GROUP PROJECT

Welcome to the COMP 247 Project - Supervising Learning Project - KSI Collisions Toronto

Relevant Information:

- College: Centennial College
- Program: Software Engineering Technology - Artificial Intelligence
- Term: Summer 2022
- Course: 22M --Supervised Learning (SEC. 001) - COMP247001_2022MW

Group Members

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COMP 247 Project

Group Project – Developing a predictive machine learning model (classifier) and deploy it as a web API for inference

Dataset

https://data.torontopolice.on.ca/datasets/TorontoPS::ksi/about (https://data.torontopolice.on.ca/datasets/TorontoPS::ksi/about)

Models:

- Logistic Regression
- Random Forest Classifier
- Decision Tree Classifier
- KNeighbors Classifier
- SVC

In [1]:
```
import os
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

```
import seaborn as sns

from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_val_score
from sklearn.metrics import *
from sklearn.metrics import confusion_matrix, accuracy_score, classificati

from sklearn.svm import SVC
from sklearn.svm import SVR
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.impute import SimpleImputer
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeRegressor, DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import MultinomialNB
from sklearn.model_selection import RandomizedSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import RandomForestRegressor
from scipy.stats import randint

from sklearn.compose import ColumnTransformer
from sklearn.preprocessing import OneHotEncoder
```

Functions

Analyze Data - Data Exploration, Stats, Plots

In [3]:

```
def analyze_data(data):

    print("\n","Data - 20 first rows")
    print(data.head(20))

    print("\n","Data info")
    print(data.info())

    print("\n","Data Shape")
    print(data.shape)

    print("\n","Data - Null Values")
    print(data.isnull().sum())

    print("\n","Data - Null Values String")
    for column in data.columns:
        print("Column:", column, " - Len:", len(data[data[column] == '<Nul

    print("\n","Data - Describe stats")
    stats = data.describe()
    print(data.describe())

    print("\n","Data - Plot histograms")
    hist = data.hist(bins=3, figsize=(9,10))

    print("\n","Data - Plot scatter matrix")
```

```
    pd.plotting.scatter_matrix(data, alpha=0.40, figsize=(13,8))
```

Analyze Data - Unique Values

In [18]:

```
def analyze_data_unique_values(data, value_counts):

    print("\n","Data - Unique Values")
    for column in data:
        print("\n", "Column:", column, " - Len:", len(data[column].unique(
        if value_counts:
            print(data[column].value_counts())
```

Cleaning Data - Replace values, Drop columns

In [19]:

```
def cleaning_data_initial(data):

    # Replace <null> with nan .
    data = data.replace('<Null>', np.nan)

    # Extract month from date and remove date column
    data['month'] = pd.DatetimeIndex(data['DATE']).month


    #BINARY COLUMNS 0: NULL 1: YES
    binary_columns=['CYCLIST','AUTOMOBILE','MOTORCYCLE','TRUCK','TRSN_CITY_

    for i in binary_columns:
        data[i].replace(np.nan, 0, inplace=True)
        data[i].replace("Yes", 1, inplace=True)
        data[i] = data[i].astype(int)

    # Drop columns that are not required

    # A lot of different values
    drop_columns=['INDEX_','ObjectId','ACCNUM', 'X', 'Y','STREET1', 'STREE
    # Duplicated with HOOD_ID and POLICE_DIVISION
    drop_columns+=['NEIGHBOURHOOD', 'DIVISION']
    # A lot of null values
    drop_columns+=["OFFSET", "PEDTYPE", "PEDACT", "PEDCOND", "CYCLISTYPE",

    drop_columns+=['TIME', 'YEAR', 'DATE', 'WARDNUM', 'INITDIR', 'INVAGE']

    # DROP
    data = data.drop(drop_columns, axis=1)

    # Drop columns with null count greater than 40 % .
    data = data.dropna(axis=1,thresh=(data.shape[0]*0.6))

    # ----------------------------------------------------------------------
    # Drop duplicates values - rows
```

```
    data = data.drop_duplicates()
    data.nunique(axis=0)

    return data
```

Cleaning Data - Replace values

In [68]:

```
def cleaning_data_values(data):


    # -----------------------------------------------------------------
    # Column: ROAD_CLASS

    # Replace the Ramp type with an other existing category
    data['ROAD_CLASS'].replace('Expressway Ramp', 'Expressway', inplace=Tr
    data['ROAD_CLASS'].replace('Major Arterial Ramp', 'Major Arterial', in

    # Replace all null values with Other category
    data['ROAD_CLASS'].replace(np.nan, 'Other', inplace=True)


    # -----------------------------------------------------------------
    # Column: DISTRICT

    # Replace in one category Toronto and East York
    data['DISTRICT'].replace('Toronto East York', 'Toronto and East York',

    # Replace all null values with Other category
    data['DISTRICT'].replace(np.nan, 'Other', inplace=True)


    # -----------------------------------------------------------------
    # Column: LOCCOORD

    # Replace in existing categories
    data['LOCCOORD'].replace('Mid-Block (Abnormal)', 'Mid-Block', inplace=
    data['LOCCOORD'].replace('Entrance Ramp Westbound', 'Exit Ramp',inplac
    data['LOCCOORD'].replace('Exit Ramp Westbound', 'Exit Ramp',inplace=Tr
    data['LOCCOORD'].replace('Exit Ramp Southbound','Exit Ramp',inplace=Tr
    data['LOCCOORD'].replace('Park, Private Property, Public Lane', 'Other

    # Replace all null values with Other category
    data['LOCCOORD'].replace(np.nan, 'Other', inplace=True)


    # -----------------------------------------------------------------
    # Column: ACCLOC

    # Replace in existing categories
    data['ACCLOC'].replace('Intersection Related', 'At Intersection', inpl
    data['ACCLOC'].replace('Private Driveway', 'At/Near Private Drive', in

    # Replace small values in Other category
    data['ACCLOC'].replace('Laneway', 'Other', inplace=True)
    data['ACCLOC'].replace('Overpass or Bridge', 'Other', inplace=True)
```

```
data['ACCLOC'].replace('Underpass or Tunnel', 'Other', inplace=True)
data['ACCLOC'].replace('Trail', 'Other', inplace=True)

# Replace all null values with Other category
data['ACCLOC'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: TRAFFCTL

# Replace small values in Other category
data['TRAFFCTL'].replace('Traffic Controller', 'Other', inplace=True)
data['TRAFFCTL'].replace('Yield Sign', 'Other', inplace=True)
data['TRAFFCTL'].replace('Streetcar (Stop for)', 'Other', inplace=True
data['TRAFFCTL'].replace('Traffic Gate', 'Other', inplace=True)
data['TRAFFCTL'].replace('School Guard', 'Other', inplace=True)
data['TRAFFCTL'].replace('Police Control', 'Other', inplace=True)

# Replace all null values with Other category
data['TRAFFCTL'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: VISIBILITY

