2440086155_FinalExam

Thursday, July 14, 2022.

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Video Link :https://binusianorg-my.sharepoint.com/personal/sharen_ivana_binus_ac_id/_layouts/15/guestaccess.aspx?guestaccesstoken=7LKliwLRPl0sfyTDxggnduINAV19WXZZ%2FreXerKU3XM%3D&folderid=2_05c4aed8786de4eb8a90e0ff708c7df2f&rev=1&e=J9cMyN

- Dataset Link

Dataset Description

a record of the crimes that have occurred in Chicago

- **Domestic :** Indicates whether the incident was domestic-related as defined by the Illinois Domestic Violence Act.
- **Beat :** Indicates the beat where the incident occurred. A beat is the smallest police geographic area – each beat has a dedicated police beat car. Three to five beats make up a police sector, and three sectors make up a police district. The Chicago Police Department has 22 police districts.
- **District :** Indicates the police district where the incident occurred
- **Ward :** The ward(City Council District) where the incident occurred
- **Community Are :** Indicates the community area where the incident occurred. Chicago has 77 community areas.
- **FBI Code :** Indicates the crime classification as outlined in the FBI's National Incident-Based Reporting System (NIBRS).
- **Date :** A given month (1 : January, 12 : December); a given hour (1 to 23)

NOTES:

- You are required to build **'the BEST and suitable'** supervised machine learning model for the given dataset. The model may be used for the effective deployment of police officers in a city across several districts regarding the degree to which each area is prone to crime at a particular hour, day, and month.
- Build multiple potentially suitable machine learning models (at least 2 different machine learning models).
- You have to evaluate the models using at least 2 performance metrics before choose what you assume to be the `"best"` model for the given dataset.

HINT:

1. You need to generate the target feature by **performing feature engineering on `Date` and `Primary Type` features** to group crimes together
2. Level of Crime Rate:
   - **0-14 :** Low Crime Rate
   - **15-33 :** Medium Crime Rate
   - **34 and above :** High Crime Rate

   - You may need to check the data proportion in each class (imbalance/not)

1. Load the neccessary Libraries and Data (2 pts.)

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
import warnings
import statsmodels.api as sm
import statsmodels.formula.api as smf
import sklearn

from sklearn import preprocessing
from sklearn.preprocessing import StandardScaler
from sklearn.datasets import make_classification
from sklearn.model_selection import train_test_split, cross_val_predict
from sklearn.pipeline import Pipeline
from sklearn.compose import ColumnTransformer
from sklearn.impute import SimpleImputer
from sklearn.preprocessing import OneHotEncoder
from math import remainder
from sklearn import svm, datasets
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import KFold, cross_val_score
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import LabelEncoder
from sklearn.datasets import load_breast_cancer
from sklearn.neighbors import KNeighborsClassifier as KNN
from sklearn.metrics import classification_report
from sklearn import metrics
from sklearn.metrics import precision_score,recall_score, confusion_matrix, classification
from sklearn.ensemble import RandomForestClassifier
```

```
/usr/local/lib/python3.7/dist-packages/statsmodels/tools/_testing.py:19: FutureWarnin
  import pandas.util.testing as tm
```

2. Data Exploration (15 pts.)

Import dataset Sharen_Odd

```
from google.colab import drive
drive.mount("/content/gdrive")
Sharen_Odd = pd.read_csv('/content/gdrive/My Drive/Dataset UAS ML/OddID.csv')
Sharen_Odd
```

```
Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive
```

Unnamed: 0	ID	Case Number	Date	Block	IUCR	Primary Type

menampilkan 10 data teratas dari dataset Sharen_Odd

```
Sharen_Odd.head(10)
```

	Unnamed: 0	ID	Case Number	Date	Block	IUCR	Primary Type	Descripti
0	1024161	11254362	JB183495	03/12/2018 07:32:00 PM	017XX W CHICAGO AVE	0560	ASSAULT	SIMP
1	428801	10540177	HZ285387	05/29/2016 11:28:00 PM	027XX S STATE ST	0454	BATTERY	AGG HAN NO/M INJU
2	1099812	11624449	JC187320	03/16/2019 02:10:00 AM	101XX S PRINCETON AVE	031A	ROBBERY	ARME HANDG
3	595228	11109388	JA459177	10/05/2017 11:00:00 AM	019XX W OGDEN AVE	0810	THEFT	OVER $5
4	1033611	11241624	JB166623	02/26/2018 07:51:00 PM	067XX S COTTAGE GROVE AVE	1330	CRIMINAL TRESPASS	TO LAN
5	954838	11349522	JB309088	06/16/2018 07:00:00 AM	063XX N WAYNE AVE	0810	THEFT	OVER $5
6	319779	10716523	HZ474727	10/14/2016 02:00:00 PM	042XX W 31ST ST	0820	THEFT	$500 AN UND
7	886493	11441117	JB428604	09/09/2018 02:10:00 PM	0000X S STATE ST	0860	THEFT	RET THE
8	918820	11398123	JB372965	07/31/2018 01:00:00 PM	006XX E GRAND AVE	0484	BATTERY	PRO E HAN NO/M INJU
9	17633	10335273	HY526308	12/05/2015 08:10:00 PM	027XX N MOODY AVE	0486	BATTERY	DOMEST BATTE SIMP

10 rows × 23 columns

Menampilkan 10 data terbawah dari dataset Sharen_Odd

```
Sharen_Odd.tail(10)
```

	Unnamed: 0	ID	Case Number	Date	Block	IUCR	Primary Type	I
1031734	998679	11291299	JB231971	04/21/2018 01:12:00 AM	058XX S FAIRFIELD AVE	1320	CRIMINAL DAMAGE	
1031735	95349	10205821	HY392671	08/22/2015 09:20:00 AM	029XX W 63RD ST	0820	THEFT	
1031736	205306	10016465	HY205929	03/31/2015 10:00:00 PM	037XX W DICKENS AVE	0820	THEFT	
1031737	249662	9936233	HY124991	01/22/2015 06:25:00 PM	009XX W NORTH AVE	0860	THEFT	RE
1031738	231171	9969662	HY159284	02/21/2015 06:15:00 PM	040XX W MADISON ST	031A	ROBBERY	
1031739	540482	11182652	JA556030	12/19/2017 08:10:00 PM	076XX S DREXEL AVE	0486	BATTERY	
1031740	750276	10880463	JA189513	03/16/2017 01:00:00 PM	028XX N MOBILE AVE	0486	BATTERY	
1031741	122985	10157277	HY346558	07/18/2015 09:30:00 PM	072XX S LOWE AVE	0620	BURGLARY	
1031742	929773	11383727	JB354262	07/17/2018 10:56:00 PM	063XX S PEORIA DR	2021	NARCOTICS	BA
1031743	337187	10689428	HZ443522	09/21/2016 01:10:00 PM	029XX N BROADWAY	1330	CRIMINAL TRESPASS	

10 rows × 23 columns

Menampilkan shape dari dataset Sharen_Odd

```
Sharen_Odd.shape
```

```
(1031744, 23)
```

Sharen_Odd.shape berfungsi untuk menjelaskan bentuk array saat ini. Numpy akan memberi tahu bahwa dataset Sharen_Odd kita terdiri dari 1031744 baris dan 23 kolom.

Menampilkan info dari dataset Sharen_Odd

```
Sharen_Odd.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1031744 entries, 0 to 1031743
Data columns (total 23 columns):
 #   Column                Non-Null Count    Dtype
---  ------                --------------    -----
 0   Unnamed: 0            1031744 non-null  int64
 1   ID                    1031744 non-null  int64
 2   Case Number           1031744 non-null  object
 3   Date                  1031744 non-null  object
 4   Block                 1031744 non-null  object
 5   IUCR                  1031744 non-null  object
 6   Primary Type          1031744 non-null  object
 7   Description           1031744 non-null  object
 8   Location Description  1028477 non-null  object
 9   Arrest                1031744 non-null  bool
 10  Domestic              1031744 non-null  bool
 11  Beat                  1031744 non-null  int64
 12  District              1031743 non-null  float64
 13  Ward                  1031738 non-null  float64
 14  Community Area        1031742 non-null  float64
 15  FBI Code              1031744 non-null  object
 16  X Coordinate          1019181 non-null  float64
 17  Y Coordinate          1019181 non-null  float64
 18  Year                  1031744 non-null  int64
 19  Updated On            1031744 non-null  object
 20  Latitude              1019181 non-null  float64
 21  Longitude             1019181 non-null  float64
 22  Location              1019181 non-null  object
dtypes: bool(2), float64(7), int64(4), object(10)
memory usage: 167.3+ MB
```

