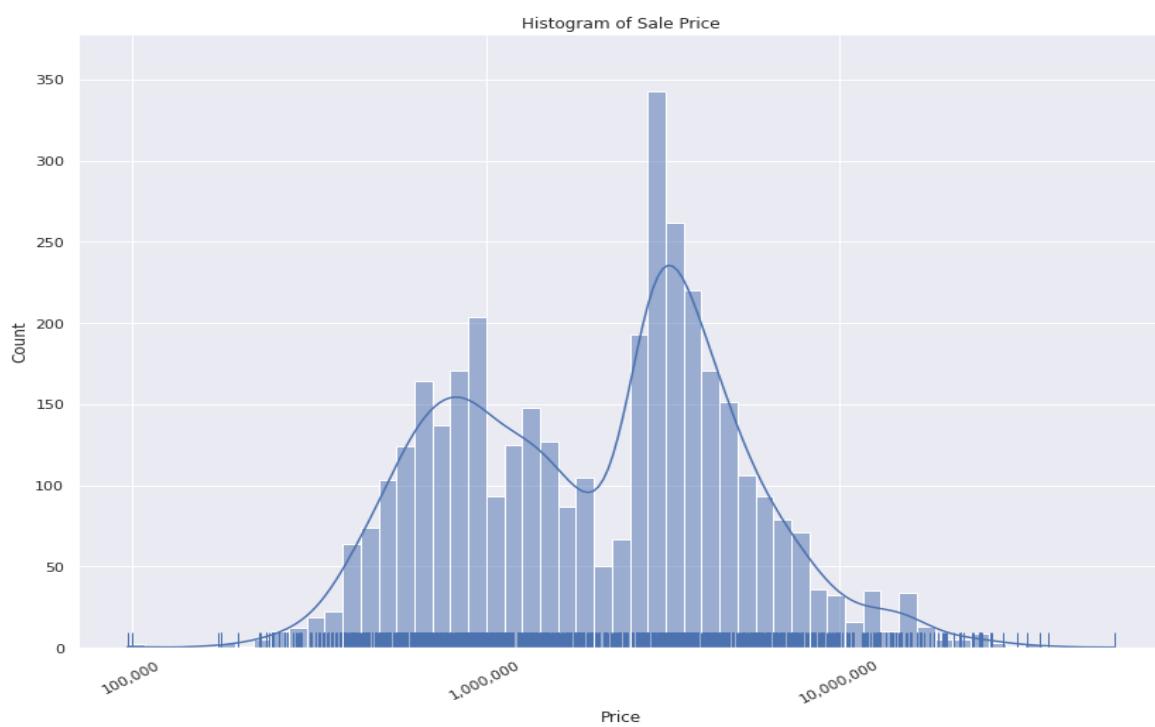


Figure 4 Histogram of real estate price in metro Vancouver, BC. (Image by the author)

Let's have a look in to the other four major statistic parameter:

```

0s
    print(f"Number of samples: {df.shape[0]}")
    print(f"Number of features in set: {df.shape[1]}")
    print("Features:", df.columns.values)
    #print(df.columns.values)
    Mean = df["Price"].mean()
    Median = df["Price"].median()
    Skewness = df["Price"].skew()
    Kurtosis = df["Price"].kurtosis()
    print(f"Mean: {Mean:.2f}")
    print(f"Median: {Median:.2f}")
    print(f"Skewness: {Skewness:.4f}")
    print(f"Kurtosis: {Kurtosis:.4f}")

```

```

Number of samples: 3809
Number of features in set: 10
Features: ['Address' 'Town' 'ZipCode' 'Area' 'Price' 'Beds' 'Baths' 'Broker' 'latitude' 'longitude']
Mean: 3,121,455.16
Median: 2,498,000.00
Skewness: 4.2408
Kurtosis: 35.1458

```

## Discussion

It shows the distribution of the price of properties in Vancouver, BC, is relatively high positive skewness (the mean is greater than the median). In the prediction model, this will cause, the less accurate in the price prediction. In the other hand, high kurtosis represents heavy tails meaning more outliers.

## Correlation:

Correlation is a statistical measure used to quantify the linear relationship between two variables, which is characterized by a constant rate of change. This measure is commonly employed in order to describe the relationship between two variables without inferring causality.

```

plt.figure(figsize=(8,8))
cor = df.corr()
sns.heatmap(cor, annot=True, cmap=plt.cm.PuBu)
plt.show()

```

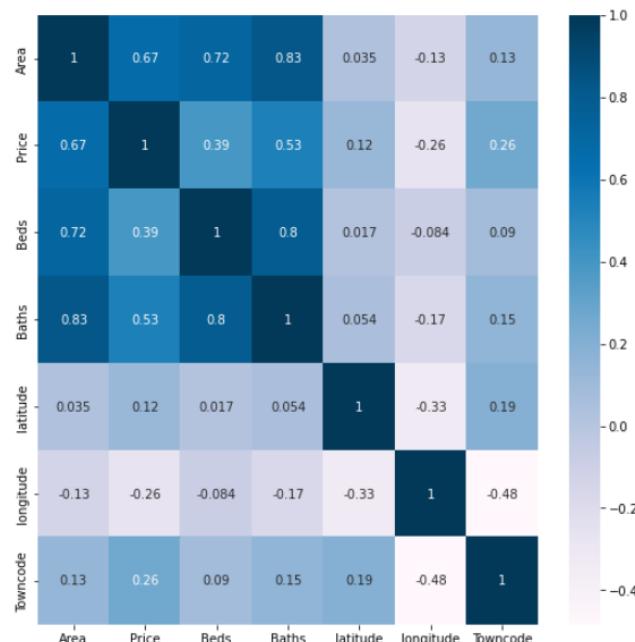


Figure 5 Correlation between attributes (Image by the author)

```

# Absolute value of correlation
cor_target = abs(cor['Price'])
# Highly correlated attributes
relevant_features = cor_target[cor_target>0.2]
# Getting the names of the attributes
names = [index for index, value in relevant_features.iteritems()]
# Erase the target attribute
names.remove('Price')
# printing the correlated attributes
print(names)
print(len(names))

```

```

['Area', 'Beds', 'Baths', 'longitude', 'Towncode']
5

```

## More statistic parameter

### Statistics per category: Property per town

Let's take a look to distribution of numbers in listing base of town:

```

from pandas._libs.hashtable import value_count
df['Town'] = df['Town'].str.strip()
type(df['Town'][0])
print('Number of real estate per individual town in the listing: ',df['Town'].nunique(),'\n')
df['Town'].value_counts()

```

Number of real estate per individual town in the listing: 50

Vancouver	1049
Surrey	516
Richmond	296
West Vancouver	242
Langley	236
Burnaby	230
Coquitlam	134
North Vancouver	133
Abbotsford	133
Maple Ridge	108
Chilliwack	98
Whistler	77
Delta	73
White Rock	58
Sardis	52
Mission	49
New Westminster	49
Squamish	40
Port Coquitlam	33
Port Moody	31
Pitt Meadows	21
Sechelt	17
Gibsons	16

The result suggest, the greatest number of properties in our dataset belong to Vancouver as a considerable portion of our listings.

### 2- Statistics per category: Activity of brokers

Here we did some coding to see distribution of numbers in listing base of brokers:

```
from pandas._libs.hashtable import value_count
df['Broker'] = df['Broker'].str.strip()
type(df['Broker'][0])
df['Broker'].nunique()
df['Broker'].value_counts()
```

RE/MAX Crest Realty	240
Sutton Group-West Coast Realty	185
Royal Pacific Realty Corp.	117
Nu Stream Realty Inc.	96
Macdonald Realty	92
...	
Emily Oh Realty	1
Westmont Realty Inc.	1
Vantage First Realty	1
Oak West Realty Ltd.	1
Engel & Volkers Vancouver (branch)	1
Name: Broker, Length: 261, dtype: int64	

As results shows, 261 individual brokers are active in our listing means some of them created more than one record in dataset.

In continue, we plot top 30 realtor histogram, Figure 6. We used matplotlib.pyplot to extract more helpful plots.



```
# Histogram top 30 Realtor
from matplotlib.pyplot import figure

figure(figsize=(10, 8), dpi=80)
df['Broker'] = df['Broker'].str.strip()
graph = df['Broker'].value_counts()[:30]
graph.plot(kind='barh', fontsize=12, title="Top 30 listing-creator realtor")
plt.show()
```



Top 30 listing-creator realtor

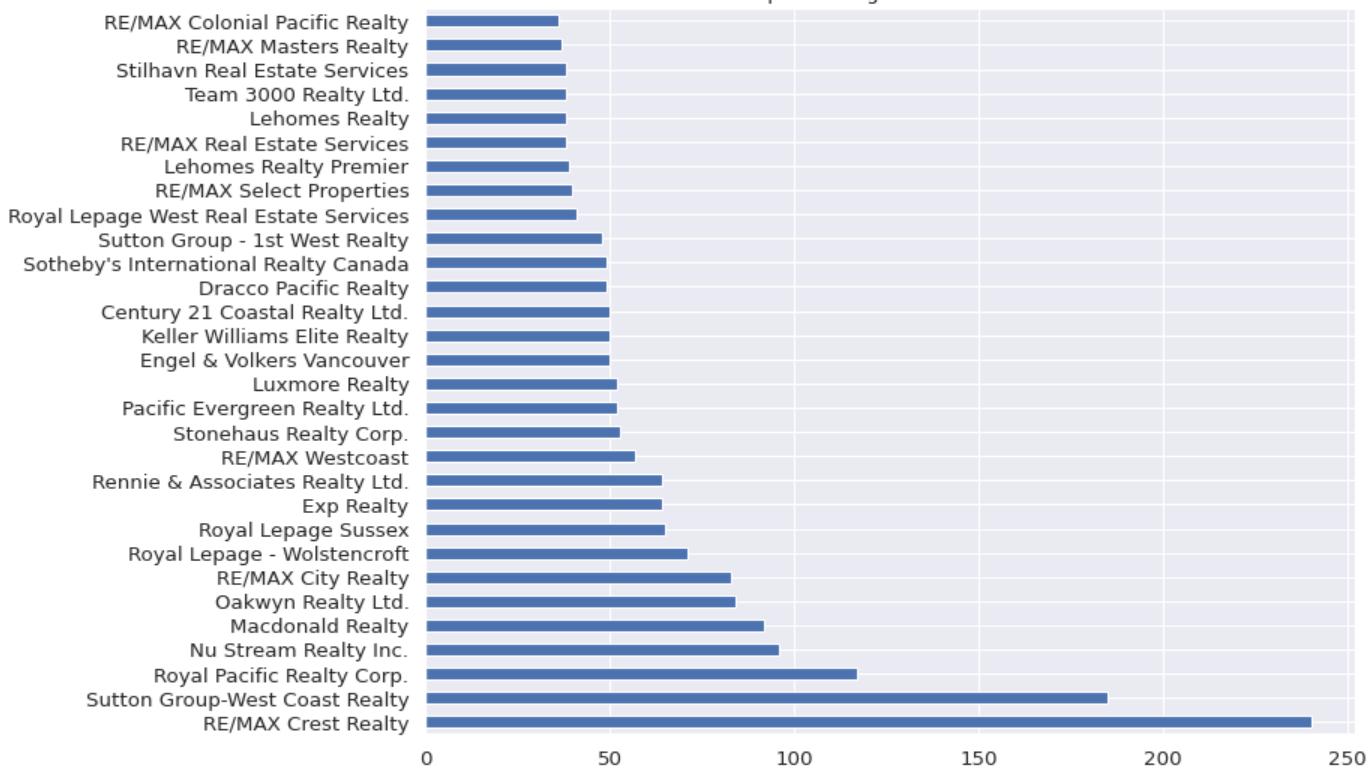


Figure 6 Top 30 realtor histogram (Image by the author)