# Replace in existing categories
data['VISIBILITY'].replace('Drifting Snow', 'Snow', inplace=True)
data['VISIBILITY'].replace('Freezing Rain', 'Rain',inplace=True)

# Replace small values in Other category
data['VISIBILITY'].replace('Strong wind', 'Other',inplace=True)

# Replace all null values with Other category
data['VISIBILITY'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: LIGHT

# Replace in existing categories
data['LIGHT'].replace('Dark, artificial', 'Dark',inplace=True)
data['LIGHT'].replace('Dusk, artificial', 'Dusk',inplace=True)
data['LIGHT'].replace('Daylight, artificial', 'Daylight',inplace=True)
data['LIGHT'].replace('Dawn, artificial', 'Dawn',inplace=True)

# Replace all null values with Other category
data['LIGHT'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: RDSFCOND

# Replace in existing categories
data['RDSFCOND'].replace('Loose Snow', 'Snow',inplace=True)
data['RDSFCOND'].replace('Packed Snow', 'Snow',inplace=True)
```

```
# Replace small values in Other category
data['RDSFCOND'].replace('Loose Sand or Gravel', 'Other',inplace=True)
data['RDSFCOND'].replace('Spilled liquid', 'Other',inplace=True)

# Replace all null values with Other category
data['RDSFCOND'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: ACCLASS

# Replace in existing categories - Property Damage Only is Non-FAtal I
data['ACCLASS'].replace('Property Damage Only', 'Non-Fatal Injury',inp

# Replace all null values with Non-Fatal Injury category
data['ACCLASS'].replace(np.nan, 'Non-Fatal Injury', inplace=True)

# Replace values with binary classification
data['ACCLASS'].replace('Non-Fatal Injury', 0, inplace=True)
data['ACCLASS'].replace('Fatal', 1, inplace=True)


# ----------------------------------------------------------------------
# Column: IMPACTYPE

# Replace all null values with Non-Fatal Injury category
data['IMPACTYPE'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: INVTYPE

# Replace in existing categories
data['INVTYPE'].replace('Witness', 'Pedestrian', inplace=True)
data['INVTYPE'].replace('Pedestrian - Not Hit', 'Pedestrian', inplace=
data['INVTYPE'].replace('Driver - Not Hit', 'Driver', inplace=True)
data['INVTYPE'].replace('Cyclist', 'Cyclist Passenger', inplace=True)
data['INVTYPE'].replace('Cyclist Passenger', 'Cyclist Passenger', inpl
data['INVTYPE'].replace('Motorcycle Driver', 'Motorcycle Passenger', i
data['INVTYPE'].replace('Motorcycle Passenger', 'Motorcycle Passenger'
data['INVTYPE'].replace('Trailer Owner', 'Truck Driver', inplace=True)

# Replace small values in Other category
data['INVTYPE'].replace('Other Property Owner', 'Other',inplace=True)
data['INVTYPE'].replace('Moped Driver', 'Other',inplace=True)
data['INVTYPE'].replace('Wheelchair', 'Other',inplace=True)
data['INVTYPE'].replace('In-Line Skater', 'Other',inplace=True)

# Replace all null values with Other category
data['INVTYPE'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: INJURY

# Replace in existing categories
```

```
data['INJURY'].replace('Minimal', 'Minor', inplace=True)

# Replace all null values with Non-Fatal Injury category
data['INJURY'].replace(np.nan, 'None', inplace=True)


# ----------------------------------------------------------------------
# Column: VEHTYPE

# Replace all types of truck in only group called 'Truck'
data['VEHTYPE'].replace('Truck - Open', 'Truck', inplace=True)
data['VEHTYPE'].replace('Truck-Tractor', 'Truck', inplace=True)
data['VEHTYPE'].replace('Truck - Closed (Blazer, etc)', 'Truck', inpla
data['VEHTYPE'].replace('Truck - Dump', 'Truck', inplace=True)
data['VEHTYPE'].replace('Truck (other)', 'Truck', inplace=True)
data['VEHTYPE'].replace('Truck - Tank', 'Truck', inplace=True)
data['VEHTYPE'].replace('Pick Up Truck', 'Truck', inplace=True)
data['VEHTYPE'].replace('Tow Truck', 'Truck', inplace=True)
data['VEHTYPE'].replace('Truck - Car Carrier', 'Truck', inplace=True)

# Replace all types of 2 wheels in only group called 2 Wheels
data['VEHTYPE'].replace('Motorcycle', '2 Wheels', inplace=True)
data['VEHTYPE'].replace('Bicycle', '2 Wheels', inplace=True)
data['VEHTYPE'].replace('Moped', '2 Wheels', inplace=True)
data['VEHTYPE'].replace('Off Road - 2 Wheels', '2 Wheels', inplace=Tru

# Replace all types of automobiles in only group called Automobile
data['VEHTYPE'].replace('Automobile, Station Wagon', 'Automobile', inp
data['VEHTYPE'].replace('Taxi', 'Automobile', inplace=True)

# Replace all types of Emergency Vehicles in only group called Emergen
data['VEHTYPE'].replace('Police Vehicle', 'Emergency', inplace=True)
data['VEHTYPE'].replace('Other Emergency Vehicle', 'Emergency', inplac
data['VEHTYPE'].replace('Fire Vehicle', 'Emergency', inplace=True)

# Replace all types of Buses in only group called Bus
data['VEHTYPE'].replace('Municipal Transit Bus (TTC)', 'Bus', inplace=
data['VEHTYPE'].replace('Street Cars', 'Bus', inplace=True)
data['VEHTYPE'].replace('Street Car', 'Bus', inplace=True)
data['VEHTYPE'].replace('Bus (Other) (Go Bus, Gray Coach)', 'Bus', inp
data['VEHTYPE'].replace('Intercity Bus', 'Bus', inplace=True)
data['VEHTYPE'].replace('School Bus', 'Bus', inplace=True)

# Replace all types of Vans in only group called Van
data['VEHTYPE'].replace('Passenger Van', 'Van', inplace=True)
data['VEHTYPE'].replace('Delivery Van', 'Van', inplace=True)

# Replace small values in Other category
data['VEHTYPE'].replace('Construction Equipment', 'Other',inplace=True

# Replace all null values with Other category
data['VEHTYPE'].replace(np.nan, 'Other', inplace=True)


# ----------------------------------------------------------------------
# Column: POLICE_DIVISION
```

```
#Police Division without 'D' character
data['POLICE_DIVISION'] = data['POLICE_DIVISION'].str.strip("D")
data['POLICE_DIVISION'] = data['POLICE_DIVISION'].astype(int)


# ----------------------------------------------------------------------
# Drop duplicates values - rows
data = data.drop_duplicates()
data.nunique(axis=0)
```

Data Preprocessing - Get pipeline transformer, and X, Y train ant test data.

In [60]:

```
def get_pipeline_x_y(data=None, test_size=0.20):

    features_columns_categorical = ["ROAD_CLASS", "DISTRICT", "LOCCOORD",
    features_columns_numbers = ['HOUR', 'CYCLIST','AUTOMOBILE','MOTORCYCLE