```
Sharen_Odd.dtypes
```

```
Unnamed: 0                int64
ID                        int64
Case Number              object
Date                     object
Block                    object
IUCR                     object
Primary Type             object
Description              object
Location Description     object
Arrest                     bool
Domestic                   bool
Beat                      int64
District                float64
```

```
Ward                    float64
Community Area          float64
FBI Code                 object
X Coordinate            float64
Y Coordinate            float64
Year                      int64
Updated On               object
Latitude                float64
Longitude               float64
Location                 object
dtype: object
```

Dari hasil diatas, diketahui terdapat 2 variabel dengan tipe data BOOL, 7 variabel dengan tipe data FLOAT, 4 variabel dengan tipe data INT, dan 10 variabel dengan tipe data OBJECT.

Menampilkan deskripsi data dari dataset Sharen_Odd

```
Sharen_Odd.describe()
```

	Unnamed: 0	ID	Beat	District	Ward	Commun: A
count	1.031744e+06	1.031744e+06	1.031744e+06	1.031743e+06	1.031738e+06	1.031742e-
mean	5.734502e+05	1.081694e+07	1.144468e+03	1.121607e+01	2.316172e+01	3.686135e-
std	3.308943e+05	7.250323e+05	6.942233e+02	6.934780e+00	1.398308e+01	2.141199e-
min	0.000000e+00	2.171400e+04	1.110000e+02	1.000000e+00	1.000000e+00	0.000000e-
25%	2.869228e+05	1.040797e+07	6.120000e+02	6.000000e+00	1.000000e+01	2.300000e-
50%	5.737245e+05	1.087063e+07	1.031000e+03	1.000000e+01	2.400000e+01	3.200000e-
75%	8.598735e+05	1.127863e+07	1.713000e+03	1.700000e+01	3.400000e+01	5.400000e-
max	1.146380e+06	1.168250e+07	2.535000e+03	3.100000e+01	5.000000e+01	7.700000e-

Dari hasil diatas, ditampilkan basic statistical data dari dataset Sharen_Odd, dimana terdapat masing-masing nilai mean, standar deviasi, maximum, minimum, dan masi banyak lagi dari setiap kolomnya.

Menampilkan urutan menurun sehingga elemen pertama adalah elemen yang paling sering muncul

```
Sharen_Odd.value_counts()
```

```
Unnamed: 0  ID        Case Number  Date                       Block
```

```
IUCR  Primary Type       Description                          Location
Description              Arrest  Domestic  Beat  District  Ward  Community Area
FBI Code  X Coordinate  Y Coordinate  Year  Updated On             Latitude
Longitude   Location
1           10365064  HZ100370     12/31/2015 11:59:00 PM  075XX S EMERALD AVE
1320  CRIMINAL DAMAGE     TO VEHICLE                           STREET
False   False     621   6.0       17.0  68.0            14        1172605.0
1854931.0     2015  02/10/2018 03:50:01 PM  41.757367  -87.642993  (41.757366519,
-87.642992854)    1
765866      10855197  JA160258     02/20/2017 12:12:00 AM  0000X W JACKSON BLVD
0460  BATTERY             SIMPLE                               STREET
False   False     113   1.0       42.0  32.0            08B       1176349.0
1898987.0     2017  02/10/2018 03:50:01 PM  41.878177  -87.627946  (41.878176784,
-87.627946266)    1
765852      10855188  JA160281     02/20/2017 12:54:00 AM  018XX S LAWNDALE AVE
0486  BATTERY             DOMESTIC BATTERY SIMPLE              APARTMENT
False   True      1014  10.0      24.0  29.0            08B       1151995.0
1890659.0     2017  02/10/2018 03:50:01 PM  41.855838  -87.717588  (41.855838254,
-87.717588081)    1
765853      10855221  JA160287     02/20/2017 12:45:00 AM  038XX W LEXINGTON ST
1310  CRIMINAL DAMAGE     TO PROPERTY                          APARTMENT
False   False     1133  11.0      24.0  26.0            14        1150920.0
1896423.0     2017  02/10/2018 03:50:01 PM  41.871676  -87.721383  (41.87167643,
-87.721383082)     1
765854      10855163  JA160277     02/20/2017 12:40:00 AM  063XX S MOZART ST
0486  BATTERY             DOMESTIC BATTERY SIMPLE              APARTMENT
False   True      823   8.0       15.0  66.0            08B       1158473.0
1862386.0     2017  02/10/2018 03:50:01 PM  41.778124  -87.694582  (41.778123668,
-87.694581962)    1
                                                                                                                                                                        
..
384680      10609562  HZ362203     07/24/2016 11:33:00 AM  013XX E 75TH ST
502P  OTHER OFFENSE       FALSE/STOLEN/ALTERED TRP             STREET
True    False     411   4.0       5.0   43.0            26        1186404.0
1855535.0     2016  02/10/2018 03:50:01 PM  41.758709  -87.592403  (41.758708964,
-87.592402969)    1
384681      10609549  HZ362184     07/24/2016 11:33:00 AM  019XX N KEELER AVE
0560  ASSAULT             SIMPLE                               RESIDENCE
False   True      2534  25.0      30.0  20.0            08A       1148077.0
1912561.0     2016  02/10/2018 03:50:01 PM  41.916016  -87.731405  (41.916015982,
-87.731405299)    1
384682      10609621  HZ362237     07/24/2016 11:30:00 AM  069XX S HARPER AVE
0560  ASSAULT             SIMPLE
CHURCH/SYNAGOGUE/PLACE OF WORSHIP  False   False     332   3.0       5.0   43.0
08A       1187581.0     1859342.0     2016  02/10/2018 03:50:01 PM  41.769128
-87.587969  (41.769127812, -87.587968505)    1
384683      10613509  HZ366376     07/24/2016 11:30:00 AM  060XX W GRAND AVE
0620  BURGLARY            UNLAWFUL ENTRY                      NURSING
HOME/RETIREMENT HOME       False   False     2512  25.0      29.0  19.0
05        1135581.0     1914244.0     2016  02/10/2018 03:50:01 PM  41.920866
-87.777275  (41.92086582, -87.777275445)     1
1146380     11583562  JC137815     01/01/2019 12:00:00 AM  045XX N GREENVIEW AVE
1153  DECEPTIVE PRACTICE  FINANCIAL IDENTITY THEFT OVER $ 300  OTHER
False   False     1912  19.0      47.0  3.0             11        1165260.0
1930188.0     2019  02/06/2019 04:03:01 PM  41.964037  -87.667773  (41.964037099,
-87.667773171)    1
Length: 1016837, dtype: int64
```

Melihat kolom-kolom pada dataset Sharen_Odd

```
Sharen_Odd.columns
```

```
Index(['Unnamed: 0', 'ID', 'Case Number', 'Date', 'Block', 'IUCR',
       'Primary Type', 'Description', 'Location Description', 'Arrest',
       'Domestic', 'Beat', 'District', 'Ward', 'Community Area', 'FBI Code',
       'X Coordinate', 'Y Coordinate', 'Year', 'Updated On', 'Latitude',
       'Longitude', 'Location'],
      dtype='object')
```

Mengubah spasi menjadi underscore untuk memudahkan pengerjaan

```
Sharen_Odd.columns = Sharen_Odd.columns.str.replace(' ','_')
```

```
Sharen_Odd.columns
```

```
Index(['Unnamed:_0', 'ID', 'Case_Number', 'Date', 'Block', 'IUCR',
       'Primary_Type', 'Description', 'Location_Description', 'Arrest',
       'Domestic', 'Beat', 'District', 'Ward', 'Community_Area', 'FBI_Code',
       'X_Coordinate', 'Y_Coordinate', 'Year', 'Updated_On', 'Latitude',
       'Longitude', 'Location'],
      dtype='object')
```

Melihat index pada dataset Sharen_Odd

```
Sharen_Odd.index
```

```
RangeIndex(start=0, stop=1031744, step=1)
```

Mengecek missing value pada dataset Sharen_Odd