### 3- Statistics per category: Price range

We continue by creating a price range histogram to observe number of properties. [Figure 7]

```
figure(figsize=(10, 8), dpi=80)
df = df[['Price', 'Town']]
df['binned_price'] = pd.cut(df.Price, [1, 1000000, 2000000, 3000000, 4000000, 5000000, 6000000, 7000000, 8000000, 9000000, 10000000])
ax = df['binned_price'].value_counts().plot(kind='bar', stacked=True, ylabel='Frequency',\n                                             xlabel='Price binned', title='Price group frequency by Town', rot=90, fontsize=9)
```

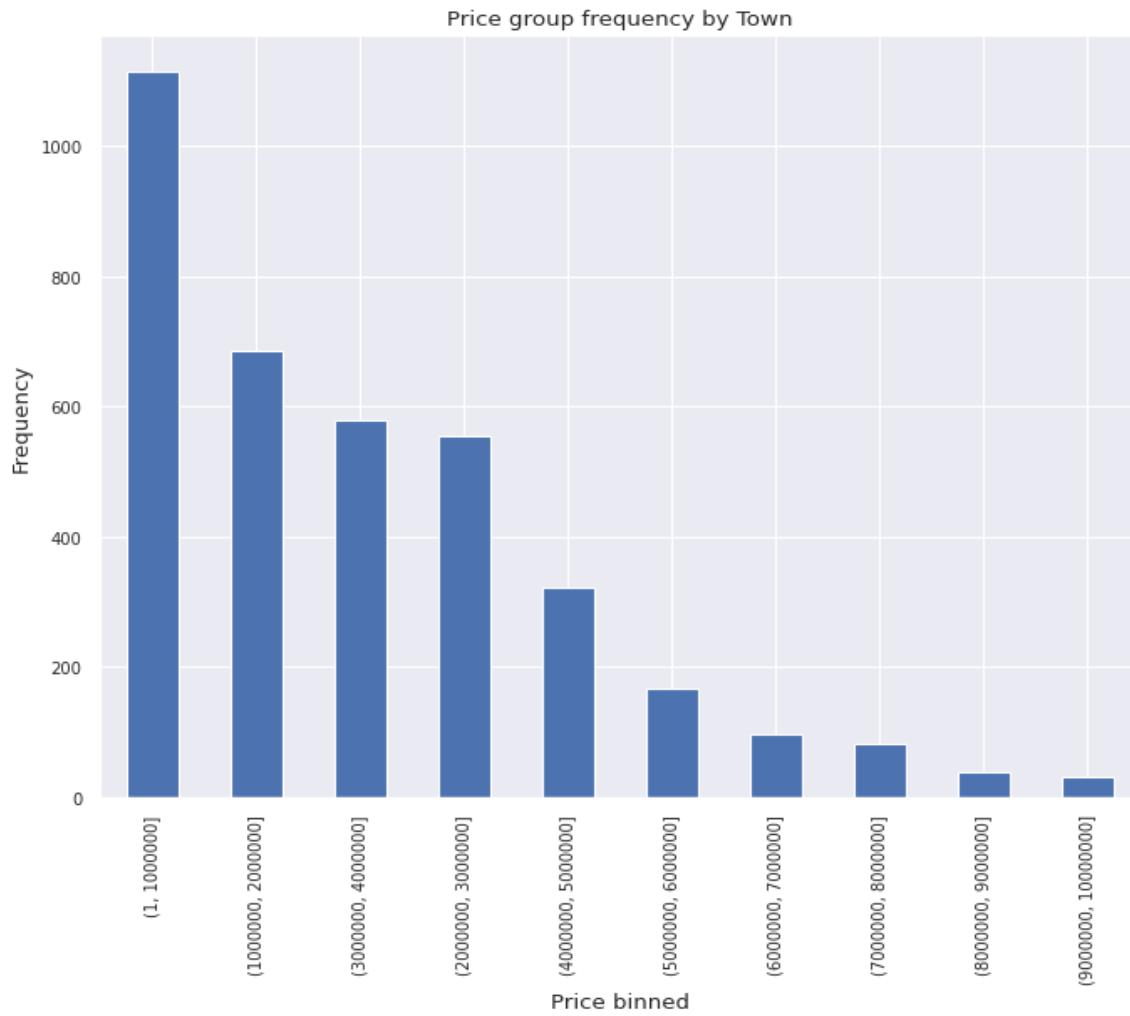


Figure 7 Histogram - Group by: price bin (Image by the author)

### 4- Scatter plot of distribution Statistics per category: Area - number of range [Figure 8]

```
df = pd.read_csv('drive/My Drive/MetroVan.csv')
plt.rcParams.update( {'figure.figsize':(12,6), 'axes.facecolor': 'White' , 'figure.dpi':150})
plt.scatter(x=df.Price, y=df.Area, c=df.Beds, cmap='Spectral')
plt.colorbar(label="Number of Beds")
plt.title('Relationships between Price and Area')
plt.xlabel('Price (CA$)')
plt.ylabel('Property Area (Square feet)')
current_values = plt.gca().get_xticks()
plt.gca().set_xticklabels(['{:.0f}'.format(x) for x in current_values])
plt.rcParams['axes.facecolor'] = 'black'
plt.show()
```



*Figure 8 Scatter plot of distribution of price based of area and number of beds (Image by the author)*

## 5- Geographical property distribution category: Map

Finally, let us examine the geographical distribution of properties in the British Columbia. To do this, we employed the Folium library, but first it was necessary to undertake some preliminary processing to differentiate the categories of property. As can be observed, this considerable improved the performance of the visualization.

```

✓ [1] !pip install git+https://github.com/python-visualization/folium

[2] import pandas as pd
    import folium
    from folium.plugins import MarkerCluster    # Import folium MousePosition plugin
    from folium.plugins import MousePosition    # Import folium DivIcon plugin
    from folium.features import DivIcon
    from google.colab import drive
    import branca.colormap as cm

✓ [3] drive.mount('drive', force_remount=True)

✓ [4] df = pd.read_csv('drive/My Drive/MetroVan.csv')

✓ [5] #Checking latitude and longitude
    df = df.query(' -121 > longitude > -124')
    df = df.query('48 < latitude < 51')

✓ [6] min_price=df.Price.min()
    max_price=df.Price.max()

    x_start = (df['latitude'].max() + df['latitude'].min()) / 2
    y_start = (df['longitude'].max() + df['longitude'].min()) / 2
    start_coord = (x_start, y_start)

✓ [7] colormap = cm.LinearColormap(colors=['b','r'],
                                    index = [min_price, max_price],
                                    vmin=min_price,vmax=max_price)

    colormap.caption = 'Color based on price'

✓ [8] map = folium.Map(location=start_coord, zoom_start=12)

    lat = list(df.latitude)
    lon = list(df.longitude)
    dat = list(df.Price)

    for loc, p in zip(zip(lat, lon), dat):
        folium.Circle(
            location=loc,
            radius=10,
            fill=True,
            color=colormap(p),
            fill_opacity=0.7
        ).add_to(map)

    map.add_child(colormap)

```

**Result:**

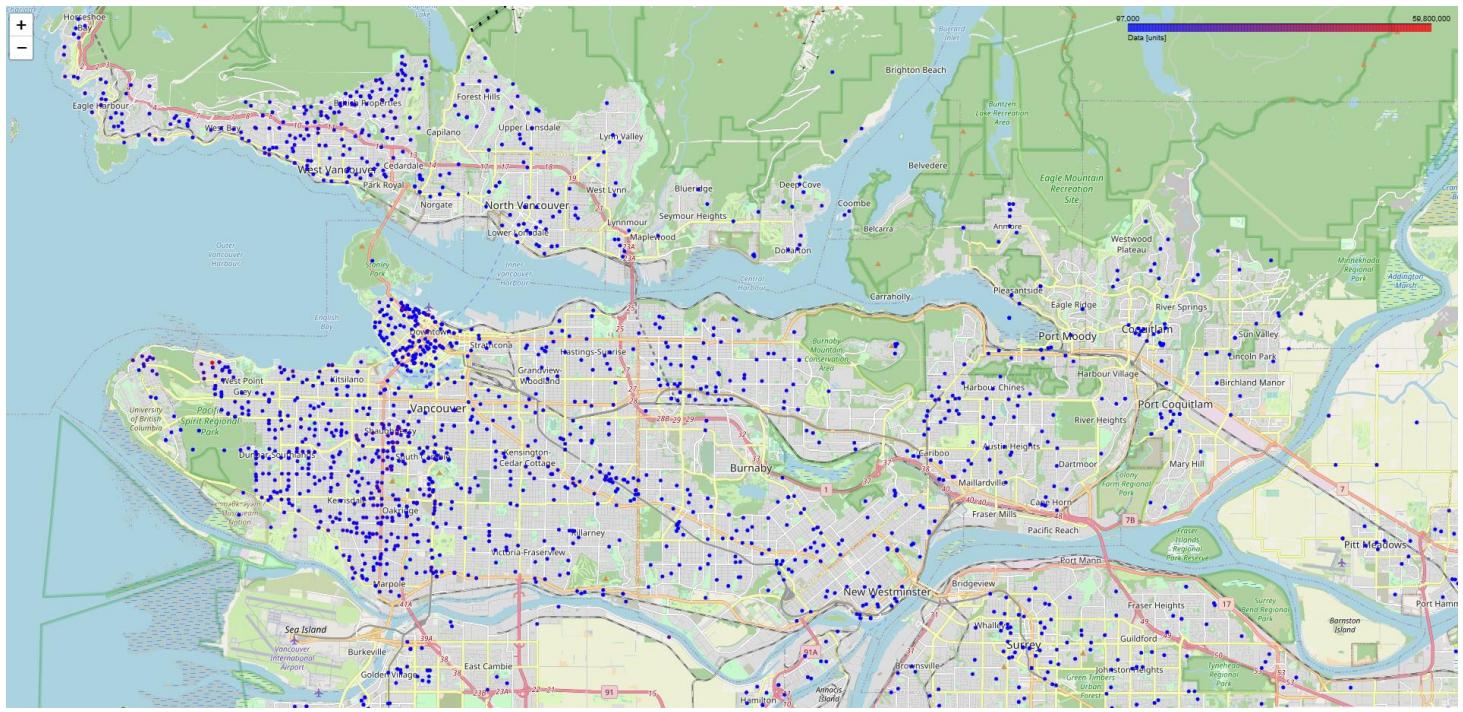


Figure 9 Geographical distribution of real estate in the Metro Vancouver map (Image by the author)

Here also we used plugins from folium library to show distribution of listing in the BC. as cluster view:

```
[ ] from folium import plugins

[ ] map = folium.Map(location=start_coord, zoom_start=12, width="%100", height="%100")

locations = list(zip(df.latitude, df.longitude))

cluster = plugins.MarkerCluster(locations=locations,
                                 popups=df.Price.tolist())
map.add_child(cluster)
```