    #    ('imputer', SimpleImputer(missing_values=np.nan, strategy='consta
    #('imputer', KNNImputer(n_neighbors=2)),


    categorical_pipeline = Pipeline(steps=[
        ('imputer', SimpleImputer(missing_values=np.nan, strategy='constan
        ('encoder', OneHotEncoder(handle_unknown='ignore'))
    ])

    num_pipeline = Pipeline([
        ('imputer', SimpleImputer(missing_values=np.nan, strategy="median"
        ('std_scaler', StandardScaler()),
    ])

    # Full pipeline - Column Transformer
    full_pipeline_transformer = ColumnTransformer([
        ("num", num_pipeline, features_columns_numbers),
        ("cat", categorical_pipeline, features_columns_categorical),
    ])

    X_group = data[features_columns_categorical + features_columns_numbers
    Y_group = data['ACCLASS']


    np.random.seed(2)

    # Divide data in train/test
    X_train, X_test, y_train, y_test = train_test_split(X_group, Y_group,


    return full_pipeline_transformer, X_group, Y_group, X_train, X_test, y
```

Get Best Model - Logistic Regression, Decision Tree, Random Forest Classifier, SVC, K-Neighbors Classifier

In [61]:

```
def get_best_model(data, classifier_model, full_pipeline_transformer, X_tr


    # Initialze the estimators
    estimator_1 = LogisticRegression(random_state=42)
    estimator_2 = DecisionTreeClassifier(random_state=42)
    estimator_3 = RandomForestClassifier(random_state=42)
    estimator_4 = SVC(probability=True, random_state=42)
    estimator_5 = MultinomialNB()
    estimator_6 = KNeighborsClassifier()


    # Initiaze the hyperparameters for each dictionary
    if classifier_model == "LogisticRegression":

        param_grid = {
            'classifier__solver': ['lbfgs', 'saga'],
            'classifier__max_iter': [100, 1000],
            'classifier__random_state': [0, 42],
            'classifier__multi_class': ['auto', 'multinomial']
        }

        full_pipeline = Pipeline([
            ('preprocessing', full_pipeline_transformer),
            ('classifier', estimator_1),
        ])


    elif classifier_model == "DecisionTreeClassifier":

        #'classifier__min_samples_split': [2, 5, 10, 20],
        #'classifier__min_samples_leaf': [1, 5, 10],
        #'classifier__max_leaf_nodes': [None, 5, 10, 20],

        param_grid = {
            'classifier__criterion': ['gini', 'entropy'],
            'classifier__max_depth': [2 ,5, 10, 25, None],
            'classifier__min_samples_split': [2],
            'classifier__min_samples_leaf': [1],
            'classifier__max_leaf_nodes': [20],
            'classifier__class_weight': [None, {0:1,1:5}, {0:1,1:10}, {0:1
        }

        full_pipeline = Pipeline([
            ('preprocessing', full_pipeline_transformer),
            ('classifier', estimator_2),
        ])

    elif classifier_model == "RandomForestClassifier":

        param_grid = {
```

```
        'classifier__n_estimators': [10, 50, 100, 250],
        'classifier__max_depth': [5,10,20],
        'classifier__class_weight': [None, {0:1,1:5}, {0:1,1:10}, {0:1
    }

    full_pipeline = Pipeline([
        ('preprocessing', full_pipeline_transformer),
        ('classifier', estimator_3),
    ])

elif classifier_model == "SVC":

    param_grid = {
        'classifier__kernel': ['linear', 'rbf','poly'],
        #'classifier__C': [0.01, 0.1, 1, 10, 100],
        #'classifier__class_weight': [None, {0:1,1:5}, {0:1,1:10}, {0:
        'classifier__gamma': ['auto'],
    }

    full_pipeline = Pipeline([
        ('preprocessing', full_pipeline_transformer),
        ('classifier', estimator_4),
    ])

elif classifier_model == "MultinomialNB":

    param_grid = {
        'classifier__alpha': [0, 10, 100]
    }

    full_pipeline = Pipeline([
        ('preprocessing', full_pipeline_transformer),
        ('classifier', estimator_5),
    ])

elif classifier_model == "KNeighborsClassifier":

    param_grid = {
        'classifier__n_neighbors': [2,5,10,25,50]
    }

    full_pipeline = Pipeline([
        ('preprocessing', full_pipeline_transformer),
        ('classifier', estimator_6),
    ])

else:
    param_grid = [
        {
            'classifier': [estimator_1],
            'classifier__solver': ['lbfgs', 'saga'],
            'classifier__max_iter': [1000],
            'classifier__random_state': [0, 42],
            'classifier__multi_class': ['auto', 'multinomial']
        },
        {
```

```
            'classifier': [estimator_2],
            'classifier__criterion': ['gini'],
            'classifier__max_depth': [5,10,25,None],
            'classifier__min_samples_split': [2,5,10],
            'classifier__class_weight': [None, {0:1,1:5}, {0:1,1:10},
        },
        {
            'classifier': [estimator_3],
            'classifier__n_estimators': [10, 50, 100, 250],
            'classifier__max_depth': [5,10,20],
            'classifier__class_weight': [None, {0:1,1:5}, {0:1,1:10},
        },
        {
            'classifier': [estimator_4],
            'classifier__kernel': ['linear', 'rbf', 'poly'],
            'classifier__gamma': ['auto'],
        },
        {
            'classifier': [estimator_5],
            'classifier__alpha': [0, 10, 100]
        },
        {
            'classifier': [estimator_6],
            'classifier__n_neighbors': [2,5,10,25,50]
        }
    ]

    full_pipeline = Pipeline([
        ('preprocessing', full_pipeline_transformer),
        ('classifier', estimator_1),
    ])

print("************************************************************")
print("Get Best Estimator/Params of the Model for ", classifier_model)


gs = GridSearchCV(full_pipeline, param_grid, cv=3, n_jobs=-1, scoring=
gs.fit(X_train, y_train)


print("Best Estimator:", gs.best_estimator_)
print("Best Params:", gs.best_params_)
print("Best Score:", gs.best_score_)

# Test data performance
print("Test Precision:",precision_score(gs.predict(X_test), y_test))
print("Test Recall:",recall_score(gs.predict(X_test), y_test))
print("Test ROC AUC Score:",roc_auc_score(gs.predict(X_test), y_test))

print("Test Accuracy Score = ", accuracy_score(gs.predict(X_test), y_t
print("Test Confusion Matrix = \n", confusion_matrix(gs.predict(X_test
print("Test Classification Report = \n", classification_report(gs.pred