```
Sharen_Odd.isna().sum()
```

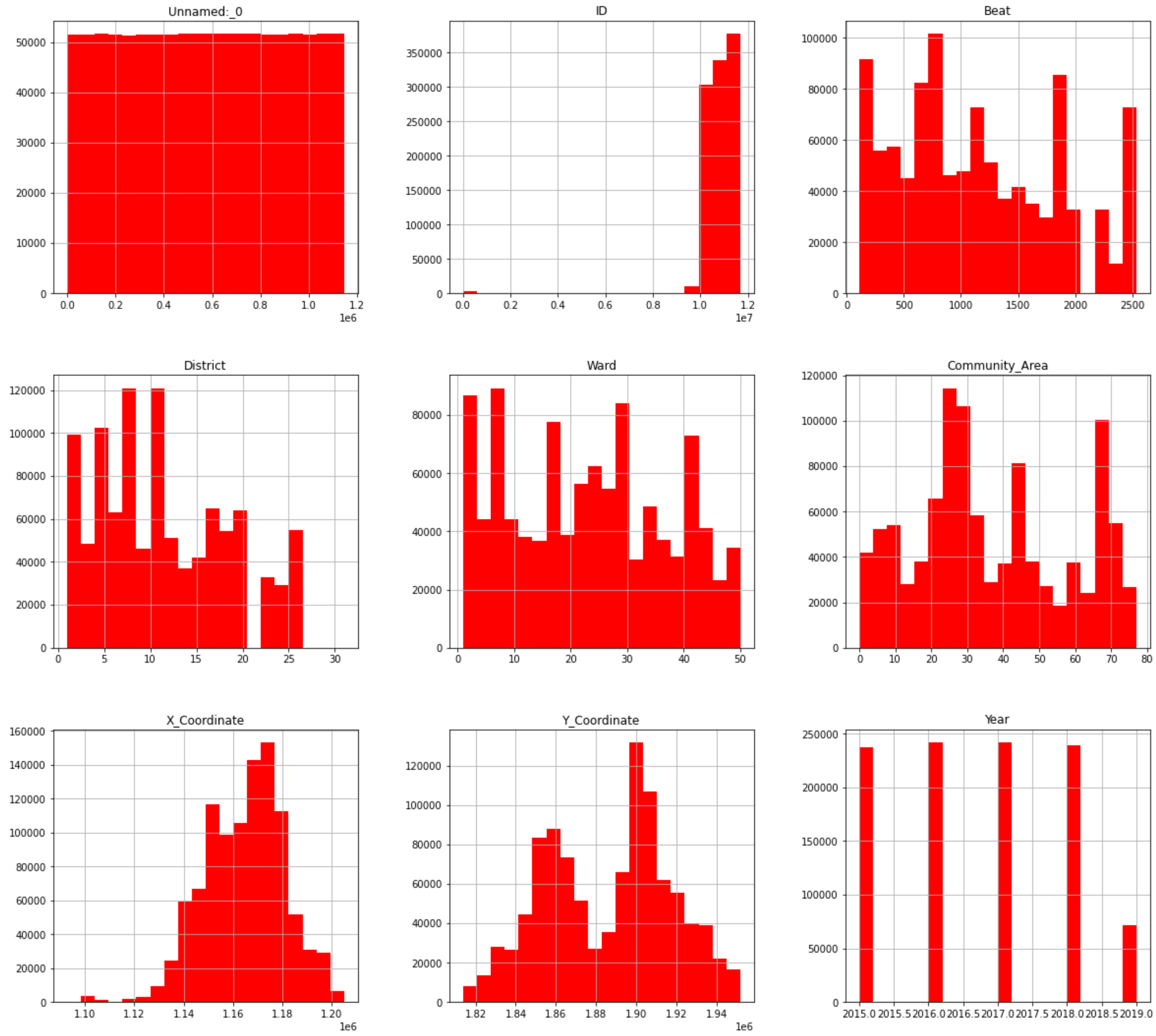
```
Unnamed:_0                  0
ID                          0
Case_Number                 0
Date                        0
Block                       0
IUCR                        0
Primary_Type                0
Description                 0
Location_Description     3267
Arrest                      0
Domestic                    0
Beat                        0
District                    1
Ward                        6
Community_Area              2
FBI_Code                    0
X_Coordinate            12563
Y_Coordinate            12563
Year                        0
```

```
Updated_On                0
Latitude              12563
Longitude             12563
Location              12563
dtype: int64
```

Dari hasil diatas, terdapat missing value pada kolom Location Description, X Coordinate, Y Coordinate, Latitude, Longitude, dan Location.

Mem-plot histogram dari dataset Sharen_Odd

```
Sharen_Odd.hist(bins = 20, figsize = (20,25), color = 'red');
```



Melihat korelasi antar variabel pada dataset Sharen_Odd

```
Sharen_Odd.corr(method ='kendall')
```

```
/usr/local/lib/python3.7/dist-packages/scipy/stats/stats.py:4812: RuntimeWarning: ove
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

	Unnamed:_0	ID	Arrest	Domestic	Beat	District	
Unnamed:_0	1.000000	0.559896	-0.031282	0.007419	-0.002323	-0.002307	0.00
ID	0.559896	1.000000	-0.047354	0.003247	-0.000905	-0.000821	0.01
Arrest	-0.031282	-0.047354	1.000000	-0.035033	-0.021422	-0.022149	-0.01
Domestic	0.007419	0.003247	-0.035033	1.000000	-0.047870	-0.049191	-0.06

Korelasi suatu variabel dengan dirinya sendiri adalah 1. Oleh karena itu semua nilai diagonalnya adalah 1.000000.

Ward	0.009596	0.012025	-0.016414	-0.063943	0.552823	0.551323	1.00

Membuat data 2D 15x15 dari modul NumPy.

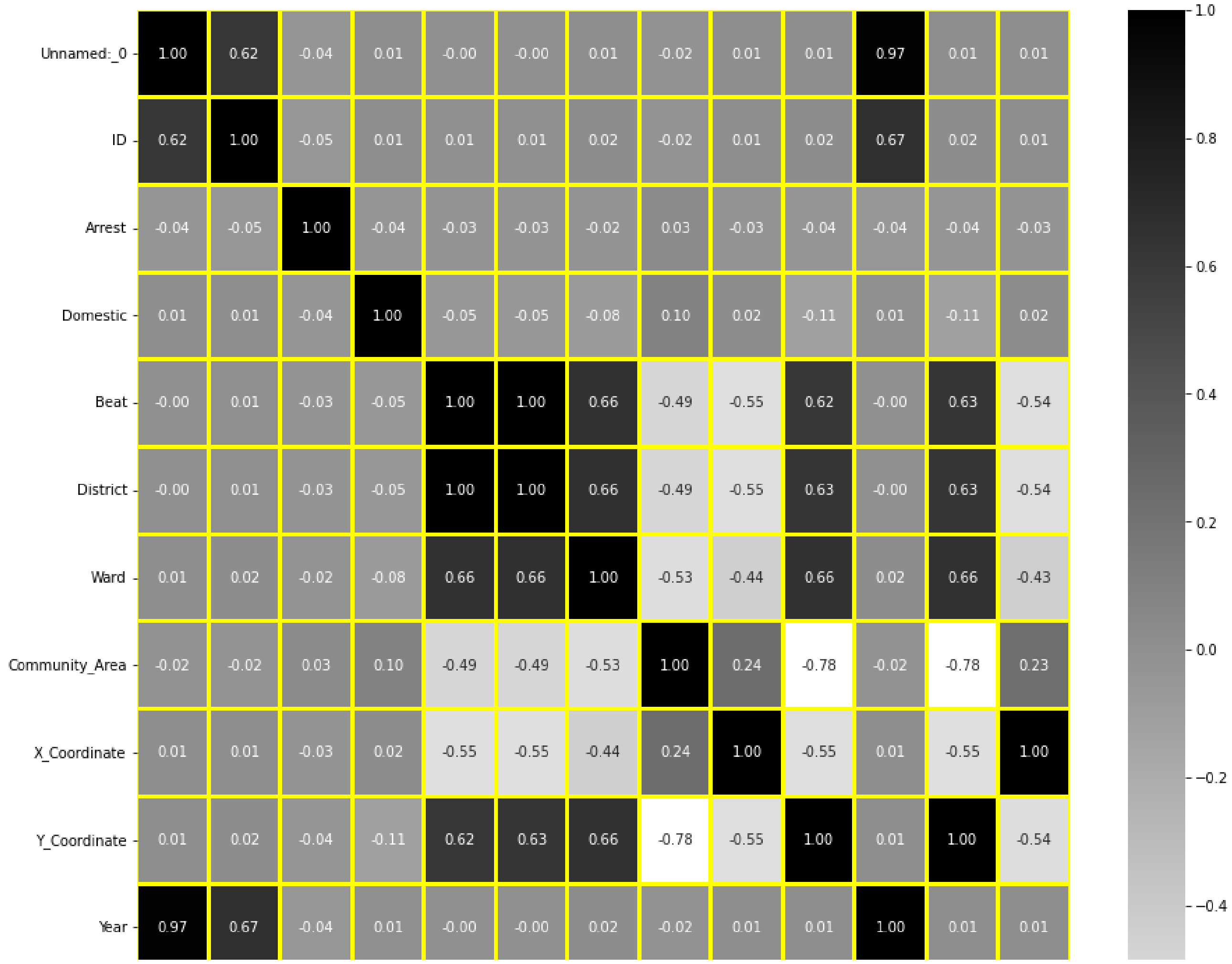
X Coordinate	0.009591	0.011623	-0.026610	0.010511	-0.408871	-0.437463	-0.30

```
plt.figure(figsize = (15,15))

annot = True
linewidths = 2
linecolor = "yellow"

sns.heatmap(Sharen_Odd.corr(),
            annot = annot,
            fmt = '.2f',
            cmap = "binary",
            linewidths = linewidths,
            linecolor = linecolor)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f71a2b92990>
```