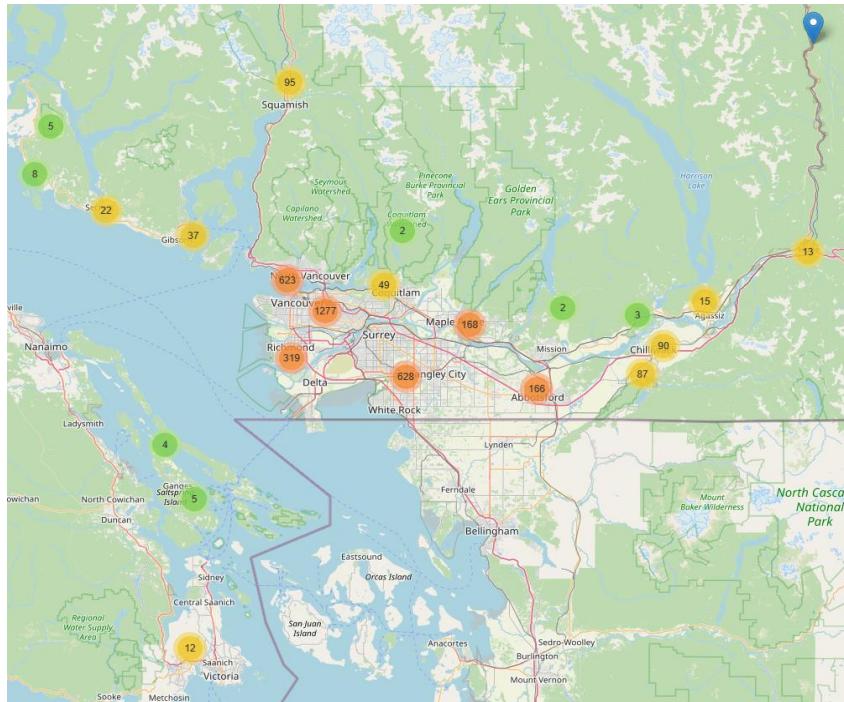


Figure 10 Cluster-based Geo distribution of real estate in the Metro Vancouver map (Image by the author)

## 6- Geographical Per Canada

This chart is not directly part of this project, but closely shows the ability of matplotlib in case of country distribution data.

```
can_map = folium.Map(location=[48, -102], zoom_start=3) # Create the map object
c_data = {
    'Alberta': 144284.48,
    'British Columbia': 141222.06000000017,
    'Manitoba': 134337.9699999994,
    'New Brunswick': 115727.6700000001,
    'Newfoundland': 6885.14000000001,
    'Northwest Territories': 91755.4400000002,
    'Nova Scotia': 80136.1800000005,
    'Nunavut': 1506.430000000014,
    'Ontario': 352263.5099999983,
    'Prince Edward Island': 28742.2,
    'Quebec': 138658.8799999998,
    'Saskatchewan': 177314.26000000013,
    'Yukon Territory': 74404.8000000003
}
```

```
folium.GeoJson(gdf).add_to(can_map) # Add the GeoJSON data to the map

folium.Choropleth(
    geo_data=gdf,
    name="choropleth",
    data=c_data,
    columns=['Province', 'Profit'],
    key_on='feature.properties.NAME',
    fill_color="YlGn",
    fill_opacity=0.7,
    line_opacity=0.2,
    legend_name="Imaginary Data",
).add_to(can_map)

can_map
```

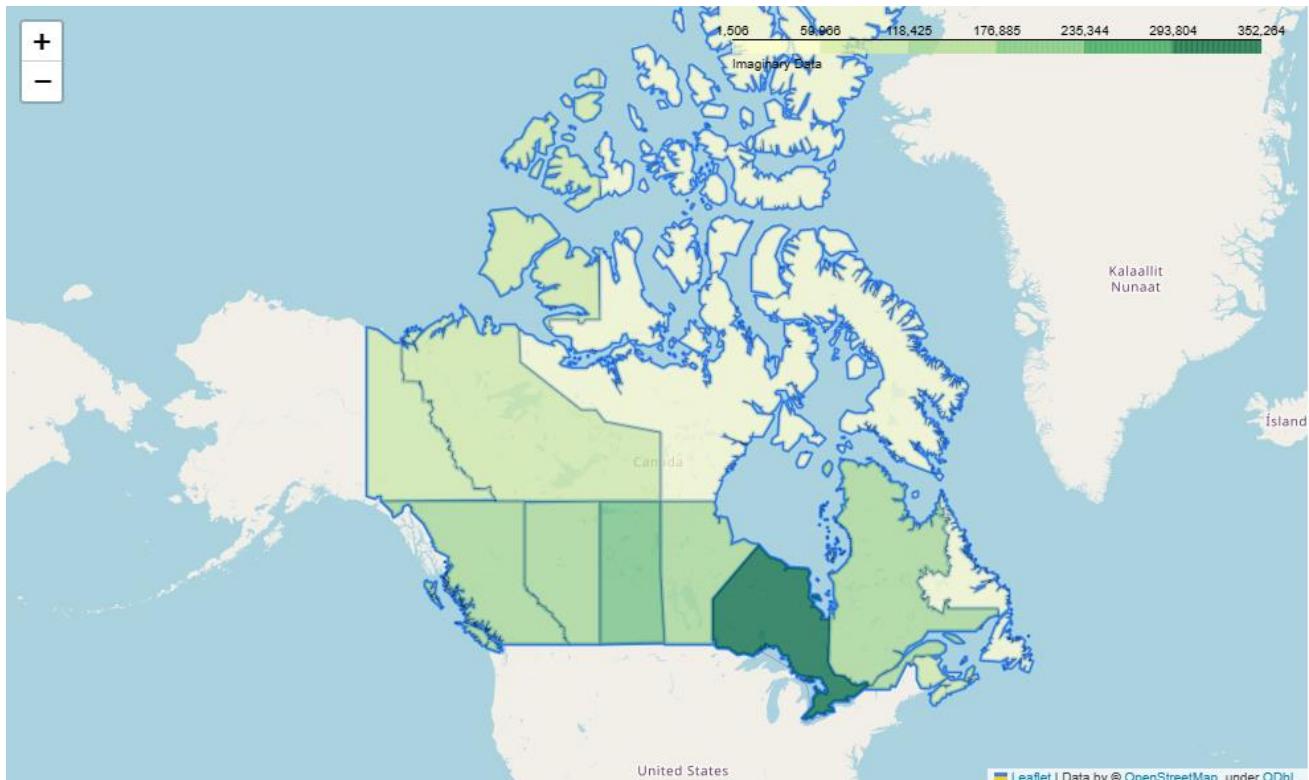


Figure 11 Geographical distribution in Canada categorized by province (Image by the author)

### 3-2 Data visualization with Tableau

Tableau is a data visualization and business intelligence software that helps users to see and understand their data. It allows to create interactive dashboards, charts, and maps to gain insights from their data. It also has built-in collaboration features, so teams can share their findings and work together on projects. Here we used Tableau (Public) to carry out some visualization.

**Chart 1:** Percentage of each type of property for sale based on percentage of all

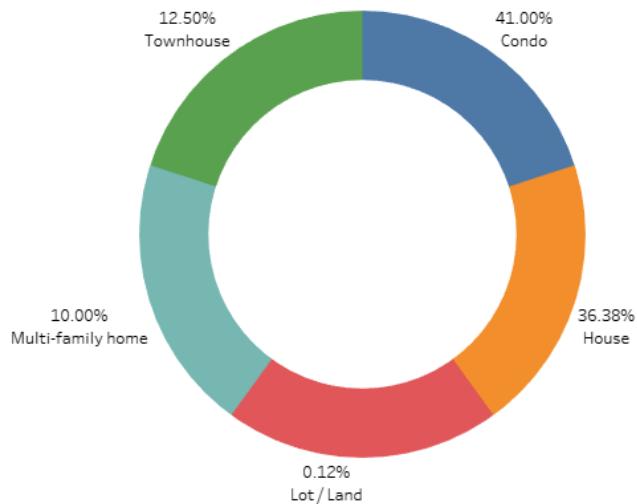


Figure 12 Donut chart shows the percentage of each type of property for sale based on percentage of all (Image by the author) URL: <https://public.tableau.com/app/profile/kasra.heidarinezhad>

**Chart 2:** Categorized histogram displays the distribution of listing Town on Price(bin)

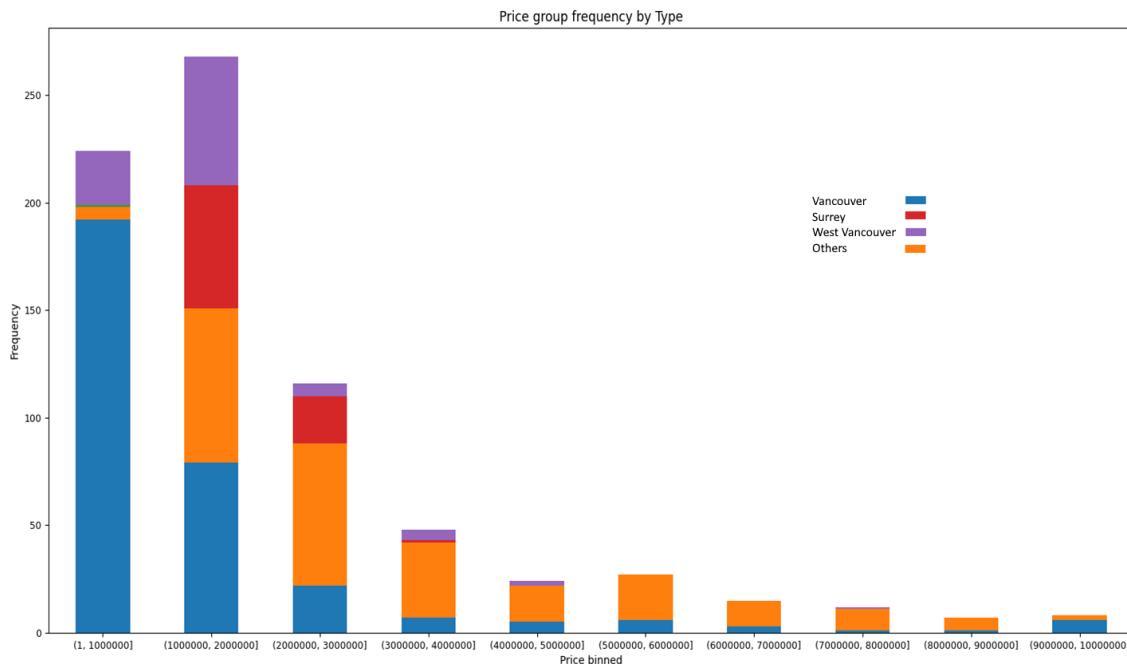


Figure 13 Histogram - Group by: Town / Price bin (Image by the author) URL: <https://public.tableau.com/app/profile/kasra.heidarinezhad>

**Chart 3:** Treemap view to demonstrate the distribution real estate based on price-range category

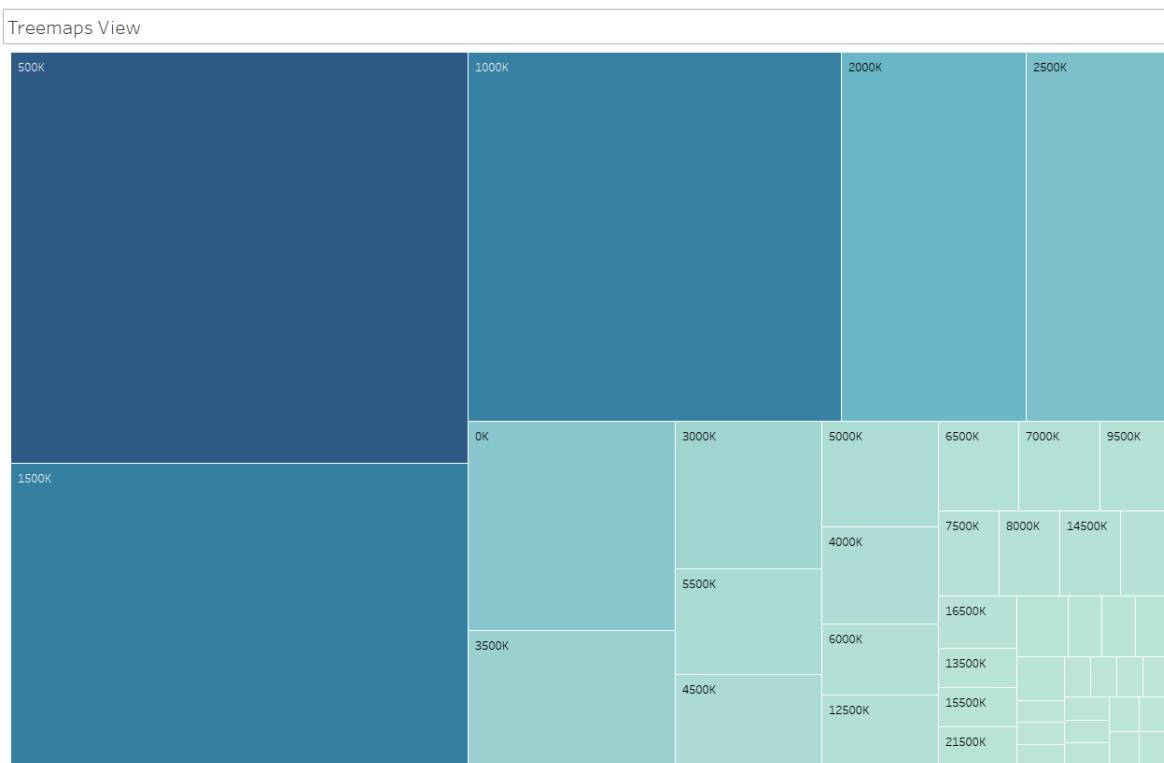


Figure 14 Treemap view shows the distribution based on price-range category (Image by the author) URL:  
<https://public.tableau.com/app/profile/kasra.heidarinezhad>

**Chart 4:** Average house price by number of items in listing. As evidenced, Vancouver has the highest number of houses listed in the database, yet West Vancouver remains the most expensive area within this listing.