# CONFUSION MATRIX PLOT
cm = confusion_matrix(gs.predict(X_test), y_test)
ax = plt.subplot()
```

```
    sns.heatmap(cm, annot=True, ax = ax); #annot=True to annotate cells

    # ROC AUC CURVE PLOT
    plot_roc_curve(gs, X_test, y_test)
    plt.show()

    return gs
```

In [ ]:

Type *Markdown* and LaTeX: α^2

Load & check the data:

In [62]:
```
data = pd.read_csv('KSI.csv')

data
```

Out[62]:

	X	Y	INDEX_	ACCNUM	YEAR	DATE	TIME	HOUR
0	-8.844611e+06	5.412414e+06	3387730	892658	2006	2006/03/11 05:00:00+00	852	8
1	-8.844611e+06	5.412414e+06	3387731	892658	2006	2006/03/11 05:00:00+00	852	8
2	-8.816480e+06	5.434843e+06	3388101	892810	2006	2006/03/11 05:00:00+00	915	9
3	-8.816480e+06	5.434843e+06	3388102	892810	2006	2006/03/11 05:00:00+00	915	9
4	-8.822759e+06	5.424516e+06	3387793	892682	2006	2006/03/12 05:00:00+00	240	2
...	...	...	...	...	...	...	...	...
16855	-8.820837e+06	5.421411e+06	81509784	1636966	2020	2020/08/30 04:00:00+00	1340	13
16856	-8.820068e+06	5.425334e+06	81505452	1650701	2020	2020/09/01 04:00:00+00	1205	12
16857	-8.820068e+06	5.425334e+06	81505453	1650701	2020	2020/09/01 04:00:00+00	1205	12
16858	-8.820068e+06	5.425334e+06	81505454	1650701	2020	2020/09/01 04:00:00+00	1205	12
16859	-8.842562e+06	5.412998e+06	81509748	1650875	2020	2020/09/01 04:00:00+00	1238	12

16860 rows × 57 columns

Analyze Data - Data Exploration Stats, Histogram, Graphs

In [63]:
```
# Analyze data - first step
analyze_data(data)
```

```
analyze_data_unique_values(data, False)
```

```
 Data - 20 first rows
              X             Y   INDEX_  ACCNUM  YEAR
DATE  \
0  -8.844611e+06  5.412414e+06  3387730  892658  2006  2006/03/11 05:00:0
0+00
1  -8.844611e+06  5.412414e+06  3387731  892658  2006  2006/03/11 05:00:0
0+00
2  -8.816480e+06  5.434843e+06  3388101  892810  2006  2006/03/11 05:00:0
0+00
3  -8.816480e+06  5.434843e+06  3388102  892810  2006  2006/03/11 05:00:0
0+00
4  -8.822759e+06  5.424516e+06  3387793  892682  2006  2006/03/12 05:00:0
0+00
5  -8.822759e+06  5.424516e+06  3387794  892682  2006  2006/03/12 05:00:0
0+00
6  -8.822759e+06  5.424516e+06  3387795  892682  2006  2006/03/12 05:00:0
0+00
7  -8.841082e+06  5.411337e+06  3388371  892913  2006  2006/03/12 05:00:0
```

Cleaning Data

In [64]:

```
# preprocessing - clean data
```

Analyze Data - Data Exploration Stats, Histogram, Graphs

In [65]:

```
# Analyze data - after the first cleaning
analyze_data(data)
analyze_data_unique_values(data, True)
```