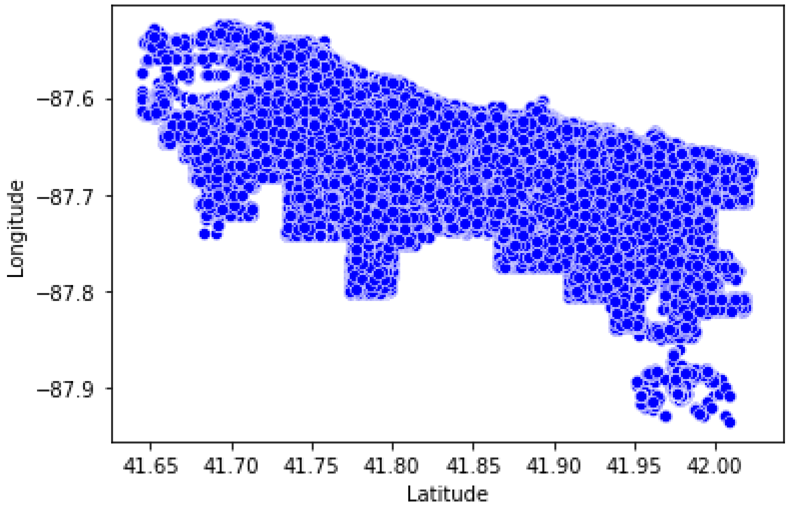


Fungsi .corr() digunakan untuk menemukan korelasi berpasangan dari semua kolom dalam kerangka data. Nilai na apa pun secara otomatis dikecualikan. Untuk kolom tipe data non-numerik apa pun dalam kerangka data, kolom ini diabaikan.

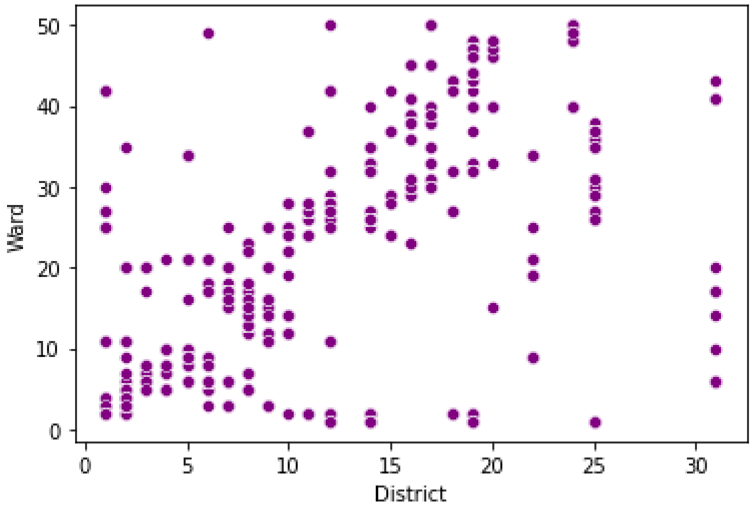
Menampilkan beberapa scatterplot pada variabel dalam dataset Sharen_Odd

```
sns.scatterplot(x = Sharen_Odd.X_Coordinate,
                y = Sharen_Odd.Y_Coordinate,
                color='green');
```

```
sns.scatterplot(x = Sharen_Odd.Latitude,
                y = Sharen_Odd.Longitude,
                color='blue');
```



```
sns.scatterplot(x = Sharen_Odd.District,
                y = Sharen_Odd.Ward,
                color='purple');
```

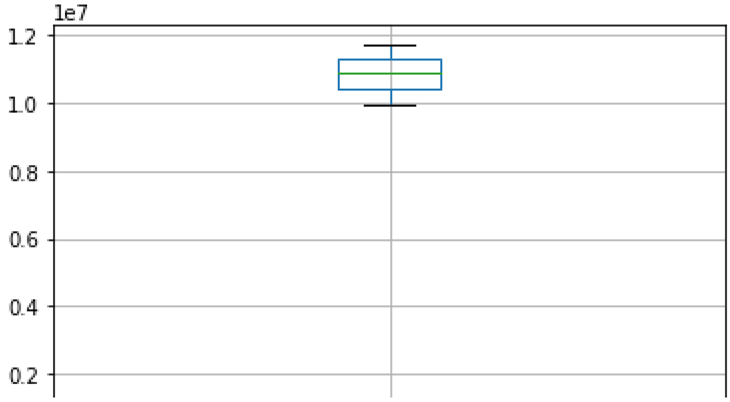


Scatterplot digunakan dengan beberapa pengelompokan semantik yang dapat membantu untuk memahami dengan baik dalam grafik dengan mem-plot grafik dua dimensi.Semua parameter kontrol semantik visual yang digunakan untuk mengidentifikasi himpunan bagian yang berbeda.

Menampilkan BLOXPOT

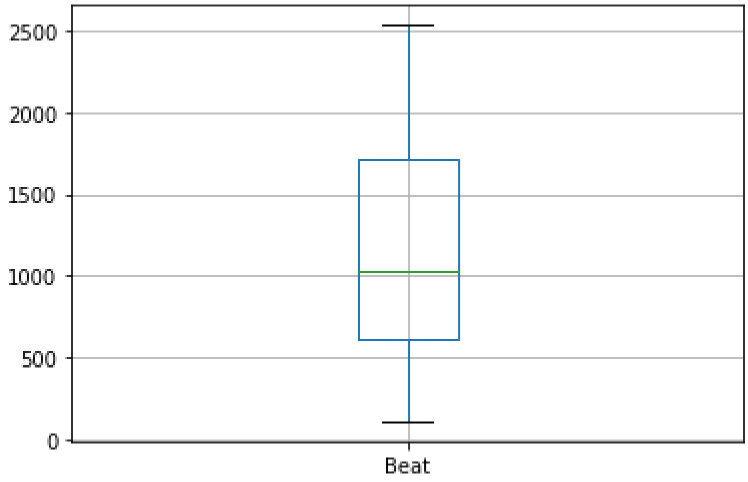
```
print(Sharen_Odd.boxplot(column = 'ID'))
```

```
AxesSubplot(0.125,0.125;0.775x0.755)
```



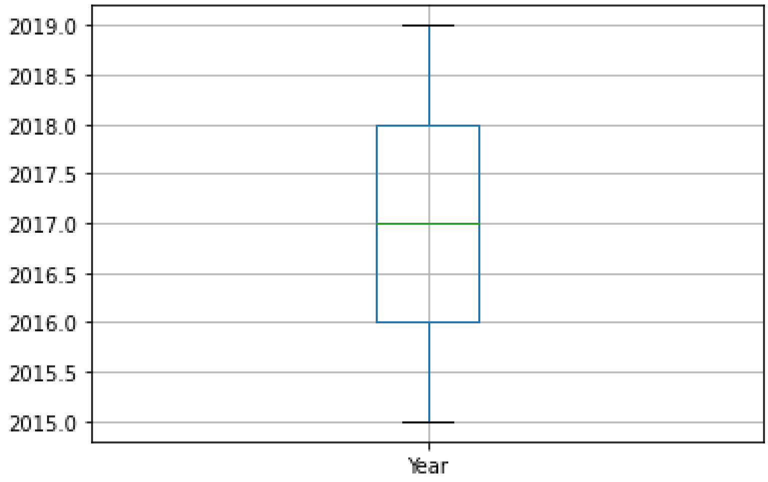
```
print(Sharen_Odd.boxplot(column = 'Beat'))
```

```
AxesSubplot(0.125,0.125;0.775x0.755)
```



```
print(Sharen_Odd.boxplot(column = 'Year'))
```

```
AxesSubplot(0.125,0.125;0.775x0.755)
```



Bloxpot adalah representasi visual dari ringkasan statistik dari kumpulan data yang diberikan. Bloxpot secara statistik merepresentasikan distribusi data melalui lima dimensi utama, yaitu nilai minimum, nilai maksimum, kuartil pertama, median (kuartil kedua), kuartil ketiga.

3. Data Preparation (30 pts.)

Dari hasil diatas, terdapat missing value pada kolom Location Description, X Coordinate, Y Coordinate, Latitude, Longitude, dan Location.