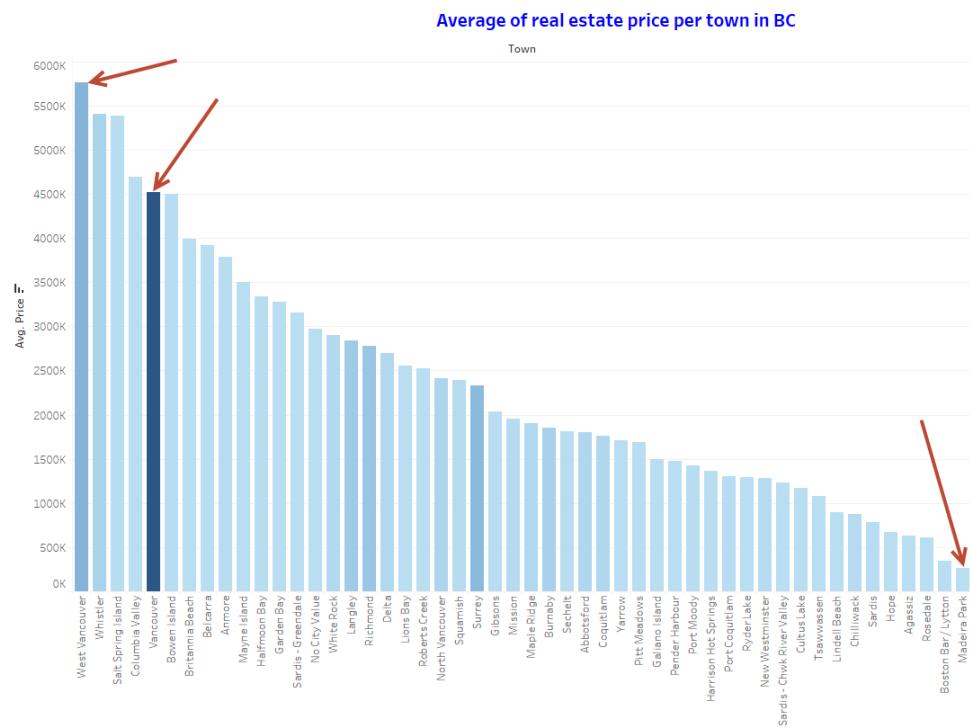


Figure 15 Categorized histogram view shows the distribution based on Price(range)-Type category (Image by the author) URL:  
<https://public.tableau.com/app/profile/kasra.heidarinezhad>

**Chart 5:** Average Categorized histogram view shows the distribution based on Avg Price(bin), Avg area per Town

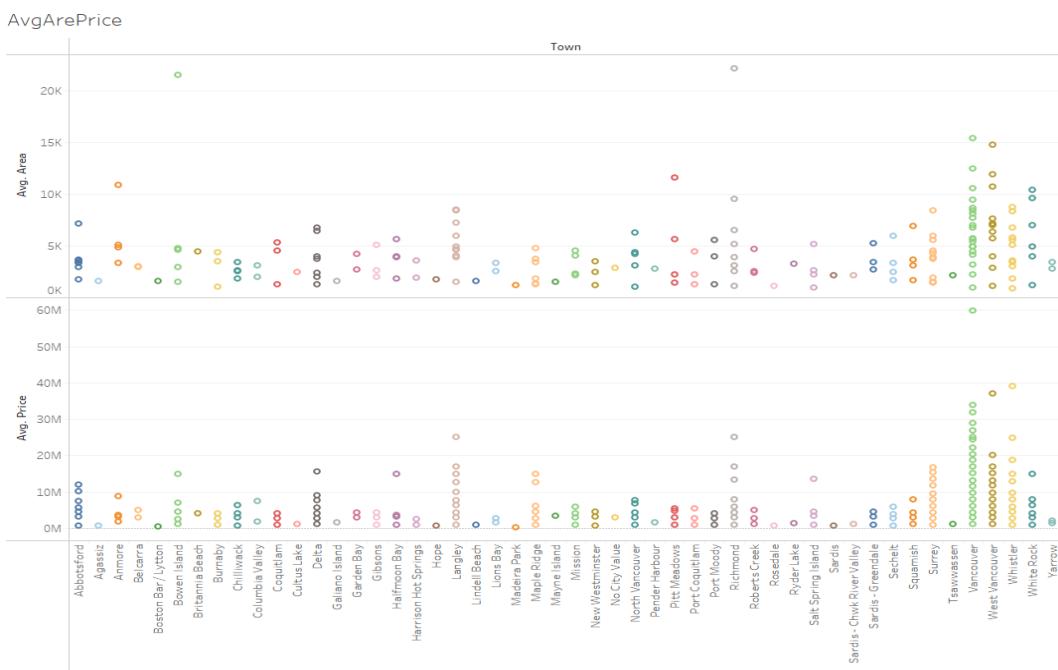


Figure 16 Categorized histogram view shows the distribution based on Avg Price(bin), Avg area per Town (Image by the author) URL: <https://public.tableau.com/app/profile/kasra.heidarinezhad/>

## Section 4 Database, SQL and Query

To manipulate data, we created a database named: VancouverProperties.db with a table named: VancouverPropertiesTable with sqlite DBMS. Afterward, data is extracted by SELECT statement:

### Query 1: A complete list of real estate in table

```
import sqlite3
from google.colab import drive
from pathlib import Path

drive.mount('drive', force_remount=True)
df = pd.read_csv('drive/My Drive/MetroVan.csv')

Path('MetroVan.db').touch()

db_conn = sqlite3.connect('VancouverProperties.db')
db_cursor = db_conn.cursor()

df.to_sql('VancouverPropertiesTable', db_conn, if_exists='append', index=False)
db_vancouverproperties_init_query = pd.read_sql(''' SELECT * FROM VancouverPropertiesTable ''', db_conn)
db_vancouverproperties_init_query.head(3)
```

	Address	Town	ZipCode	Area	Price	Beds	Baths	Broker	latitude	longitude
0	104 1139 W Cordova Street	Vancouver	V9C 0A2	3788	7870000	4	5	Exp Realty	48.3980	-123.5423
1	4868 Summit Lane	Whistler	V8E 1G4	4349	14995000	5	6	Whistler Real Estate Company Limited	48.4908	-123.4508
2	227 4800 Spearhead Drive	Whistler	V8E 1G1	790	1997000	2	2	RE/MAX Sea To Sky Real Estate	48.4908	-123.4508

### Query 2: List of real estate by filtering: Kingsway, and sorting

```

data_stat = pd.read_sql('''

    SELECT ZipCode, Area, Price, Beds, Address
    FROM VancouverPropertiesTable
    WHERE Address LIKE '%Kingsway%'
    ORDER BY Price DESC ''', db_conn)

data_stat.head(4)

```

	ZipCode	Area	Price	Beds	Address	🔗
0	V5H 0E9	623	768000	1	2202 4688 Kingsway	
1	V5R 0C3	771	698000	2	515 2689 Kingsway	
2	V5R 5G8	554	619000	1	314 2435 Kingsway	
3	V3N 0G9	556	579990	1	1203 7388 Kingsway	

### Query 3: Average price (CA\$) and area (Square feet) of house for sales in town = Richmond

```

data_stat_Avg = pd.read_sql('''

    SELECT AVG(Price) AS Avg_price_richmond , AVG(Area) AS Avg_area
    FROM VancouverPropertiesTable
    WHERE Town LIKE '%Richmond%' ''', db_conn)

print(f"Average house price for sale in Richmond is : {data_stat_Avg.Avg_price_richmond[0]:,.2f} CA$")
print(f"Average area of houses for sale in Richmond is : {data_stat_Avg.Avg_area[0]:,.2f} Sqfeet")

Average house price for sale in Richmond is : 2,783,492.50 CA$
Average area of houses for sale in Richmond is : 2,731.68 Sqfeet

```

## Section 5 Statistical data modeling

Data modeling refer to the process of creating a mathematical representation of an existing data. This representation, known as a model, can be used to make predictions or decisions based on new or unseen data. In data science, statistical models and machine-learning models are two most important types of models that widely used. In this project, we going to first option.

One of most important goals of data modeling is prediction, in our case: prediction of housing price. Here we used multivariable Linear Regression (LR) to predict target variable, and used a filtered attributes as bellow:

- 1- Numerical attributes: Price, Beds , Area, Baths, Latitude, Longitude
- 2- Classified attribute: Town, Address, ZipCode, Broker

### 5-1 Linear Regression Modeling (LRM) using sklearn library

In this phase, we will involve the construction and training of six distinct linear regression models, namely:

- 1- Ordinary Least Squares (OLS) algorithm
- 2- Ridge algorithm
- 3- Lasso algorithm
- 4- Bayesian algorithm
- 5- Elastic Net algorithm
- 6- Support Vector Machine algorithm

To facilitate the implementation of these models, the pre-built algorithms provided by the scikit-learn Python package will be utilized. The process for each model will be consistent, comprising of three steps:

- 1- Definition of a variable to store the model algorithm
- 2- Fitting of the train set variables to the model
- 3- Prediction of values on the test set.

```

df = pd.read_csv('drive/My Drive/MetroVan.csv')

# Converting Town as a category attribute to numbers
df.Town = pd.Categorical(df.Town)
df['Towncode'] = df.Town.cat.codes

#print(df.describe())
print(df.dtypes)

Unnamed: 0      int64
Address         object
Town            category
ZipCode        object
Area           int64
Price          int64
Beds            int64
Baths           int64
Broker          object
latitude       float64
longitude      float64
Towncode        int8

# Absolute value of correlation
cor = df.corr()
cor_target = abs(cor['Price'])
# Highly correlated attributes
relevant_features = cor_target[cor_target>0.2]
# Getting the names of the attributes
names = [index for index, value in relevant_features.iteritems()]
# Erase the target attribute
names.remove('Price')
# printing the correlated attributes
print(names)
print(len(names))