```
 Data - 20 first rows
    HOUR      ROAD_CLASS              DISTRICT      LOCCOORD  \
0      8  Major Arterial  Toronto and East York  Intersection
1      8  Major Arterial  Toronto and East York  Intersection
2      9  Major Arterial            Scarborough  Intersection
3      9  Major Arterial            Scarborough  Intersection
4      2  Major Arterial            Scarborough     Mid-Block
5      2  Major Arterial            Scarborough     Mid-Block
6      2  Major Arterial            Scarborough     Mid-Block
7     19  Major Arterial  Toronto and East York  Intersection
8     19  Major Arterial  Toronto and East York  Intersection
9     15  Major Arterial          Etobicoke York  Intersection
10    15  Major Arterial          Etobicoke York  Intersection
11     9  Major Arterial            Scarborough  Intersection
12     9  Major Arterial            Scarborough  Intersection
13     9  Major Arterial            Scarborough  Intersection
14     9  Major Arterial            Scarborough  Intersection
15     9  Major Arterial            Scarborough  Intersection
```

Analyze Data with Power BI

Count of accidents

16.86K

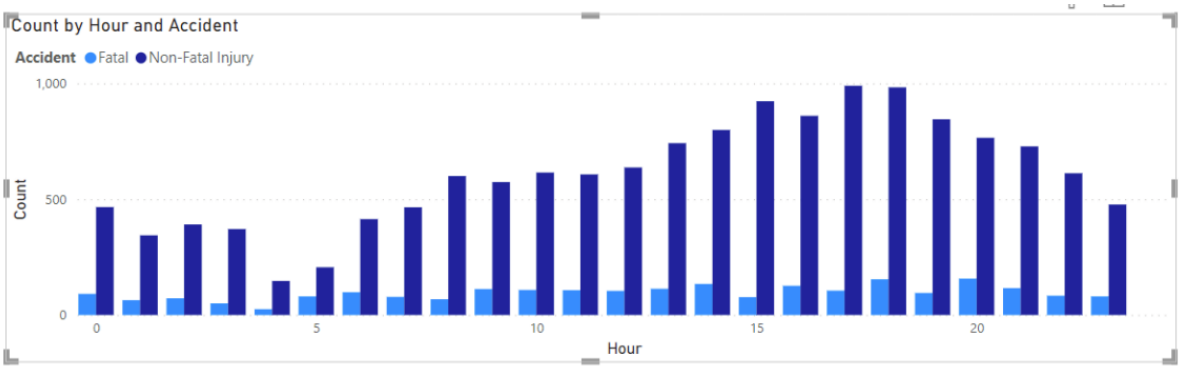
Total Number of people Injured or dead

6002

Total Number of Accidents

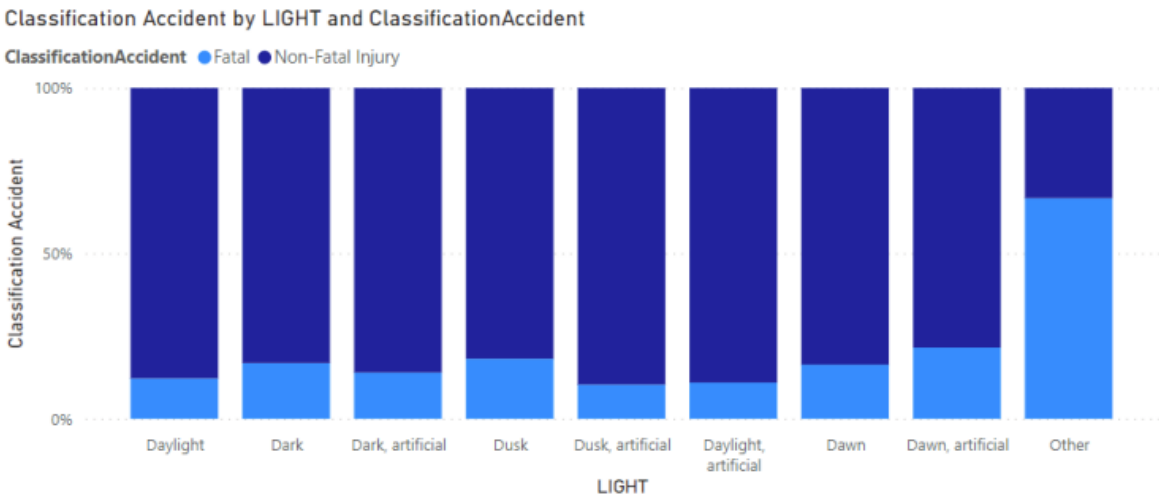
Relation between accidents and time

We can see that the total number of accident are high in evening hours where as no such conclusion can be derived for fatal accident

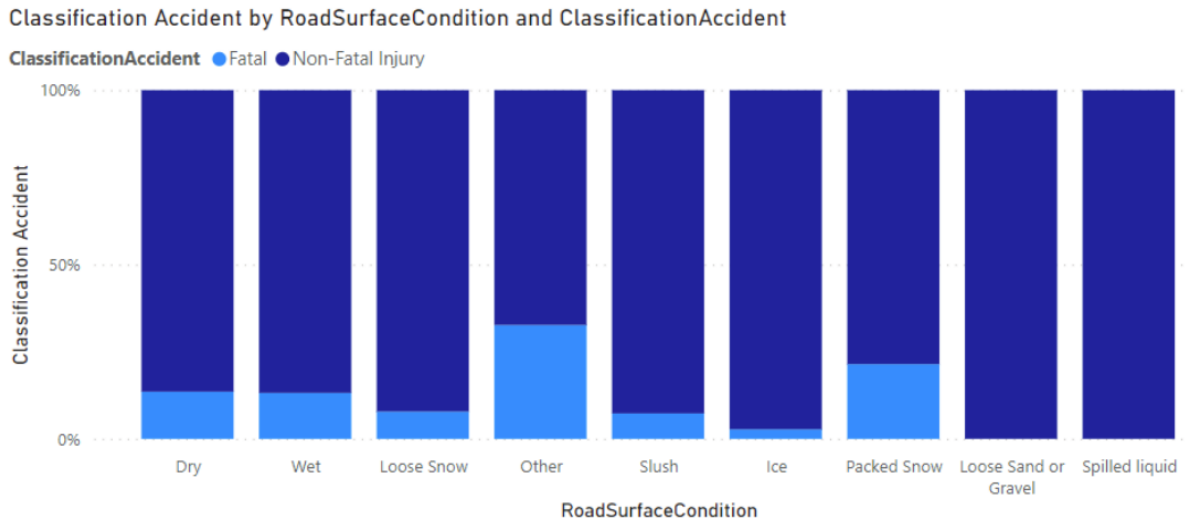


Percentage of accident by Light

We can see that the total number of accident are high in evening hours where as no such conclusion can be derived for fatal accident

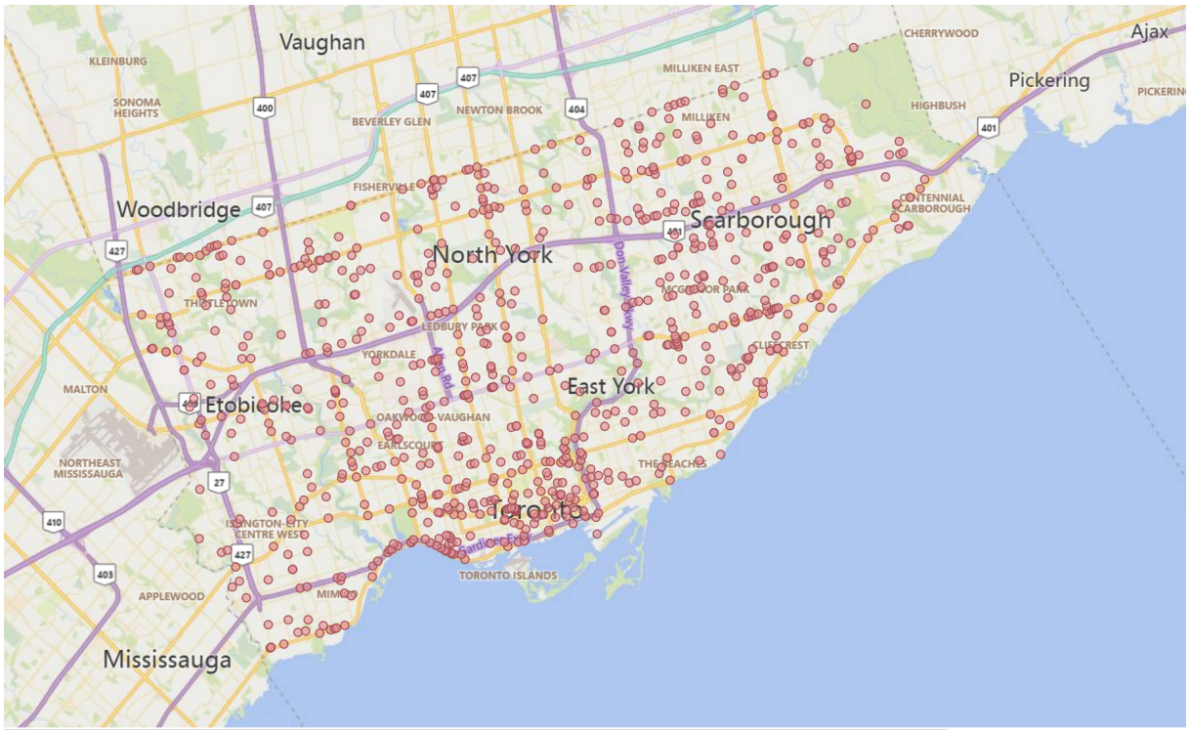


Percentage of accident by Road Condition

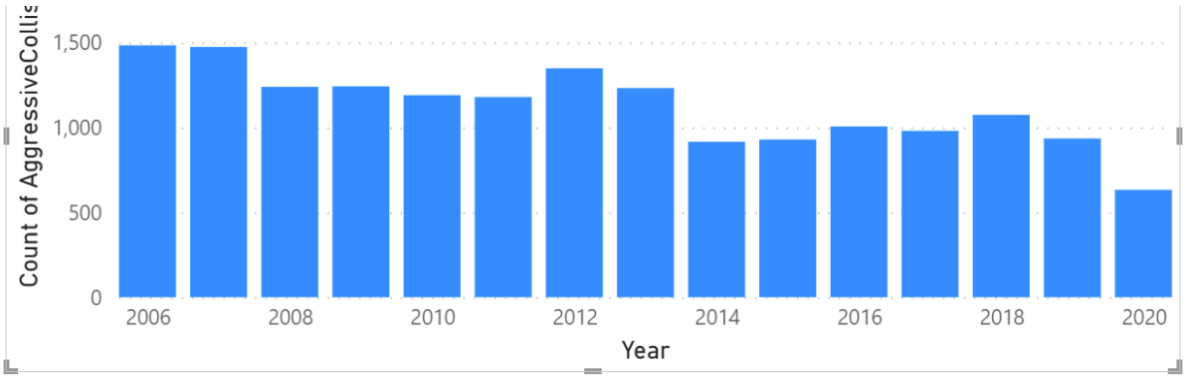


The Spots of all the fatal accidents

We can clearly see the hot spots



Counts of accident are falling

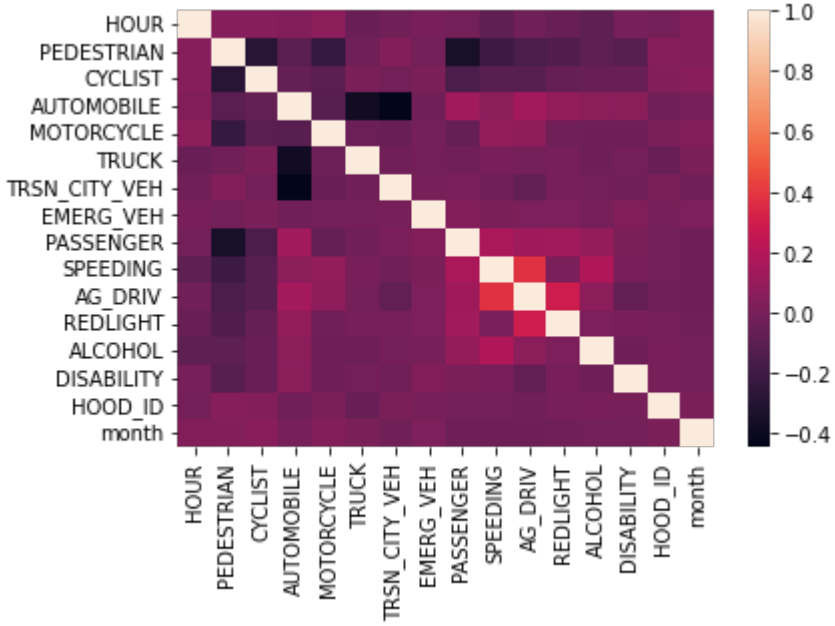


Correlation in the dataset

Trying to find corelation in the dataset

In [66]:
```
corr_matrix = data.corr()
sns.heatmap(corr_matrix)
```

Out[66]: <AxesSubplot:>



Cleaning Data - Replace Values

In [69]:
```
# preprocessing - clean data
```

In [ ]:
```
```

Analyze Data - Data Exploration Stats, Histogram, Graphs

In [70]:
```
# Analyze data - after the second cleaning
```

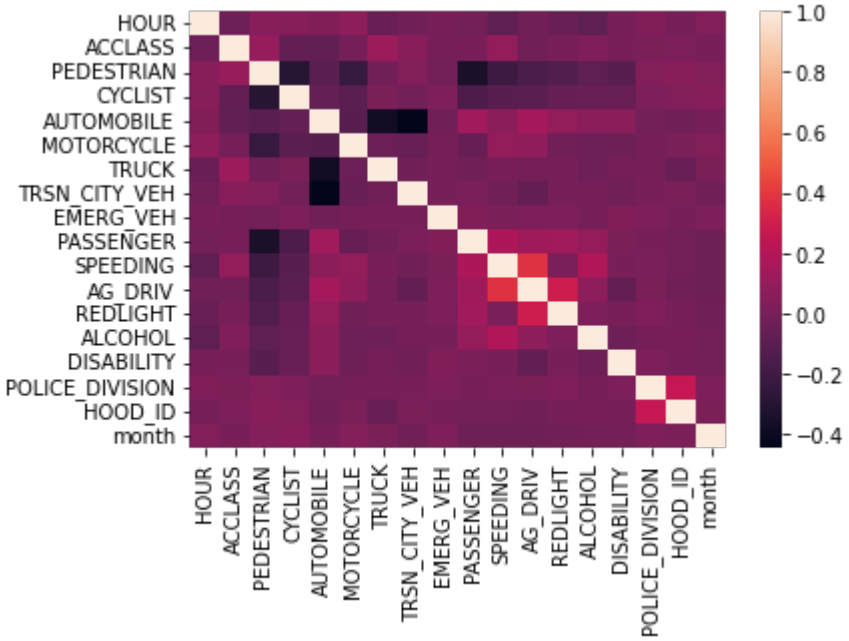
```
analyze_data(data)
```