Men-drop kolom yang memiliki missing value

```
Sharen_Odd.dropna()
```

Unnamed: 0 ID Case Number Date Block IUCR Primary Ty

Data diatas sudah tidak memiliki missing value. Selanjutnya kita men-drop data yang terduplikat.

Menghapus data yang terduplikat pada dataset Sharen_Odd

```
Sharen_Odd.drop_duplicates()
```

	Unnamed:_0	ID	Case_Number	Date	Block	IUCR	Primary_Ty
0	1024161	11254362	JB183495	03/12/2018 07:32:00 PM	017XX W CHICAGO AVE	0560	ASSAU
1	428801	10540177	HZ285387	05/29/2016 11:28:00 PM	027XX S STATE ST	0454	BATTE
2	1099812	11624449	JC187320	03/16/2019 02:10:00 AM	101XX S PRINCETON AVE	031A	ROBBE
3	595228	11109388	JA459177	10/05/2017 11:00:00 AM	019XX W OGDEN AVE	0810	THE
4	1033611	11241624	JB166623	02/26/2018 07:51:00 PM	067XX S COTTAGE GROVE AVE	1330	CRIMIN TRESPA
...	...	...	...	...	...	...	
1031739	540482	11182652	JA556030	12/19/2017 08:10:00 PM	076XX S DREXEL AVE	0486	BATTE
1031740	750276	10880463	JA189513	03/16/2017 01:00:00 PM	028XX N MOBILE AVE	0486	BATTE
1031741	122985	10157277	HY346558	07/18/2015 09:30:00 PM	072XX S LOWE AVE	0620	BURGLA
1031742	929773	11383727	JB354262	07/17/2018 10:56:00 PM	063XX S PEORIA DR	2021	NARCOTI
1031743	337187	10689428	HZ443522	09/21/2016 01:10:00 PM	029XX N BROADWAY	1330	CRIMIN TRESPA

1031744 rows × 23 columns

Karena sudah tidak ada lagi data yang missing value ataupun terduplikat, kita kembali mengecek bentuk dari dataset Sharen_Odd.

```
Sharen_Odd.shape
```

```
    (1031744, 23)
```

Dari hasil diatas, karena Shape nya sama yaitu 1031744 baris dan 23 kolom, maka dapat disimpulkan sudah tidak ada lagi data yang duplikat.

Numerical Columns

```
NumColumns = Sharen_Odd.select_dtypes(include=[np.float, np.int]).columns
print("Numerical·columns·:·"·)
print(NumColumns)

scaler_numerical = StandardScaler()
Numerical_transform = Pipeline(steps=[('scale', scaler_numerical)])
```

```
    Numerical columns :
    Index(['Unnamed:_0', 'ID', 'Beat', 'District', 'Ward', 'Community_Area',
           'X_Coordinate', 'Y_Coordinate', 'Year', 'Latitude', 'Longitude'],
          dtype='object')
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: DeprecationWarning: `
    Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/devdocs/re
      """Entry point for launching an IPython kernel.
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: DeprecationWarning: `
    Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/devdocs/re
      """Entry point for launching an IPython kernel.
```

Dari hasil diatas :

Numerical columns :

Index(['Unnamed:_0', 'ID', 'Beat', 'District', 'Ward', 'Community_Area', 'X_Coordinate', 'Y_Coordinate', 'Year', 'Latitude', 'Longitude']

```
CategColumns = Sharen_Odd.select_dtypes(include=[np.object, np.bool]).columns
print("Categorical columns : " )
print(CategColumns)

impute_categorical = SimpleImputer(strategy="most_frequent")
onehot_categorical = OneHotEncoder(handle_unknown="ignore")
Categorical_transform = Pipeline(steps=[('impute', impute_categorical),('onehot', onehot_c
```

```
    Categorical columns :
    Index(['Case_Number', 'Date', 'Block', 'IUCR', 'Primary_Type', 'Description',
           'Location_Description', 'Arrest', 'Domestic', 'FBI_Code', 'Updated_On',
           'Location'],
          dtype='object')
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: DeprecationWarning: `
    Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/devdocs/re
      """Entry point for launching an IPython kernel.
    /usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:1: DeprecationWarning: `
    Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/devdocs/re
      """Entry point for launching an IPython kernel.
```

Dari hasil diatas :

Categorical columns :

Index(['Case_Number', 'Date', 'Block', 'IUCR', 'Primary_Type', 'Description', 'Location_Description', 'Arrest', 'Domestic', 'FBI_Code', 'Updated_On', 'Location']

FEATURE ENGINEERING

Di bagian HINT soal diminta untuk generate the target by performing engineering on 'DATE' and 'PRIMARY TYPE'. Namun, kedua fitur tersebut memiliki datatype OBJECT yang merupakan categorical, sehingga harus di ubah menjadi numerical terlebih dahulu.

Pertama, mengubah datatype kolom 'Date' dari OBJECT menjadi datetime64[ns]

```
Sharen_Odd['Date'] = pd.to_datetime(Sharen_Odd['Date'])
Sharen_Odd['Year'] = Sharen_Odd['Date'].dt.year
Sharen_Odd['Month'] = Sharen_Odd['Date'].dt.month
Sharen_Odd['Day'] = Sharen_Odd['Date'].dt.day
Sharen_Odd['Hour'] = Sharen_Odd['Date'].dt.hour
```

```
print(Sharen_Odd.Date)
```

```
0         2018-03-12 19:32:00
1         2016-05-29 23:28:00
2         2019-03-16 02:10:00
3         2017-10-05 11:00:00
4         2018-02-26 19:51:00
                  ...
1031739   2017-12-19 20:10:00
1031740   2017-03-16 13:00:00
1031741   2015-07-18 21:30:00
1031742   2018-07-17 22:56:00
1031743   2016-09-21 13:10:00
Name: Date, Length: 1031744, dtype: datetime64[ns]
```

Kedua, mengubah datatype kolom 'Primary_Type' dari OBJECT menjadi INT

```
Sharen_Odd['Primary_Type'] = pd.factorize(Sharen_Odd['Primary_Type'])[0]
```

```
print(Sharen_Odd.Primary_Type)
```

```
0           0
1           1
2           2
3           3
4           4
           ..
1031739     1
1031740     1
1031741    14
1031742     9
1031743     4
Name: Primary_Type, Length: 1031744, dtype: int64
```

Data types terbaru dari yang sudah di update

```
Sharen_Odd.dtypes
```

```
Unnamed:_0                       int64
ID                               int64
Case_Number                     object
Date                    datetime64[ns]
Block                           object
IUCR                            object
Primary_Type                     int64
Description                     object
Location_Description            object
Arrest                            bool
Domestic                          bool
Beat                             int64
District                       float64
Ward                           float64
Community_Area                 float64
FBI_Code                        object
X_Coordinate                   float64
Y_Coordinate                   float64
Year                             int64
Updated_On                      object
Latitude                       float64
Longitude                      float64
Location                        object
Month                            int64
Day                              int64
Hour                             int64
dtype: object
```

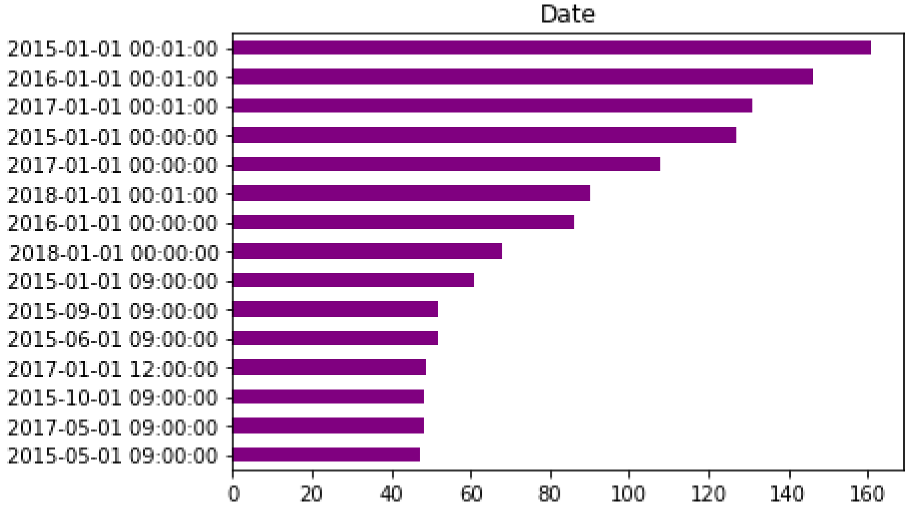
Dari hasil diatas, dapat dilihat variabel Date sudah berubah datatype menadi Datetime dan variabel Primary_Type sudah berubah datatype menjadi Integer.