```

['Area', 'Beds', 'Baths', 'longitude', 'Towncode']  
5

```

from sklearn.model_selection import train_test_split

# Dropping rows contain NaN and unrequired columns
df.dropna(inplace=True, axis=0)

x = df.drop(['Price', 'Address', 'Town', 'ZipCode', 'Broker'], axis=1)
y = df['Price']

# Dividing the data into training and test set
x_train, x_test, y_train, y_test = train_test_split(x,y,test_size=0.2, random_state=42)

#Print Num of rows and Columns of test and training tet
print("X-Train data set :", x_train.shape)
print("X-Test data set :", x_test.shape)
print("Y-Train data set :", y_train.shape)
print("Y-Test data set :", y_test.shape)

```

X-Train data set : (2328, 7)  
X-Test data set : (583, 7)  
Y-Train data set : (2328,)  
Y-Test data set : (583,)

```

from sklearn.linear_model import LinearRegression # Ordinary Least Squares(OLS) algorithm
from sklearn.linear_model import Ridge # Ridge algorithm
from sklearn.linear_model import Lasso # Lasso algorithm
from sklearn.linear_model import BayesianRidge # Bayesian algorithm
from sklearn.linear_model import ElasticNet # Elastic Net algorithm
from sklearn.svm import SVR # Support Vector Machine algorithm

# OLS Algorithm
ols = LinearRegression()
ols.fit(x_train, y_train)
ols_yhat = ols.predict(x_test)
print(f'Score of OLS regression : {ols.score(x, y):.4f}')
print(f'Average value of the house by OLS regression: CA$ {y_test.mean():,.2f}') # Present Price
print(f'Model predicted average value by OLS regression: CA$ {ols_yhat.mean():,.2f}') # Predicted Price
print('-----')
# Ridge Algorithm
ridge = Ridge(alpha = 0.5).fit(x_train, y_train)
ridge_yhat = ridge.predict(x_test)

# Lasso Algorithm
lasso = Lasso(alpha = 0.01).fit(x_train, y_train)
lasso_yhat = lasso.predict(x_test)

# Bayesian Algorithm
bayesian = BayesianRidge().fit(x_train, y_train)
bayesian_yhat = bayesian.predict(x_test)

# Elastic Net Algorithm
en = ElasticNet(alpha = 0.01).fit(x_train, y_train)
en_yhat = en.predict(x_test)

# SVR Algorithm
svm = SVR(C=100000, gamma = 150000).fit(x_train, y_train)
svm_yhat = svm.predict(x_test) #Predictions of House Prices
print(f'Average value of the house by SVM: CA$ {y_test.mean():,.2f}') # Present Price
print(f'Model predicted average value by: CA$ {svm_yhat.mean():,.2f}') # Predicted Price

```

```

Score of OLS regression : 0.5189
Average value of the house by OLS regression: CA$ 3,082,483.79
Model predicted average value by OLS regression: CA$ 3,157,120.92
-----
Average value of the house by SVM: CA$ 3,082,483.79
Model predicted average value by: CA$ 2,747,125.32

```

## Evaluation

To check the accuracy of implemented model, we used and explained variance score and Root-squared score. These metric are implemented and is available in scikit-learn library in Python.

```

# evaluation metric : Explained Variance Score
from sklearn.metrics import explained_variance_score as evs
from sklearn.metrics import mean_squared_error

print('EXPLAINED VARIANCE SCORE values:')
print('Explained Variance Score of OLS model is: {:.4f}'.format(evs(y_test, ols_yhat)))
print('Mean squared error of OLS is: {:.2f}'.format(mean_squared_error(y_test, ols_yhat,squared = False)))
print('-----')
print('Explained Variance Score of Ridge model is: {:.4f}'.format(evs(y_test, ridge_yhat)))
print('Mean squared error of Ridge is: {:.2f}'.format(mean_squared_error(y_test, ridge_yhat,squared = False)))
print('-----')
print('Explained Variance Score of Lasso model is: {:.4f}'.format(evs(y_test, lasso_yhat)))
print('Mean squared error of Lasso is: {:.2f}'.format(mean_squared_error(y_test, lasso_yhat,squared = False)))
print('-----')
print('Explained Variance Score of Bayesian model is: {:.4f}'.format(evs(y_test, bayesian_yhat)))
print('Mean squared error of Bayesian model is: {:.2f}'.format(mean_squared_error(y_test, bayesian_yhat,squared = False)))
print('-----')
print('Explained Variance Score of Elastic Net is: {:.4f}'.format(evs(y_test, en_yhat)))
print('Mean squared error of Elastic Net is: {:.2f}'.format(mean_squared_error(y_test, en_yhat,squared = False)))
print('-----')
print('Explained Variance Score of SVM is: {:.4f}'.format(evs(y_test, svm_yhat)))
print('Mean squared error of SVM is: {:.4f}'.format(mean_squared_error(y_test, svm_yhat,squared = False)))

```

EXPLAINED VARIANCE SCORE values:  
Explained Variance Score of OLS model is: 0.6214  
Mean squared error of OLS is: 2,097,939.20  
-----  
Explained Variance Score of Ridge model is: 0.6214  
Mean squared error of Ridge is: 2,097,955.65  
-----  
Explained Variance Score of Lasso model is: 0.6214  
Mean squared error of Lasso is: 2,097,939.20  
-----  
Explained Variance Score of Bayesian model is: 0.6211  
Mean squared error of Bayesian model is: 2,098,799.21  
-----  
Explained Variance Score of Elastic Net is: 0.6213  
Mean squared error of Elastic Net is: 2,098,213.15  
-----  
Explained Variance Score of SVM is: 0.0000  
Mean squared error of SVM is: 3,423,809.3367

```

# evaluation metric : R-squared

from sklearn.metrics import r2_score as r2

print('R-SQUARED values:')
print('Explained Variance Score of OLS model is: {:.4f}'.format(r2(y_test, ols_yhat)))
print('Explained Variance Score of Ridge model is: {:.4f}'.format(r2(y_test, ridge_yhat)))
print('Explained Variance Score of Lasso model is: {:.4f}'.format(r2(y_test, lasso_yhat)))
print('Explained Variance Score of Bayesian model is: {:.4f}'.format(r2(y_test, bayesian_yhat)))
print('Explained Variance Score of Elastic Net is: {:.4f}'.format(r2(y_test, en_yhat)))
print('Explained Variance Score of SVM is: {:.4f}'.format(r2(y_test, svm_yhat)))

```

R-SQUARED values:  
Explained Variance Score of OLS model is: 0.6209  
Explained Variance Score of Ridge model is: 0.6209  
Explained Variance Score of Lasso model is: 0.6209  
Explained Variance Score of Bayesian model is: 0.6206  
Explained Variance Score of Elastic Net is: 0.6208  
Explained Variance Score of SVM is: -0.0090

## Discussion

The theoretical ideal values for R-squared and Explained Variance scores are greater than 0.7 and 0.6, respectively. However, our results showed that the scores for all of the models are below these values, indicating that the constructed models based on data set are inadequate for predicting the prices, accurately.

## Result

In this section, we successfully developed and evaluated five distinct linear regression models through Python. After that, the most appropriate model based on our dataset is suggested. Nevertheless, this does not end here. Each model we created is underpinned by its own statistical and mathematical principles. We used these five models due to their

popularity. However, there are a variety of other linear regression models, such as the Poisson regression model, boosted decision tree model and decision tree model that could be considered in the next version on this work.

## 5-2 Handle of big data workloads with Apache Spark

Our data in this project are not big to use big data processing tools. But to show ability of one of them, we have used **Apache Spark**. It is an open-source, distributed computing system that allows for large-scale data processing and analysis. It provides a general-purpose cluster-computing framework for a wide range of data processing tasks, such as batch processing, interactive queries, stream processing, and machine learning. Spark uses in-memory data processing, which allows for much faster processing of data than traditional disk-based systems.

Spark provides a programming interface, called **PySpark**, for working with data in the Python programming language. One of the key features of Spark is its ability to process data in parallel across a cluster of machines, which allows for faster processing of large data sets. This makes it a popular choice for big data processing and analytics, especially in industries such as finance and retail. It can also be used in combination with other big data technologies such as Hadoop and Apache Storm.

The screenshot shows a Jupyter Notebook interface with the title 'VancouverPropertyAnl.ipynb'. The notebook contains the following code:

```
[128] !pip install pyspark
import pyspark
from pyspark import SparkConf, SparkContext
from pyspark.sql import SparkSession
from pyspark.sql.functions import monotonically_increasing_id
from pyspark.sql.functions import avg
from pyspark.sql.functions import mean
from pyspark.sql.types import FloatType
from pyspark.sql.functions import col
from pyspark.sql.functions import udf
import pandas as pd

Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: pyspark in /usr/local/lib/python3.8/dist-packages (3.3.1)
Requirement already satisfied: py4j==0.10.9.5 in /usr/local/lib/python3.8/dist-packages (from pyspark) (0.10.9.5)

[129] spark = SparkSession.builder.appName("Vancouver House Value prediction").getOrCreate()

[130] from google.colab import files
uploaded = files.upload()

Choose Files Formatted_Zillow.csv
• Formatted_Zillow.csv (text/csv) - 109104 bytes, last modified: 1/26/2023 - 100% done
Saving Formatted_Zillow.csv to Formatted_Zillow (5).csv

[130]

[131] from pyspark.sql.types import DoubleType
df = spark.read.csv("Formatted_Zillow.csv", header=True, inferSchema=True)
df = df.withColumn('Price', col("Price").cast(DoubleType()))
df.printSchema()
```

```

✓ [131] root
0s
|-- Type_Property: string (nullable = true)
|-- Price: double (nullable = true)
|-- Address: string (nullable = true)
|-- Address_Street: string (nullable = true)
|-- Address_Zipcode: string (nullable = true)
|-- N_Beds: integer (nullable = true)
|-- N_Baths: integer (nullable = true)
|-- Area: integer (nullable = true)
|-- Lat: double (nullable = true)
|-- Long: double (nullable = true)
|-- Broker_Name: string (nullable = true)

✓ [132] df.show(5)
0s
+-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|Lat|Long|Broker_Name|
+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo | 429000.0|4990 McGeer St #1...| 4990 McGeer St #114| V5R6C1| 1| 1| 527| 49.23952|-123.032814| RE/MAX City Realty|
| House | 5.988714838 Belmont Ave,...| 4838 Belmont Ave| V6T1A9| 5| 8| 12410| 49.27489|-123.22121| Macdonald Realty|
| Condo | 558000.0|1216 W 11th Ave #...| 1216 W 11th Ave #206| V6H1K5| 1| 1| 865| 49.261246|-123.13179| Sotheby's Interna...|
| Condo | 638800.0|489 Interurban Wa...| 489 Interurban Wa...| V5X0C7| 1| 1| 492| 0.0| 0.0| Jovi Realty Inc.|
| Condo | 1428000.0|3188 Riverwalk Av...| 3188 Riverwalk Av...| V5S0E7| 2| 2| 1131| 49.205387|-123.03918| RE/MAX Crest Realty|
+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 5 rows

✓ [133] df.count()
0s
800

✓ [134] df.select(*[mean(c) for c in df.columns]).show()
0s
+-----+-----+-----+-----+-----+-----+-----+-----+
|avg(Type_Property)| avg(Price)|avg(Address)|avg(Address_Street)|avg(Address_Zipcode)| avg(N_Beds)| avg(N_Baths)| avg(Area)| avg(Lat)| avg(Long)|avg(Broker_Name)|
+-----+-----+-----+-----+-----+-----+-----+-----+
| null|31646498.75375| null| null| null| 3.3404255319148937| 3.0938673341677094| [2196.09625|42.052280633750016|-105.11074844875006| null|
+-----+-----+-----+-----+-----+-----+-----+-----+