```
 Data - 20 first rows
    HOUR      ROAD_CLASS              DISTRICT      LOCCOORD  \
0      8  Major Arterial  Toronto and East York  Intersection
1      8  Major Arterial  Toronto and East York  Intersection
2      9  Major Arterial            Scarborough  Intersection
3      9  Major Arterial            Scarborough  Intersection
4      2  Major Arterial            Scarborough     Mid-Block
5      2  Major Arterial            Scarborough     Mid-Block
6      2  Major Arterial            Scarborough     Mid-Block
7     19  Major Arterial  Toronto and East York  Intersection
8     19  Major Arterial  Toronto and East York  Intersection
9     15  Major Arterial         Etobicoke York  Intersection
10    15  Major Arterial         Etobicoke York  Intersection
11     9  Major Arterial            Scarborough  Intersection
12     9  Major Arterial            Scarborough  Intersection
13     9  Major Arterial            Scarborough  Intersection
14     9  Major Arterial            Scarborough  Intersection
15     9  Major Arterial            Scarborough  Intersection
```

Correlation of the variables

In [73]:
```
corr_matrix = data.corr()
sns.heatmap(corr_matrix)
```

Out[73]: <AxesSubplot:>



In [79]:
```
corr_matrix = data.corr()
corr_matrix["ACCLASS"].sort_values(ascending=False)
```

Out[79]:

```
ACCLASS            1.000000
TRUCK              0.114711
PEDESTRIAN         0.100861
SPEEDING           0.089580
TRSN_CITY_VEH      0.048213
ALCOHOL            0.021518
HOOD_ID            0.015462
POLICE_DIVISION    0.007411
REDLIGHT          -0.000108
month             -0.001364
PASSENGER         -0.003197
DISABILITY        -0.004044
MOTORCYCLE        -0.012923
EMERG_VEH         -0.015988
AG_DRIV           -0.029194
HOUR              -0.037819
```

Build Classification Models

Get full pipeline transformer and data (train and test)

In [80]:

```
full_pipeline_transformer, X_group, Y_group, X_train, X_test, y_train, y_t

print(full_pipeline_transformer, X_group, Y_group, X_train, X_test, y_trai
```

```
ColumnTransformer(transformers=[('num',
                                 Pipeline(steps=[('imputer',
                                                  SimpleImputer(strategy=
'median')),
                                                 ('std_scaler',
                                                  StandardScaler())]),
                                 ['HOUR', 'CYCLIST', 'AUTOMOBILE', 'MOTOR
CYCLE',
                                  'TRUCK', 'TRSN_CITY_VEH', 'EMERG_VEH',
                                  'SPEEDING', 'AG_DRIV', 'REDLIGHT', 'ALC
OHOL',
                                  'DISABILITY', 'PEDESTRIAN', 'PASSENGER
',
                                  'POLICE_DIVISION', 'HOOD_ID', 'month
']),
                                ('cat',
                                 Pipeline(steps=[('imputer',
                                                  SimpleImputer(fill_valu
e='missing',
```

Testing models

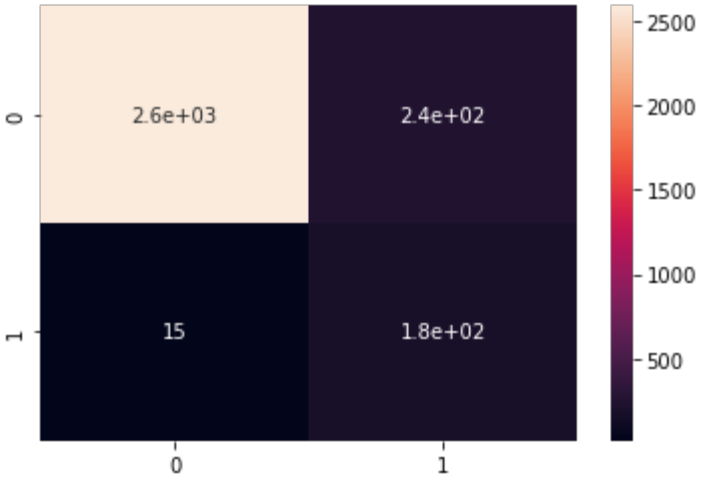
Logistic Regression

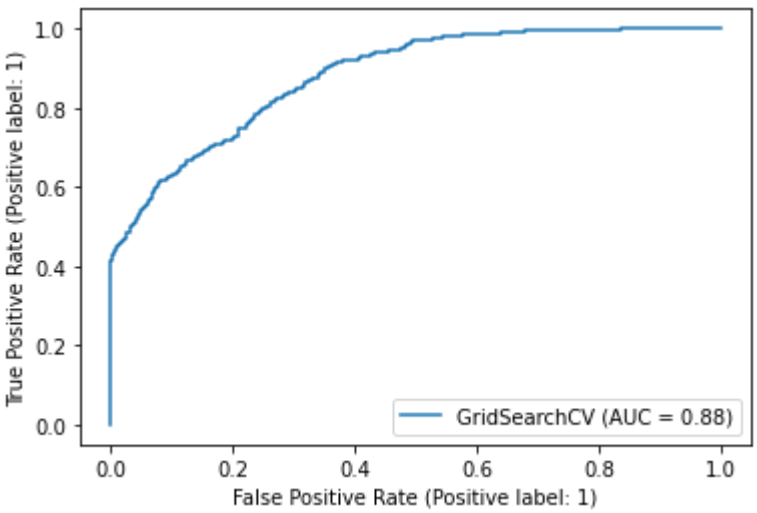
In [81]:

```
gs_logistic = get_best_model(data, 'LogisticRegression', full_pipeline_tra
```

```
**********************************************************
Get Best Estimator/Params of the Model for  LogisticRegression
Best Estimator: Pipeline(steps=[('preprocessing',
                 ColumnTransformer(transformers=[('num',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(strategy='median')),
                                                                  ('std_s
caler',
                                                                   Standa
rdScaler())]),
                                                  ['HOUR', 'CYCLIST',
                                                   'AUTOMOBILE', 'MOTORCY
CLE',
                                                   'TRUCK', 'TRSN_CITY_VE
H',
                                                   'EMERG_VEH', 'SPEEDING
',
                                                   'AG_DRIV', 'REDLIGHT',
                                                   'ALCOHOL', 'DISABILITY
',
                                                   'PEDESTRIAN', 'PASSENG
ER',
                                                   'POLICE_DIVISION', 'HO
OD...
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(fill_value='missing',

strategy='constant')),
                                                                  ('encod
er',
                                                                   OneHot
Encoder(handle_unknown='ignore'))]),
                                                  ['ROAD_CLASS', 'DISTRIC
T',
                                                   'LOCCOORD', 'ACCLOC',
                                                   'TRAFFCTL', 'VISIBILIT
Y',
                                                   'LIGHT', 'RDSFCOND',
                                                   'IMPACTYPE', 'INVTYPE
',
                                                   'INJURY', 'VEHTYPE
'])])),
                ('classifier',
                 LogisticRegression(max_iter=1000, multi_class='multinomi
al',
                                    random_state=0))])
Best Params: {'classifier__max_iter': 1000, 'classifier__multi_class': 'm
ultinomial', 'classifier__random_state': 0, 'classifier__solver': 'lbfgs
'}
```

```
Best Score: 0.881947451783029
Test Precision: 0.43705463182897863
Test Recall: 0.9246231155778895
Test ROC AUC Score: 0.9203498014150071
Test Accuracy Score =  0.916639100231558
Test Confusion Matrix =
 [[2587  237]
 [  15  184]]
Test Classification Report =
              precision    recall  f1-score   support

           0       0.99      0.92      0.95      2824
           1       0.44      0.92      0.59       199

    accuracy                           0.92      3023
   macro avg       0.72      0.92      0.77      3023
weighted avg       0.96      0.92      0.93      3023
```



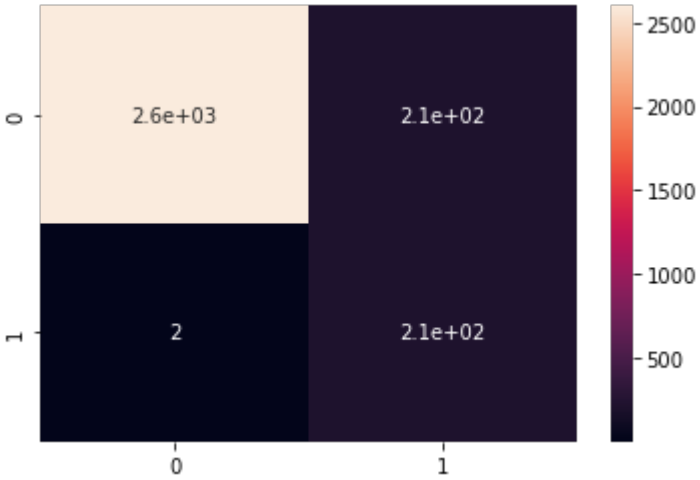


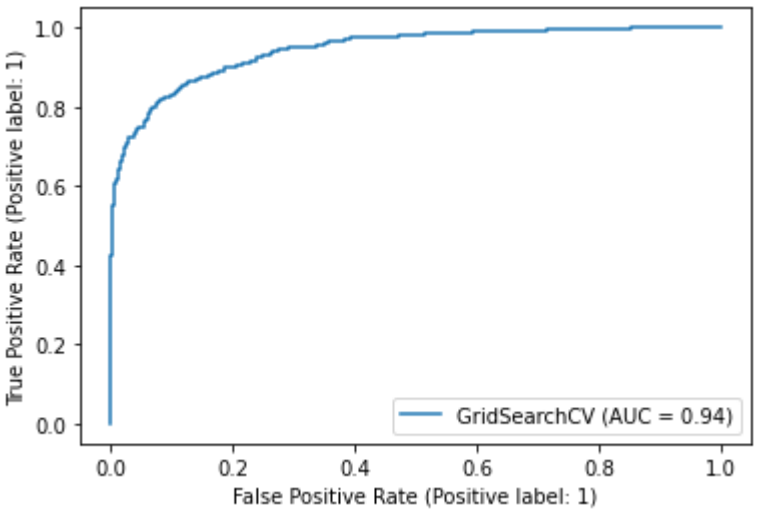
RandomForestClassifier

In [82]:
```
gs_random = get_best_model(data, 'RandomForestClassifier', full_pipeline_t
```