Data Visualization

Visualiasi Data kolom 'Date'

```
Sharen_Odd['Date'].value_counts()[:15].sort_values(ascending=True).plot(kind='barh',
                                                                          title='Date',
                                                                          color='purple')
```

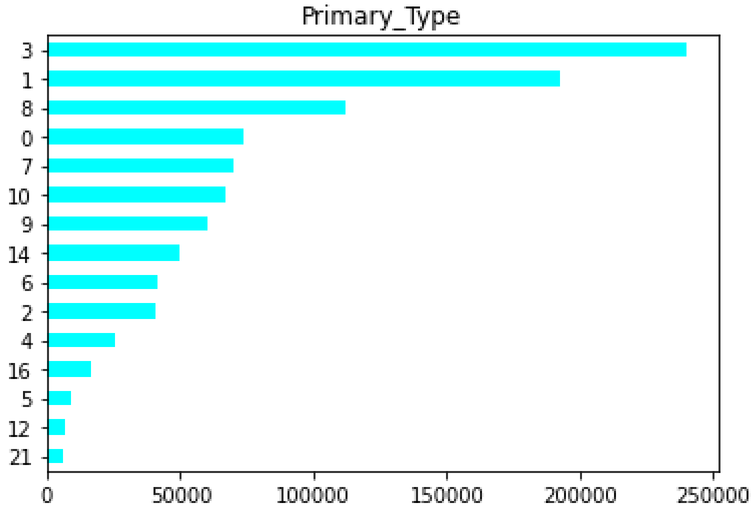
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f71a2b56ed0>
```



Visualiasi Data kolom 'Primary_Type'

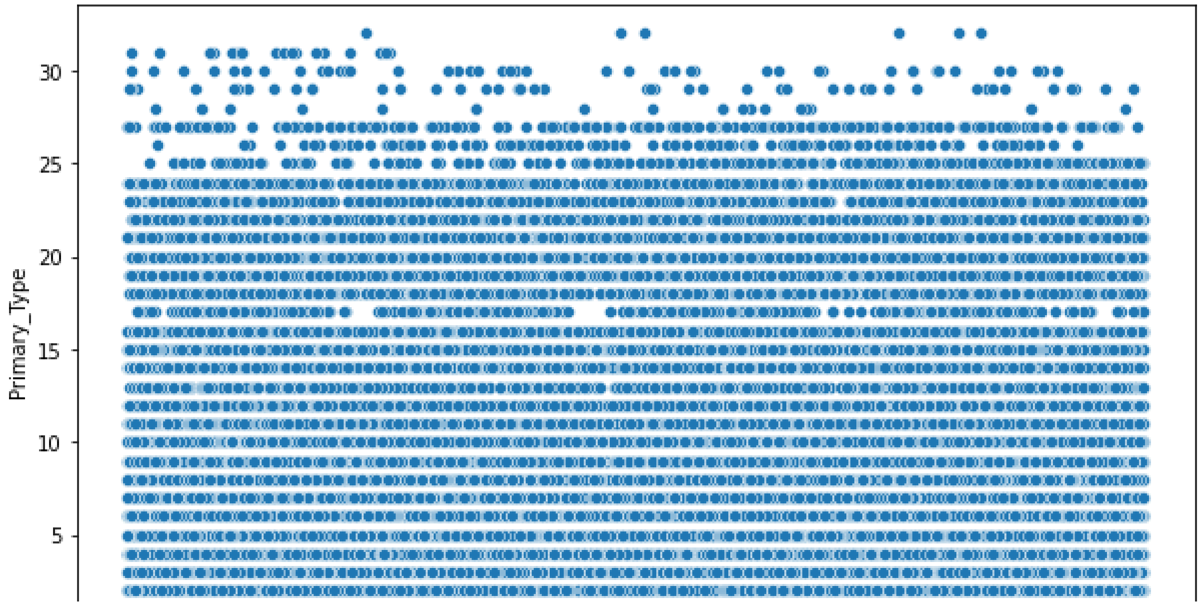
```
Sharen_Odd['Primary_Type'].value_counts()[:15].sort_values(ascending=True).plot(kind='barh
                                                                                  title='Prim
                                                                                   color='cya
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f71a2c00ad0>
```



Visualisasi scatterplot kolom 'Date' dan 'Primary_Type'

```
plt.figure(figsize=(10,6))
ax = sns.scatterplot(x='Date',y='Primary_Type', data=Sharen_Odd)
```



Masing-masing teknik dikelompokkan berdasarkan kolom yang mereka butuhkan untuk diterapkan menggunakan **ColumnTransformer**. Idealnya, ini dijalankan dalam pipeline tepat sebelum model dilatih. Namun, untuk memahami seperti apa tampilan data, biasanya data akan diubah menjadi variabel sementara.

```
PreprocessorCategoricalCol = ColumnTransformer(transformers=[('categorical',
                                                               Categorical_transform,
                                                               CategColumns)],
                                                               remainder="passthrough")

PreprocessorAllCol = ColumnTransformer(transformers=[('categorical',
                                                       Categorical_transform,
                                                       CategColumns),
                                                      ('Numerical',
                                                       Numerical_transform,
                                                       NumColumns)],
                                                       remainder="passthrough")


Sharen_Odd_temp_1 = PreprocessorCategoricalCol.fit_transform(Sharen_Odd)
print("Data seleah di transform :")
print(Sharen_Odd_temp_1)

Sharen_Odd_temp_2 = PreprocessorAllCol.fit_transform(Sharen_Odd)
print("Data seleah di transform :")
print(Sharen_Odd_temp_2)
```

```
      (1031743, 1841065)    2016.0
      (1031743, 1841066)    41.935361214
      (1031743, 1841067)    -87.644241031
      (1031743, 1841068)    9.0
      (1031743, 1841069)    21.0
      (1031743, 1841070)    13.0
    Data seleah di transform :
      (0, 757539)   1.0
      (0, 1371188)  1.0
```

```
  (0, 1511526)	1.0
  (0, 1535905)	1.0
  (0, 1536188)	1.0
  (0, 1536494)	1.0
  (0, 1536673)	1.0
  (0, 1536706)	1.0
  (0, 1536708)	1.0
  (0, 1536719)	1.0
  (0, 1537556)	1.0
  (0, 1735021)	1.0
  (0, 1841057)	1.3620995589101363
  (0, 1841058)	0.6033172156125879
  (0, 1841059)	0.0987170127750439
  (0, 1841060)	0.11304381023336667
  (0, 1841061)	-1.5848965493341785
  (0, 1841062)	-0.6006614250776775
  (0, 1841063)	-0.01830855508110071
  (0, 1841064)	0.6125739213802728
  (0, 1841065)	1.060557379035099
  (0, 1841066)	0.6114854377943567
  (0, 1841067)	-0.008598286264049631
  (0, 1841068)	3.0
  (0, 1841069)	12.0
  :	:
  (1031743, 1213459)	1.0
  (1031743, 1516498)	1.0
  (1031743, 1535978)	1.0
  (1031743, 1536192)	1.0
  (1031743, 1536515)	1.0
  (1031743, 1536684)	1.0
  (1031743, 1536706)	1.0
  (1031743, 1536708)	1.0
  (1031743, 1536735)	1.0
  (1031743, 1536960)	1.0
  (1031743, 1782673)	1.0
  (1031743, 1841057)	-0.7140143705409286
  (1031743, 1841058)	-0.17586771506502724
  (1031743, 1841059)	1.1372882441898646
  (1031743, 1841060)	1.1224490402248235
  (1031743, 1841061)	1.4902503559953786
  (1031743, 1841062)	-1.4413124020845758
  (1031743, 1841063)	0.43225387756376626
  (1031743, 1841064)	1.07437806036593
  (1031743, 1841065)	-0.5411765203166606
  (1031743, 1841066)	1.0704296452834323
  (1031743, 1841067)	0.45314994477725185
  (1031743, 1841068)	9.0
  (1031743, 1841069)	21.0
  (1031743, 1841070)	13.0
```

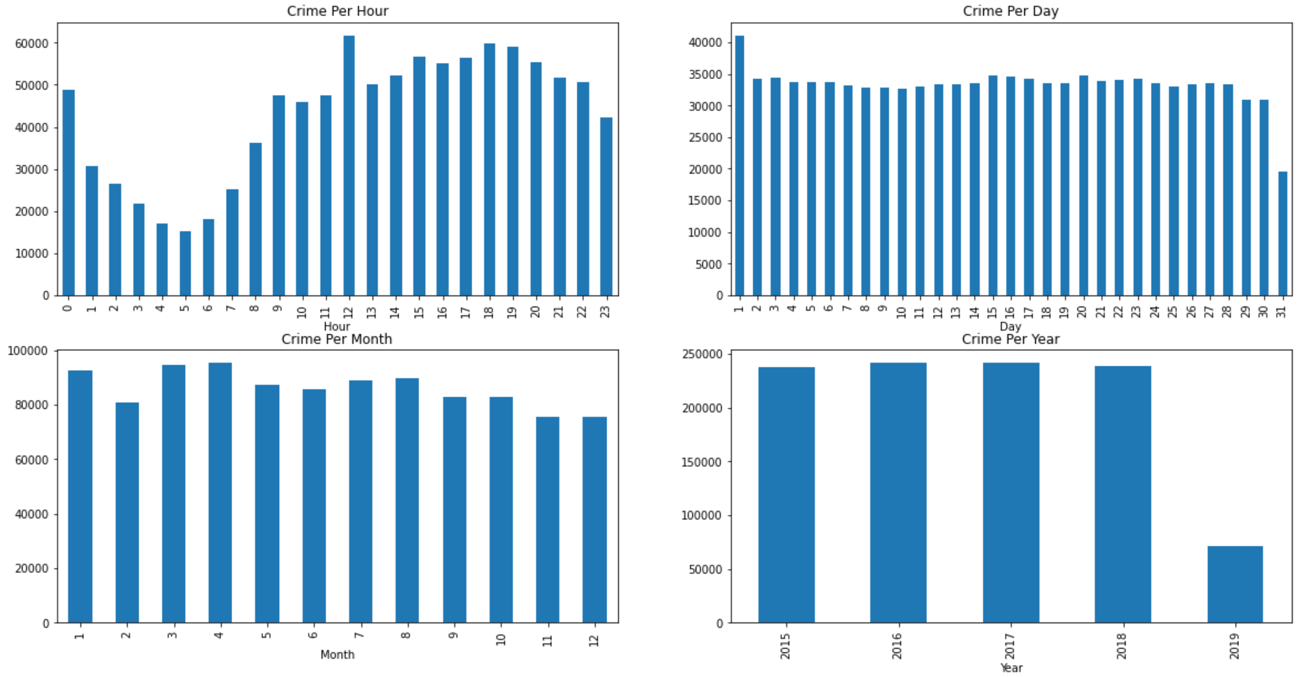
Dari hasil data transforming diatas, terdapat beberapa nilai. Ada yang termasuk ke level crime Low(0-14), medium(15-33), dan high(34 and above)

Plot grafik antara Date(Hour,Day,Month,Year) dengan jumlah crime pada Primary_Type