```

```

✓ [135] df.groupby('Type_Property').agg({col: 'avg' for col in df.columns[0:17]}).show()
0s
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Type_Property| avg(Area)| avg(N_Beds)|avg(Broker_Name)|avg(Address)| avg(N_Baths)| avg(Lat)| avg(Price)|avg(Type_Property)| avg(Long)|avg(Address_Street)|avg(Addres...|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Townhouse| 1460.36| 2.66| null| null| 2.62| 41.37400892699999| 1718102.61| null|-103.41481889000003| null|
| Lot / Land| 10888.0| null| null| null| null| 49.21254| 650000.0| null|-123.10618| null|
| Condo |1129.8597560975609| 1.8353658536585367| null| null| 1.8353658536585367| 38.001195841463385| 1797490.243902439| null|-94.96351820731712| null|
| House |3770.498281786942| 5.1821308419244| null| null| 4.5326466481899655| 47.21695499656358| 5572819.16494853| null|-118.04527509965634| null|
|Multi-family home| 1651.9| 3.6625| null| null| 3.6125| 40.63356125| 1853304.5625| null|-101.50003080000002| null|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

```

```

✓ [136] train, test = df.randomSplit([0.7, 0.3])
0s
train, test

(DataFrame[Type_Property: string, Price: double, Address: string, Address_Street: string, Address_Zipcode: string, N_Beds: int, N_Baths: int, Area: int, Lat: double, Long: double, Broker_Name: string],
 DataFrame[Type_Property: string, Price: double, Address: string, Address_Street: string, Address_Zipcode: string, N_Beds: int, N_Baths: int, Area: int, Lat: double, Long: double, Broker_Name: string])

✓ [137] numerical_features_lst = train.columns
0s
numerical_features_lst.remove('Price')
numerical_features_lst.remove('Address')
numerical_features_lst.remove('Address_Zipcode')
numerical_features_lst.remove('Address_Street')
numerical_features_lst.remove('Broker_Name')
numerical_features_lst.remove('Type_Property')
numerical_features_lst

['N_Beds', 'N_Baths', 'Area', 'Lat', 'Long']

✓ [138] from pyspark.ml.feature import Imputer
0s
imputer = Imputer(inputCols=numerical_features_lst,
                     outputCols=numerical_features_lst)
imputer = imputer.fit(train)
train = imputer.transform(train)
test = imputer.transform(test)
train.show(7)

✓ [138] +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|Lat|Long|Broker_Name|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo |319000.0|1250 Burnaby St #06| 1250 Burnaby St #06| V6E1P6| 1| 1| 560| 0.0| 0.0| Sutton Group-West...|
| Condo |339000.0|1251 Cardero St #...| 1251 Cardero St #06| V6G2H9| 1| 1| 436| 0.0| 0.0| Coldwell Banker P...|
| Condo |349000.0|1250 Burnaby St #...| 1250 Burnaby St #06| V6E1P6| 1| 1| 570| 49.28147|-123.135605| Sutton Group-West...|
| Condo |378000.0|1850 Comox St #10...| 1850 Comox St #1008| V6G1R3| 1| 1| 546| 0.0| 0.0| Royal Pacific Tr...|
| Condo |399000.0|1219 Harwood St #...| 1219 Harwood St #06| V6E1S5| 1| 1| 540| 0.0| 0.0| Sunrich Realty|
| Condo |399000.0|2165 W 40th Ave #...| 2165 W 40th Ave #404| V6M1W4| 1| 1| 560| 49.235817|-123.157295| RE/MAX Select Pro...|
| Condo |405000.0|1850 Comox St #12...| 1850 Comox St #1207| V6G1R3| 1| 1| 613| 49.288967|-123.140787| Homelife Benchmar...|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 7 rows

✓ [139] from pyspark.ml.feature import VectorAssembler
0s
numerical_vectorAssembler = VectorAssembler(inputCols=numerical_features_lst,
                                             outputCol='numerical_feature_vector')

train = numerical_vectorAssembler.transform(train)
test = numerical_vectorAssembler.transform(test)
train.show(2)

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|Lat|Long|Broker_Name|numerical_feature_vector|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo |319000.0|1250 Burnaby St #06| 1250 Burnaby St #06| V6E1P6| 1| 1| 560| 0.0| 0.0| Sutton Group-West...| [1.0,1.0,560.0,0.0,...|
| Condo |339000.0|1251 Cardero St #...| 1251 Cardero St #06| V6G2H9| 1| 1| 436| 0.0| 0.0| Coldwell Banker P...| [1.0,1.0,436.0,0.0,...|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 2 rows

✓ [140] train.select('numerical_feature_vector').take(2)
0s
[Row(numerical_feature_vector=DenseVector([1.0, 1.0, 560.0, 0.0, 0.0])), Row(numerical_feature_vector=DenseVector([1.0, 1.0, 436.0, 0.0, 0.0]))]

```

```

✓ [141] from pyspark.ml.feature import StandardScaler
  1s
    scaler = StandardScaler(inputCol = 'numerical_feature_vector',
                            outputCol= 'scaled_numerical_feature_vector',
                            withStd= True, withMean=True)

    scaler = scaler.fit(train)

    train = scaler.transform(train)
    test = scaler.transform(test)

    train.show(3)

+-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|
+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo|319000.0|1250 BurRby St #6...| 1250 BurRby St #606| V6E1P6| 1| 1| 560| 0.0| 0.0| Sutton Group-West...|[1.0,1.0,560.0,0,...]| [-1.2099470025672...]
| Condo|339000.0|1251 Cardero St #...|1251 Cardero St #806| V6G2H0| 1| 1| 436| 0.0| 0.0| Coldwell Banker P...|[1.0,1.0,436.0,0,...]| [-1.2099470025672...]
| Condo|349000.0|1250 Burnaby St #...|1250 Burnaby St #607| V6E1P6| 1| 1| 570|49.28147|-123.135605|Sutton Group-West...|[1.0,1.0,570.0,49...]| [-1.2099470025672...]
+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 3 rows

✓ [142] train.select('scaled_numerical_feature_vector').take(3)
  0s
[Row(scaled_numerical_feature_vector=DenseVector([-1.2099, -1.0281, -0.8324, -2.4688, 2.4688])),  

 Row(scaled_numerical_feature_vector=DenseVector([-1.2099, -1.0281, -0.8943, -2.4688, 2.4688])),  

 Row(scaled_numerical_feature_vector=DenseVector([-1.2099, -1.0281, -0.8275, 0.4058, -0.4047]))]

✓ [143] from pyspark.ml.feature import StringIndexer
  1s
    indexer = StringIndexer(inputCol = 'Type_Property', outputCol = 'Type_Property_Index' )

    indexer = indexer.fit(train)
    train = indexer.transform(train)
    test = indexer.transform(test)

    train.show(3)

✓ [143] +-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|
+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo|319000.0|1250 BurRby St #6...| 1250 BurRby St #606| V6E1P6| 1| 1| 560| 0.0| 0.0| Sutton Group-West...|[1.0,1.0,560.0,0,...]| [-1.2099470025672...]
| Condo|339000.0|1251 Cardero St #...|1251 Cardero St #806| V6G2H0| 1| 1| 436| 0.0| 0.0| Coldwell Banker P...|[1.0,1.0,436.0,0,...]| [-1.2099470025672...]
| Condo|349000.0|1250 Burnaby St #...|1250 Burnaby St #607| V6E1P6| 1| 1| 570|49.28147|-123.135605|Sutton Group-West...|[1.0,1.0,570.0,49...]| [-1.2099470025672...]
+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 3 rows

✓ [144] set(train.select('Type_Property_Index').collect())
  0s
{Row(Type_Property_Index=0.0),  

 Row(Type_Property_Index=1.0),  

 Row(Type_Property_Index=2.0),  

 Row(Type_Property_Index=3.0)}

✓ [145] from pyspark.ml.feature import OneHotEncoder
  1s
    one_hot_encoder = OneHotEncoder(inputCol='Type_Property_Index', outputCol = 'Type_Property_One_Hot' )

    one_hot_encoder = one_hot_encoder.fit(train)

    train = one_hot_encoder.transform(train)
    test = one_hot_encoder.transform(test)

    train.show(3)

+-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|
+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo|319000.0|1250 BurRby St #6...| 1250 BurRby St #606| V6E1P6| 1| 1| 560| 0.0| 0.0| Sutton Group-West...|[1.0,1.0,560.0,0,...]| [-1.2099470025672...]
| Condo|339000.0|1251 Cardero St #...|1251 Cardero St #806| V6G2H0| 1| 1| 436| 0.0| 0.0| Coldwell Banker P...|[1.0,1.0,436.0,0,...]| [-1.2099470025672...]
| Condo|349000.0|1250 Burnaby St #...|1250 Burnaby St #607| V6E1P6| 1| 1| 570|49.28147|-123.135605|Sutton Group-West...|[1.0,1.0,570.0,49...]| [-1.2099470025672...]
+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 3 rows

✓ [146] assembler = VectorAssembler(inputCols=['scaled_numerical_feature_vector', 'Type_Property_One_Hot'],
  0s
          outputCol='final_feature_vector')

    train = assembler.transform(train)
    test = assembler.transform(test)
    train.show(2)

+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|Type_Property| Price| Address| Address_Street|Address_Zipcode|N_Beds|N_Baths|Area|Lat|Long| Broker_Name|numerical_feature_vector|scaled_numerical_feature_vector|Type_Property_Index|Typ
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo|319000.0|1250 BurRby St #6...| 1250 BurRby St #606| V6E1P6| 1| 1| 560|0.0| 0.0| Sutton Group-West...|[1.0,1.0,560.0,0,...]| [-1.2099470025672...]| 0.0|
| Condo|339000.0|1251 Cardero St #...|1251 Cardero St #806| V6G2H0| 1| 1| 436|0.0| 0.0| Coldwell Banker P...|[1.0,1.0,436.0,0,...]| [-1.2099470025672...]| 0.0|
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 2 rows

✓ [147] train.select('final_feature_vector').take(2)
  0s
[Row(final_feature_vector=DenseVector([-1.2099, -1.0281, -0.8324, -2.4688, 2.4688, 1.0, 0.0, 0.0, 0.0))),  

 Row(final_feature_vector=DenseVector([-1.2099, -1.0281, -0.8943, -2.4688, 2.4688, 1.0, 0.0, 0.0, 0.0]))]

✓ [148] from pyspark.ml.regression import LinearRegression
  0s
    lr = LinearRegression(featuresCol = 'final_feature_vector', labelCol='Price')

    lr

    LinearRegression_2972c72ffff8

✓ [149] lr = lr.fit(train)
  1s
    lr

    LinearRegressionModel: uid=LinearRegression_2972c72ffff8, numFeatures=8

✓ [150] pred_train_df = lr.transform(train).withColumnRenamed('prediction', 'Predicted_House_Price')
  0s
    pred_train_df.show(5)

```

```

[176] +-----+-----+-----+-----+-----+-----+-----+-----+
| Type_Property | Price | Address | Address_Street | Address_Zipcode | N_Beds | N_Baths | Area | Lat | Long | Broker_Name | numerical_feature_vector | scaled_numerical_feature_vector | type_Prop
+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo [319000.0] | 1250 Burnaby St #... | 1250 Burnaby St #061 | V6E1P6 | 1 | 1 | 560 | 0.0 | 0.0 | Sutton Group-West... | [1,0,1,0,560,0,0,...] | [-1.2422016680011...]
| Condo [349000.0] | 1250 Burnaby St #... | 1250 Burnaby St #067 | V6E1P6 | 1 | 1 | 570 | 49.28147 | -123.135605 | Sutton Group-West... | [1,0,1,0,570,0,49,...] | [-1.2422016680011...]
| Condo [378000.0] | 1850 Comox St #10... | 1850 Comox St #1088 | V6G1R3 | 1 | 1 | 546 | 0.0 | 0.0 | Royal Pacific Tri... | [1,0,1,0,546,0,0,...] | [-1.2422016680011...]
| Condo [399000.0] | 1219 Harwood St #... | 1219 Harwood St #603 | V6E1SS | 1 | 1 | 540 | 0.0 | 0.0 | Sunrich Realty | [1,0,1,0,540,0,0,...] | [-1.2422016680011...]
| Condo [399000.0] | 1534 Harwood St #... | 1534 Harwood St #... | V6G1X9 | 1 | 1 | 540 | 49.283222 | -123.140495 | Stilhavn Real Est... | [1,0,1,0,540,0,49,...] | [-1.2422016680011...
+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 5 rows