```
ig, axes = plt.subplots(2, 2, figsize=(20, 10))
```

```
Sharen_Odd.groupby('Hour').count()['Primary_Type'].plot(kind='bar', title='Crime Per Hour'
Sharen_Odd.groupby('Day').count()['Primary_Type'].plot(kind='bar', title='Crime Per Day',
Sharen_Odd.groupby('Month').count()['Primary_Type'].plot(kind='bar', title='Crime Per Mont
Sharen_Odd.groupby('Year').count()['Primary_Type'].plot(kind='bar', title='Crime Per Year'
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f719e38fb50>
```



Melihat korelasi

```
corr = Sharen_Odd.corr()
corr.style.background_gradient(cmap='coolwarm')
```

	Unnamed:_0	ID	Primary_Type	Arrest	Domestic	Beat
Unnamed:_0	1.000000	0.619242	-0.018518	-0.038335	0.009086	-0.002889
ID	0.619242	1.000000	-0.124232	-0.047438	0.011389	0.005324
Primary_Type	-0.018518	-0.124232	1.000000	0.152579	-0.208837	0.006367
Arrest	-0.038335	-0.047438	0.152579	1.000000	-0.035033	-0.031986
Domestic	0.009086	0.011389	-0.208837	-0.035033	1.000000	-0.054418
Beat	-0.002889	0.005324	0.006367	-0.031986	-0.054418	1.000000
District	-0.002882	0.005378	0.006365	-0.032082	-0.054452	0.999723
Ward	0.014496	0.020361	-0.010559	-0.023560	-0.081570	0.659778
Community_Area	-0.015820	-0.024534	0.026138	0.034056	0.096904	-0.485325
X_Coordinate	0.012545	0.010323	-0.043487	-0.028767	0.017577	-0.547681
Y_Coordinate	0.008968	0.021032	-0.021171	-0.040441	-0.111847	0.624609
Year	0.972282	0.668731	-0.020240	-0.045000	0.007442	-0.002826

A value closer to 0 implies weaker correlation

A value closer to 1 implies stronger positive correlation

A value closer to -1 implies stronger negative correlation

Machine Learning tidak dapat menggunakan teks sederhana. Kita harus mengubah data dari teks menjadi angka. Oleh karena itu, untuk setiap string yang merupakan kelas, kami menetapkan label yang berupa angka.

Misalnya, dalam kumpulan data 'Date' pelanggan, mereka diklasifikasikan menjadi 3 bagian, yaitu high, medium, atau low dan diberi label 0, 1, atau 2. Kami menggunakan kelas LabelEncoder yang disediakan oleh Sklearn untuk ini.

Oleh karena itu, variabel 'Date' akan di LabelEncoder agar bisa dipakai sebagai data numerical.

```
features = []
features = Sharen_Odd.drop(['Date'], axis = 1)

Label_Date = pd.DataFrame(Sharen_Odd, columns = ['Date'])
Label_encorder = LabelEncoder()
Label = Sharen_Odd['Date']

Label = Label_encorder.fit_transform(Label)
print("Nilai 'Date' setelah diberi label encoder : "+str(Label))
```

```
Nilai 'Date' setelah diberi label encoder : [339569 146852 455574 ...  56455 380484 1
```

Splitting data for training and testing

```
X = Label.reshape(-1, 1)
y = Sharen_Odd['Primary_Type']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=1)
print("Training dan testing split was successfulpada dataset HousingData : BERHASIL")
```

```
Training dan testing split was successfulpada dataset HousingData : BERHASIL
```

4. Build and Assess the machine learning models (35 pts.)

Mencoba Model ML

You have to evaluate the machine learning models using at least two performance metrics (for example: precision and recall).

First Model : Logistic Regression

```
LG·=·LogisticRegression()
LG.fit(X_train,y_train)
pred_LG·=·LG.predict(X_test)

confusion_matrix(y_test,·pred_LG)

print·('\n·confussion·matrix Logistic Regression :\n',confusion_matrix(y_test, pred_LG))
```

```
 confussion matrix Logistic Regression :
 [[0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 ...
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]]
/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:818: Converg
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  extra_warning_msg=_LOGISTIC_SOLVER_CONVERGENCE_MSG,
print ('Accuracy:', accuracy_score(y_test, pred_LG))
```

```
Accuracy: 0.23304692535461766
```

```
Class_report_LogistrikRegression = print(classification_report(y_test, pred_LG))
Class_report_LogistrikRegression
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
              precision    recall  f1-score   support

           0       0.00      0.00      0.00     14860
           1       0.00      0.00      0.00     38522
           2       0.00      0.00      0.00      8122
           3       0.23      1.00      0.38     48089
           4       0.00      0.00      0.00      5122
           5       0.00      0.00      0.00      1862
           6       0.00      0.00      0.00      8175
           7       0.00      0.00      0.00     13718
           8       0.00      0.00      0.00     22326
           9       0.00      0.00      0.00     11932
          10       0.00      0.00      0.00     13473
          11       0.00      0.00      0.00       945
          12       0.00      0.00      0.00      1277
          13       0.00      0.00      0.00       145
          14       0.00      0.00      0.00      9997
          15       0.00      0.00      0.00       831
          16       0.00      0.00      0.00      3447
          17       0.00      0.00      0.00       161
          18       0.00      0.00      0.00       701
          19       0.00      0.00      0.00       336
          20       0.00      0.00      0.00       493
          21       0.00      0.00      0.00      1208
          22       0.00      0.00      0.00       145
          23       0.00      0.00      0.00       122
          24       0.00      0.00      0.00       164
          25       0.00      0.00      0.00        72
          26       0.00      0.00      0.00        30
          27       0.00      0.00      0.00        55
          28       0.00      0.00      0.00         5
          29       0.00      0.00      0.00         6
          30       0.00      0.00      0.00         4
          31       0.00      0.00      0.00         2
          32       0.00      0.00      0.00         2

    accuracy                           0.23    206349
   macro avg       0.01      0.03      0.01    206349
weighted avg       0.05      0.23      0.09    206349

/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
```

Second Model : KNeighborsClassifier (KNN)