```

```

[177] pred_test_df = lr.transform(test).withColumnRenamed('prediction', 'Predicted_House_Price')
pred_test_df.show(5)

```

```

+-----+-----+-----+-----+-----+-----+-----+-----+
| Type_Property | Price | Address | Address_Street | Address_Zipcode | N_Beds | N_Baths | Area | Lat | Long | Broker_Name | numerical_feature_vector | scaled_numerical_feature_vector | type_Prop
+-----+-----+-----+-----+-----+-----+-----+-----+
| Condo [339000.0] | 1251 Cardero St #... | 1251 Cardero St #806 | V6G2H9 | 1 | 1 | 436 | 0.0 | 0.0 | Coldwell Banker P... | [1,0,1,0,436,0,0,...] | [-1.2422016680011...]
| Condo [349000.0] | 1219 Harwood St #... | 1219 Harwood St #604 | V6E1S5 | 1 | 1 | 547 | 49.2808 | -123.13561 | Century 21 In Tow... | [1,0,1,0,547,0,49,...] | [-1.2422016680011...
| Condo [380000.0] | 2255 Eton St #106... | 2255 Eton St #106 | VSL1C9 | 1 | 1 | 541 | 49.287766 | -123.05868 | RE/MAX Crest Realt... | [1,0,1,0,541,0,49,...] | [-1.2422016680011...
| Condo [399000.0] | 2165 W 40th Ave #... | 2165 W 40th Ave #404 | V6M1W4 | 1 | 1 | 560 | 49.235817 | -123.157295 | RE/MAX Select Pro... | [1,0,1,0,560,0,49,...] | [-1.2422016680011...
| Condo [438800.0] | 567 Hornby St #1207 | 567 Hornby St #1207 | V6C2E8 | 1 | 1 | 383 | 0.0 | 0.0 | Park Georgia Real... | [1,0,1,0,383,0,0,...] | [-1.2422016680011...
+-----+-----+-----+-----+-----+-----+-----+-----+
only showing top 5 rows

```

```

[178] pred_test_pd_df = pred_test_df.toPandas()
pred_test_pd_df.head(2)

```

index	Type_Property	Price	Address	Address_Street	Address_Zipcode	N_Beds	N_Baths	Area	Lat	Long	Broker_Name	numerical_feature_vector	scaled_numerical_feature_vector
0	Condo	339000.0	1251 Cardero St #806	1251 Cardero St #806	V6G2H9	1	1	436	0.0	Coldwell Banker Prestige Realty	[1,0,1,0,436,0,0,0,0]	[-1.2422016680011334,-1.0607991189354384,-0.9212716771034052,-2.52652885]	
1	Condo	349000.0	1219 Harwood St #604	1219 Harwood St #604	V6E1S5	1	1	547	49.2808	-123.13561	Century 21 In Town Realty	[1,0,1,0,547,0,49,2808,-123.13561]	[-1.2422016680011334,-1.0607991189354384,-0.8641896927378544,0.396553585]

Show 25 per page  
Like what you see? Visit the [data.table notebook](#) to learn more about interactive tables.

```

[179] predictions_and_actuals = pred_test_df[['Predicted_House_Price','Price']]
predictions_and_actuals_rdd = predictions_and_actuals.rdd
predictions_and_actuals_rdd.take(3)

```

```

[Row(Predicted_House_Price=437382.53898741305, Price=339000.0),
 Row(Predicted_House_Price=793096.2317139432, Price=349000.0),
 Row(Predicted_House_Price=1030928.0085978992, Price=380000.0)]

```

```

[180] predictions_and_actuals = predictions_and_actuals_rdd.map(tuple)
predictions_and_actuals_rdd.take(2)

```

```

[Row(Predicted_House_Price=437382.53898741305, Price=339000.0),
 Row(Predicted_House_Price=793096.2317139432, Price=349000.0)]

```

```

[181] from pyspark.mllib.evaluation import RegressionMetrics
metrics = RegressionMetrics(predictions_and_actuals_rdd)

s = """
Mean Squared Error:      {0}
Root Mean Squared Error: {1}
Mean Absolute Error:    {2}
R**2:                   {3}
""".format(metrics.meanSquaredError,
           metrics.rootMeanSquaredError,
           metrics.meanAbsoluteError,
           metrics.r2)
print(s)

/usr/local/lib/python3.8/dist-packages/pyspark/sql/context.py:157: FutureWarning: Deprecation in 3.0.0. Use SparkSession.builder.getOrCreate() instead.
warnings.warn(

```

```

Mean Squared Error:      7540412179856.261
Root Mean Squared Error: 2745981.096048598
Mean Absolute Error:    1078876.1753957355
R**2:                   0.7232783849229282

```

## 5-2 Discussion

To see precise of our modeling, we calculate four following metrics to evaluate the performance of our LR model:

- 1- Mean Squared Error (MSE)
- 2- Root of Mean Squared Error (RMSE)
- 3- Mean Absolut Error (MAE)
- 4- R<sup>2</sup>

It is evident that a high Mean Squared Error (MSE) value indicates that the model is a poorer fit for the data and has a larger discrepancy between the predicated and actual values. It is important to note that MSE is highly sensitive to the scale of the target variable, and consequently, if the target variable is on a large scale, then the MSE will also be large. In order to compare different models or datasets, it is recommended to use relative error metrics, such as Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE).

The primary reasons for such errors are primarily due to an insufficient data set, a small sample size and the presence of outliers. A comprehensive data set which includes a wide array of information about the properties, such as living room area (in sqft), number of floors, waterfront (yes/ no), view (ranked), condition (ranked), grade (level in building for condo), area of above floor (in sqft), area of basement (in sqft), year of built, renovated (yes/ no), and year of renovation, can allow for more precise price predictions.

A meager sample size of 2900 rows inadequate to split into training and test sets is also a contributing factor. Finally, linear regression is highly sensitive to outliers, and if the data set contains any such points, robust regression methods should be implemented.

## Section 6 Building a data pipeline with Google Dataflow and Apache Beam

In this section, we continue our job by creating a data-parallel processing pipeline with GCP<sup>6</sup>. Among existing tools, we work with Google Cloud Dataflow, a fully-managed, serverless data processing service that provides a programming model for batch and stream processing, with support for distributed processing back-end, Apache Beam.

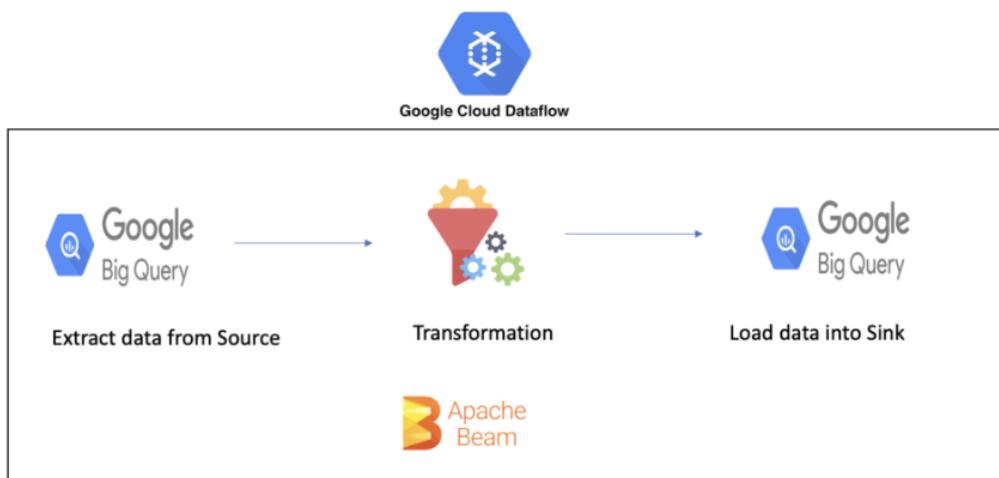


Figure 17 BigQuery data pipeline using Google Cloud Dataflow/Apache Beam [source: www.revisitclass.com]

To build and execute data pipeline ETL, we follow next steps.

First of all we enabled Dataflow and Bigquery APIs. Afterwards we create a cloud storage bucket in the nearest region and store the Zillow.csv data file in the bucket.

This phase includes following steps:

- 1- Read input data file into a pcollection: Input data for pipelines can be in any form: csv or json. We used Zillow.csv that created in previous section.
- 2- Create new pcollection(s) by applying filters, transforms on existing pcollection
- 3- Create new pcollection(s) by grouping: GroupByKey
- 4- Create new pcollection(s) by combining pcollection s: CoGroupByKey
- 5- Apply aggregate functions: count, sum
- 6- Mapping the result to convert into a dictionary format
- 7- Dumping the pipeline output into BigQuery table sink

Here we have some code snapshot and screenshot of GCP environment:

<sup>6</sup> Google Cloud Platform

```

File Edit View Insert Runtime Tools Help
+ Code + Text
[1]: !pip install apache_beam
[2]: import apache_beam as beam
[3]: pipe = beam.Pipeline()
[4]: 
[5]: from logging import Filter
from postxpath import split
from apache_beam.typehints.schemas import Mapping
data = (pipe | beam.io.ReadFromText('/content/zillow.csv', skip_header_lines=True)
| beam.Map(lambda x:x.split(","))
| beam.Map(print))
[6]: 
[7]: pipe.run()

```

[23]: from logging import Filter  
from postxpath import split  
from apache\_beam.typehints.schemas import Mapping  
data = (pipe | beam.io.ReadFromText('/content/zillow.csv', skip\_header\_lines=True)  
| beam.Map(lambda x:x.split(","))  
| beam.Map(print))  
)

[24]: pipe.run()