```
knn = KNN()
knn.fit(X_train, y_train)
pred_KNN = knn.predict(X_test)

confusion_matrix(y_test, pred_KNN)

print ('\n confussion matrix KNN:\n',confusion_matrix(y_test, pred_KNN))
```

```
 confussion matrix KNN:
 [[ 2100  4615   356 ...     0     0     0]
 [ 5147 13165  1110 ...     0     0     0]
 [ 1097  2760   295 ...     0     0     0]
 ...
 [    0     1     0 ...     0     0     0]
 [    0     0     0 ...     0     0     0]
 [    0     1     0 ...     0     0     0]]
```

```
print ('Accuracy KNN:', accuracy_score(y_test, pred_KNN))
```

```
Accuracy KNN: 0.19013903629288245
```

```
Class_report_KNN = print(classification_report(y_test, pred_KNN))
Class_report_KNN
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Undef
  _warn_prf(average, modifier, msg_start, len(result))
              precision    recall  f1-score   support

           0       0.08      0.14      0.10     14860
           1       0.22      0.34      0.27     38522
           2       0.05      0.04      0.04      8122
           3       0.26      0.38      0.31     48089
           4       0.03      0.01      0.01      5122
           5       0.16      0.04      0.06      1862
           6       0.06      0.03      0.04      8175
           7       0.18      0.14      0.15     13718
           8       0.13      0.09      0.10     22326
           9       0.14      0.06      0.08     11932
          10       0.07      0.03      0.04     13473
          11       0.00      0.00      0.00       945
          12       0.01      0.00      0.00      1277
          13       0.00      0.00      0.00       145
          14       0.08      0.03      0.04      9997
          15       0.00      0.00      0.00       831
          16       0.06      0.01      0.01      3447
          17       0.00      0.00      0.00       161
          18       0.09      0.02      0.03       701
          19       0.00      0.00      0.00       336
          20       0.10      0.01      0.01       493
          21       0.03      0.00      0.01      1208
          22       0.00      0.00      0.00       145
          23       0.00      0.00      0.00       122
          24       0.00      0.00      0.00       164
          25       0.00      0.00      0.00        72
          26       0.00      0.00      0.00        30
          27       0.00      0.00      0.00        55
          28       0.00      0.00      0.00         5
          29       0.00      0.00      0.00         6
          30       0.00      0.00      0.00         4
          31       0.00      0.00      0.00         2
          32       0.00      0.00      0.00         2

    accuracy                           0.19    206349
   macro avg       0.05      0.04      0.04    206349
weighted avg       0.16      0.19      0.16    206349

/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Undef
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Undef
  _warn_prf(average, modifier, msg_start, len(result))
```

Third Model : Decision Tree Classifier(DTC)

```
from sklearn.tree import DecisionTreeClassifier
DTC = DecisionTreeClassifier()
DTC.fit(X_train, y_train)
pred_DTC = DTC.predict(X_test)

confusion_matrix(y_test, pred_DTC)

print ('\n confussion matrix DTC:\n',confusion_matrix(y_test, pred_DTC))
```

```
 confussion matrix DTC:
 [[ 1553  3541   546 ...     0     0     0]
 [ 3770 10119  1655 ...     2     0     0]
 [  790  2137   400 ...     0     0     0]
 ...
 [    0     0     1 ...     0     0     0]
 [    0     0     0 ...     0     0     0]
 [    0     0     0 ...     0     0     0]]
```

```
print ('Accuracy DTC:', accuracy_score(y_test, pred_DTC))
```

```
Accuracy DTC: 0.186208801593417
```

```
Class_report_DTC = print(classification_report(y_test, pred_DTC))
Class_report_DTC
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Undef
  _warn_prf(average, modifier, msg_start, len(result))
              precision    recall  f1-score   support

           0       0.08      0.10      0.09     14860
           1       0.22      0.26      0.24     38522
           2       0.05      0.05      0.05      8122
           3       0.27      0.40      0.32     48089
           4       0.03      0.02      0.02      5122
           5       0.10      0.05      0.07      1862
           6       0.05      0.03      0.04      8175
           7       0.18      0.17      0.17     13718
           8       0.13      0.09      0.11     22326
           9       0.14      0.09      0.11     11932
          10       0.08      0.04      0.05     13473
          11       0.00      0.00      0.00       945
          12       0.01      0.01      0.01      1277
          13       0.00      0.00      0.00       145
          14       0.07      0.03      0.04      9997
          15       0.00      0.00      0.00       831
          16       0.05      0.03      0.04      3447
          17       0.01      0.01      0.01       161
          18       0.07      0.04      0.05       701
          19       0.03      0.01      0.02       336
          20       0.07      0.04      0.05       493
          21       0.01      0.00      0.00      1208
          22       0.00      0.00      0.00       145
          23       0.00      0.00      0.00       122
          24       0.01      0.01      0.01       164
          25       0.00      0.00      0.00        72
          26       0.00      0.00      0.00        30
          27       0.00      0.00      0.00        55
          28       0.00      0.00      0.00         5
          29       0.00      0.00      0.00         6
          30       0.00      0.00      0.00         4
          31       0.00      0.00      0.00         2
          32       0.00      0.00      0.00         2

    accuracy                           0.19    206349
   macro avg       0.05      0.05      0.05    206349
weighted avg       0.16      0.19      0.17    206349

/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
```

Fourth Model : GaussianNB

```
from sklearn.naive_bayes import GaussianNB
NB = GaussianNB()
NB.fit(X_train, y_train)
pred_NB = NB.predict(X_test)

confusion_matrix(y_test, pred_NB)

print ('\n confussion matrix pred_NB:\n',confusion_matrix(y_test, pred_NB))
```

```
 confussion matrix pred_NB:
 [[0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 ...
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]
 [0 0 0 ... 0 0 0]]
```

```
print ('Accuracy NB:', accuracy_score(y_test, pred_NB))
```

```
Accuracy NB: 0.23304692535461766
```

```
Class_report_NB = print(classification_report(y_test, pred_NB))
Class_report_NB
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
              precision    recall  f1-score   support

           0       0.00      0.00      0.00     14860
           1       0.00      0.00      0.00     38522
           2       0.00      0.00      0.00      8122
           3       0.23      1.00      0.38     48089
           4       0.00      0.00      0.00      5122
           5       0.00      0.00      0.00      1862
           6       0.00      0.00      0.00      8175
           7       0.00      0.00      0.00     13718
           8       0.00      0.00      0.00     22326
           9       0.00      0.00      0.00     11932
          10       0.00      0.00      0.00     13473
          11       0.00      0.00      0.00       945
          12       0.00      0.00      0.00      1277
          13       0.00      0.00      0.00       145
          14       0.00      0.00      0.00      9997
          15       0.00      0.00      0.00       831
          16       0.00      0.00      0.00      3447
          17       0.00      0.00      0.00       161
          18       0.00      0.00      0.00       701
          19       0.00      0.00      0.00       336
          20       0.00      0.00      0.00       493
          21       0.00      0.00      0.00      1208
          22       0.00      0.00      0.00       145
          23       0.00      0.00      0.00       122
          24       0.00      0.00      0.00       164
          25       0.00      0.00      0.00        72
          26       0.00      0.00      0.00        30
          27       0.00      0.00      0.00        55
          28       0.00      0.00      0.00         5
          29       0.00      0.00      0.00         6
          30       0.00      0.00      0.00         4
          31       0.00      0.00      0.00         2
          32       0.00      0.00      0.00         2

    accuracy                           0.23    206349
   macro avg       0.01      0.03      0.01    206349
weighted avg       0.05      0.23      0.09    206349

/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.7/dist-packages/sklearn/metrics/_classification.py:1318: Unde
  _warn_prf(average, modifier, msg_start, len(result))
```

5. Choose your Final Model (3 pts.)

You finally have your final model. Write comments to justify your final model

KESIMPULAN :

Confusion matrix dapat mengetahui keakuratan dari model yang kita buat dengan performance metrics seperti: accuracy, recall, dan precision.

Recall menggambarkan keberhasilan model dalam menemukan kembali sebuah informasi. Maka, recall merupakan rasio prediksi benar positif dibandingkan dengan keseluruhan data yang benar positif.

Pada dataset Sharen_Odd, dapat dilihat bahwa data menginginkan terjadinya True Negatif dan sangat tidak menginginkan terjadinya False Positif. Oleh sebab itu, dalam pemilihan model sebaiknya dapat dilihat dari Precision-nya.

Berdasarkan pengujian terhadap beberapa model ML, saya memilih model ketiga : **Decision Tree Classifier(DTC)**. Dapat dilihat dari nilai precision dan recallnya, Model DTC ini memliki nilai yang lebih tinggi dari model-model lainnya.