[427]: '2069444667', '2069444667', '[https://photos.zilloustatic.com/f0/38ea12eeda3b433bd13bda48fe8296\\_o\\_a.jpg](https://photos.zilloustatic.com/f0/38ea12eeda3b433bd13bda48fe8296_o_a.jpg)', '[https://www.zillow.com/homedetails/1135-Barclay-St-5-Vancouver-BC-v6f448b3-31438928\\_z.html](https://www.zillow.com/homedetails/1135-Barclay-St-5-Vancouver-BC-v6f448b3-31438928_z.html)'  
[385]: '314426956', '314426956', '[https://photos.zilloustatic.com/f0/4c1a4c7d7498beffaf9543d0ca73807f\\_o\\_a.jpg](https://photos.zilloustatic.com/f0/4c1a4c7d7498beffaf9543d0ca73807f_o_a.jpg)', '[https://www.zillow.com/homedetails/1486-W-Hastings-St-Vancouver-BC-v6d3385c-314426956\\_z.html](https://www.zillow.com/homedetails/1486-W-Hastings-St-Vancouver-BC-v6d3385c-314426956_z.html)'  
[442]: '2069055925', '2069055925', '[https://photos.zilloustatic.com/f0/5e9197d1387ed023ebc3823a0a395a4563\\_o\\_a.jpg](https://photos.zilloustatic.com/f0/5e9197d1387ed023ebc3823a0a395a4563_o_a.jpg)', '[https://www.zillow.com/homedetails/1382-CobbLane-Ave-Vancouver-BC-v593548c-2069055925\\_z.html](https://www.zillow.com/homedetails/1382-CobbLane-Ave-Vancouver-BC-v593548c-2069055925_z.html)'  
[381]: '20690515061', '20690515061', '[https://photos.zilloustatic.com/f0/873d0d9b7919b3c71ed515708736c41-o\\_a.jpg](https://photos.zilloustatic.com/f0/873d0d9b7919b3c71ed515708736c41-o_a.jpg)', '[https://www.zillow.com/homedetails/1893-W-15th-Ave-Vancouver-BC-v672448b-20690515061\\_z.html](https://www.zillow.com/homedetails/1893-W-15th-Ave-Vancouver-BC-v672448b-20690515061_z.html)'  
[478]: '2075344684', '2075344684', '[https://photos.zilloustatic.com/f0/11d02aa5a1917386ed5039b7e310d\\_o\\_a.jpg](https://photos.zilloustatic.com/f0/11d02aa5a1917386ed5039b7e310d_o_a.jpg)', '[https://www.zillow.com/homedetails/1888-E-Kent-Ave-Vancouver-BC-v593548c-2075344684\\_z.html](https://www.zillow.com/homedetails/1888-E-Kent-Ave-Vancouver-BC-v593548c-2075344684_z.html)'  
[787]: '20698340900', '20698340900', '[https://photos.zilloustatic.com/f0/aae9843bf731af7a010500300hfefid\\_o\\_a.jpg](https://photos.zilloustatic.com/f0/aae9843bf731af7a010500300hfefid_o_a.jpg)', '[https://www.zillow.com/homedetails/1988-E-Kent-Ave-Vancouver-BC-v593548c-20698340900\\_z.html](https://www.zillow.com/homedetails/1988-E-Kent-Ave-Vancouver-BC-v593548c-20698340900_z.html)'  
[1195]: '2072711525', '2072711525', '<https://maps.googleapis.com/maps/api/statistics/mobile=false&sensor=true&key=your satellite key&zoom=17&center=-123.027>'  
[2072711525], '[https://www.zillow.com/homedetails/1135-Barclay-St-5-Vancouver-BC-v6f448b3-31438928\\_z.html](https://www.zillow.com/homedetails/1135-Barclay-St-5-Vancouver-BC-v6f448b3-31438928_z.html)'

Google Cloud VancouverRSPipeline

**Project info**

- Project name: VancouverRSPipeline
- Project number: 438286799803
- Project ID: vancouverrspipeline

**RPC APIs**

Requests (requests/sec)

Google Cloud Platform status

Multiple Products

Cloud Build: Google Cloud Networking experiencing GCLB connection errors from virtual instances. Began at 2023-01-30 (09:35:16)

Cloud Firestore: Europe-west2: Cloud Firestore Degraded Availability. Began at 2023-01-30 (09:32:53)

Multiple Products

Cloud Build: Global: Cloud Build is experiencing permission issues while uploading some Google Cloud Storage artifacts. Began at 2023-01-30 (08:59:03)

All times are US/Pacific Data provided by status.cloud.google.com

Go to Cloud status dashboard

**Resources**

- BigQuery: Data warehouse/analytics
- SQL: Managed MySQL, PostgreSQL, SQL Server
- Compute Engine: VMs, GPUs, TPUs, Disks
- Storage: Multi-class multi-region object storage
- Cloud Functions: Event-driven serverless functions
- App Engine: Managed app platform

**Trace**

**Billing**

Estimated charges CAD \$0.00 For the billing period Jan 1 – 30, 2023

Take a tour of billing

View detailed charges

**Monitoring**

Create my dashboard Set up alerting policies

BigQuery bqjob\_1e4d3543\_1860443f922

+ Code + Text Copy to Drive

**Setup**

```

[ ] # @title Setup
from google.colab import auth
from google.cloud import bigquery
from google.colab import data_table

```

project = 'vancouverrspipeline' # Project ID inserted based on the query results selected to explore  
location = 'US' # Location inserted based on the query results selected to explore  
client = bigquery.Client(project=project, location=location)  
data\_table.enable\_dataframe\_formatter()  
auth.authenticate\_user()

**Reference SQL syntax from the original job**

Use the `jobs.query` method to return the SQL syntax from the job. This can be copied from the output cell below to edit the query now or in the future. Alternatively, you can use this link back to BigQuery to edit the query within the BigQuery user interface.

```

[ ] # Running this code will display the query used to generate your previous job
job = client.get_job('bqjob_1e4d3543_1860443f922') # Job ID inserted based on the query results selected to explore
print(job.query)

```

**Result set loaded from BigQuery job as a DataFrame**

Query results are referenced from the Job ID ran from BigQuery and the query does not need to be re-run to explore results. The `to_dataframe` method downloads the results to a Pandas DataFrame by using the BigQuery Storage API.

To edit query syntax, you can do so from the BigQuery SQL editor or in the `Optional:` sections below.

```

[ ] # Running this code will read results from your previous job
job = client.get_job('bqjob_1e4d3543_1860443f922') # Job ID inserted based on the query results selected to explore
results = job.to_dataframe()
results

```

Here we can see descriptive result of run bigQuery with above criteria. They include count, mean, std, min, max, 25%, 50%, 75% and max.

Show descriptive statistics using describe()

Use the pandas DataFrame.describe() method to generate descriptive statistics. Descriptive statistics include those that summarize the central tendency, dispersion and shape of a dataset's distribution, excluding NaN values. You may also use other Python methods to interact with your data.

[5] results.describe()

	level_0	index	zpid	id	Price	beds	baths	area	Lat	Long	best_deal
count		192.0	192.0	192.0	192.0	192.0	192.0	192.0	192.0	192.0	192.0
mean		407.5260416666667	1999112127.890625	1999112127.890625	677814.1927083334	1.4010416666666667	1.3385416666666667	732.0572916666666	39.0003855895833	-97.46146816749999	677814.1927083334
std		290.9767795362299	328600253.37105954	328600253.37105954	177427.6615062614	0.6557030983826607	0.4744508628840805	203.20662851702156	20.059090241841872	50.1274005715234	177427.6615062614
min		40.0	314324455.0	314324455.0	319000.0	0.0	1.0	383.0	0.0	-123.211754	319000.0
25%		164.75	2060218579.75	2060218579.75	550750.0	1.0	1.0	567.0	49.21496949999995	-123.132186	550750.0
50%		344.0	2060835838.5	2060835838.5	649450.0	1.0	1.0	719.0	49.2636105	-123.10145	649450.0
75%		608.0	2062338753.5	2062338753.5	811750.0	2.0	2.0	860.25	49.277709	-123.0322937500001	811750.0
max		1199.0	2081362214.0	2081362214.0	999999.0	3.0	2.0	1350.0	49.29315	0.0	999999.0

Show [25] per page

The screenshot shows the Google Cloud BigQuery interface. On the left, the sidebar includes sections for Analysis, Data transfers, Scheduled queries, Analytics Hub, Dataform, and Partner Center. The main area displays a query titled 'Query1-2023-01-30' with the following SQL code:

```
1 SELECT * FROM `zillow_dataset.zillow_table` WHERE ( Price < 1000000 AND TypeofProperty="Condo" )
```

The 'Query results' section shows a table with the following data:

Row	index	zpid	id	imgSrc	detailUrl	TypeofProperty	formattedprice	Price	address
1	411	2060499969	2060499969	https://photos.zillowstatic.com/fp/85694207604c51fec4d4a083ffcb13d_p_e.jpg	https://www.zillow.com/homedetails/2239-Kingsway-109-Vancouver-BC-V5N-0E5/2060499969_zpid/	Condo	C\$449,000	449000	2239 Kingsway
2	636	2060854306	2060854306	https://photos.zillowstatic.com/fp/91c17129a9e62dd0c158a8457c99fb_p_e.jpg	https://www.zillow.com/homedetails/1221-Bidwell-St-904-Vancouver-BC-V6G-0B1/2060854306_zpid/	Condo	C\$599,900	599900	1221 Bidwell St
3	463	2081362214	2081362214	https://photos.zillowstatic.com/fp/a981c7129a9e62dd0c158a8b060c5d11_p-e.jpg	https://www.zillow.com/homedetails/1225-Richards-St-805-Vancouver-BC-V6B-1E6/2081362214_zpid/	Condo	C\$564,900	564900	1225 Richards
4	52	2060119979	2060119979	https://photos.zillowstatic.com/fp/e8540b3e63afef0de69a8d9801ba-p_e.jpg	https://www.zillow.com/homedetails/2408-Grant-St-204-Vancouver-BC-V5K-304/2060119979_zpid/	Condo	C\$478,000	478000	2408 Grant St
5	967	2060499969	2060499969	https://photos.zillowstatic.com/fp/91c17129a9e62dd0c158a8457c99fb_p-e.jpg	https://www.zillow.com/homedetails/2239-Kingsway-109-Vancouver-BC-V5N-0E5/2060499969_zpid/	Condo	C\$449,000	449000	2239 Kingsway

## Section 7 Conclusion

In this study, we have walked through to providing required data about real estate market in Vancouver, BC. Canada, we scraped data, preprocessed and did some basic statistical procedure. Afterward. We had some visualization with Python and Tableau to demonstration feature of distribution of real estate based on diversity and category. We also carried out some data manipulate through database specially SQL and SELECT statement. Finally we tried to predict housing price with LR model based on data in hand.

To be sure, prediction property price is a challenging problem. In our case, it may be more appropriate to use non-linear models or other types of statistical analysis. Additionally, it is important to be aware of the assumptions of LR, such as linearity, independence of errors, and normality of errors and check if these assumptions are met before applying LR. It is also worth considering other factors that may be affecting the relationship between the variables, such as outliers or multi-collinearity.

Linear regression (LR) is a powerful tool that allows researchers to examine the multiple factors that contribute to social experiences and control for the influence of spurious effects. It also helps in creating refined graphs of relationships through regression lines, which can be a straightforward and accessible way of presenting results. Understanding LR coefficients enables us to understand both the direction and strength of the relationship between variables. However, care is needed to examine variables and construct them in forms that are amenable to this approach, such as creating

dummy variables. They also need to examine findings carefully and test for concerns such as collinearity or patterns among residuals. Despite this, LRs are quite forgiving of minor breaches of these assumptions and can produce some of the most useful information on the relationships between variables.

Based on our dataset, using of LR is not recommended, because the direction of the correlation is not clear from the scatter plot. If the scatter plot shows a clear pattern, such as a positive or negative correlation, it is more likely that a LR model will provide useful results. However, in our case, the scatter plot [Figure 8] shows a complex pattern or no clear relationship.

## Appendix

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### Keywords

data pipeline, json, big data, bigquery, GCP, data science, data mining, ETL (Extract-Transform-Load), Github, pandas, GeoJson, geopy ,machine learning, mathplotlib, scraping, pyspark, apache spark, apache beam, data visualization, tableau, folium, seaborn, sqlite3, numpy, web scraping, google dataflow, sklearn

### The Tools

Anaconda, Python, SQL, Tableau (Public), Google Cloud Platform (GCP), Google Colab, Google Trends

### About the author



Kasra Heidarinezhad has achieved Bachelor and Master's degree in Computer Engineering from the I. Azad University. He is an accomplished Data engineer, having developed effective solutions to challenging data-related problems. His expertise includes Big Data, Machine Learning, and Predictive Analytics, and he is well-versed in various programming languages and software tools which aid in the analysis and engineering of data. Kasra has been involved in data-driven projects in the financial services, retail, gas-oil, and energy industries. He has a comprehensive knowledge of the data lifecycle, from acquisition, cleaning, and analysis to visualization. Additionally, Kasra is highly capable of designing data pipelines, data warehouses, and machine learning models.

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