```
**********************************************************
Get Best Estimator/Params of the Model for  RandomForestClassifier
Best Estimator: Pipeline(steps=[('preprocessing',
                 ColumnTransformer(transformers=[('num',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(strategy='median')),
                                                                  ('std_s
caler',
                                                                   Standa
rdScaler())]),
                                                  ['HOUR', 'CYCLIST',
                                                   'AUTOMOBILE', 'MOTORCY
CLE',
                                                   'TRUCK', 'TRSN_CITY_VE
H',
                                                   'EMERG_VEH', 'SPEEDING
',
                                                   'AG_DRIV', 'REDLIGHT',
                                                   'ALCOHOL', 'DISABILITY
',
                                                   'PEDESTRIAN', 'PASSENG
ER',
                                                   'POLICE_DIVISION', 'HO
OD...
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(fill_value='missing',

strategy='constant')),
                                                                  ('encod
er',
                                                                   OneHot
Encoder(handle_unknown='ignore'))]),
                                                  ['ROAD_CLASS', 'DISTRIC
T',
                                                   'LOCCOORD', 'ACCLOC',
                                                   'TRAFFCTL', 'VISIBILIT
Y',
                                                   'LIGHT', 'RDSFCOND',
                                                   'IMPACTYPE', 'INVTYPE
',
                                                   'INJURY', 'VEHTYPE
'])])),
                ('classifier',
                 RandomForestClassifier(max_depth=20, n_estimators=250,
                                        random_state=42))])
Best Params: {'classifier__class_weight': None, 'classifier__max_depth':
20, 'classifier__n_estimators': 250}
Best Score: 0.9314571740975975
Test Precision: 0.498812351543943
Test Recall: 0.9905660377358491
Test ROC AUC Score: 0.9577518911553666
Test Accuracy Score =  0.9295401918623883
```

```
Test Confusion Matrix =
 [[2600  211]
 [   2  210]]
Test Classification Report =
              precision    recall  f1-score   support

           0       1.00      0.92      0.96      2811
           1       0.50      0.99      0.66       212

    accuracy                           0.93      3023
   macro avg       0.75      0.96      0.81      3023
weighted avg       0.96      0.93      0.94      3023
```



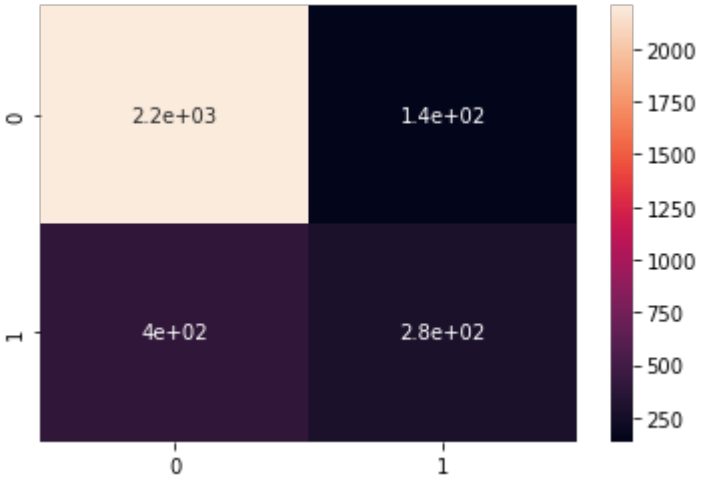


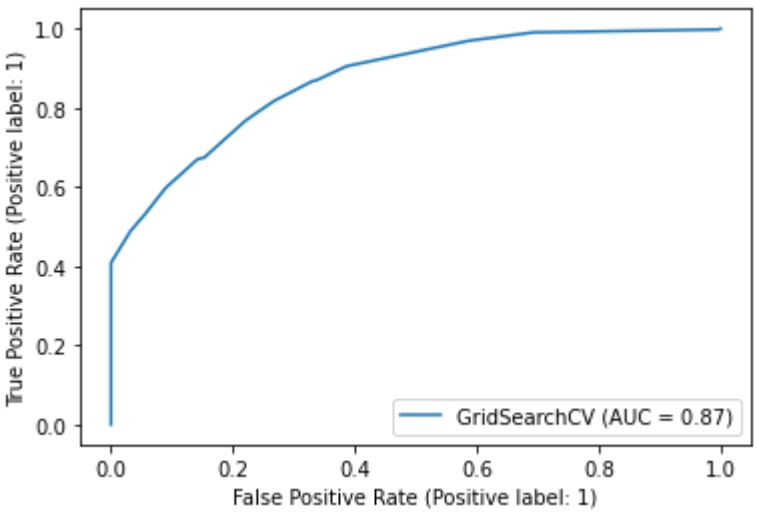
DecisionTreeClassifier

In [83]:
```
gs_decisiontree = get_best_model(data, 'DecisionTreeClassifier', full_pipe
```

```
**********************************************************
Get Best Estimator/Params of the Model for  DecisionTreeClassifier
Best Estimator: Pipeline(steps=[('preprocessing',
                 ColumnTransformer(transformers=[('num',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(strategy='median')),
                                                                  ('std_s
caler',
                                                                   Standa
rdScaler())]),
                                                  ['HOUR', 'CYCLIST',
                                                   'AUTOMOBILE', 'MOTORCY
CLE',
                                                   'TRUCK', 'TRSN_CITY_VE
H',
                                                   'EMERG_VEH', 'SPEEDING
',
                                                   'AG_DRIV', 'REDLIGHT',
                                                   'ALCOHOL', 'DISABILITY
',
                                                   'PEDESTRIAN', 'PASSENG
ER',
                                                   'POLICE_DIVISION', 'HO
OD...
                                                                   Simple
Imputer(fill_value='missing',

strategy='constant')),
                                                                  ('encod
er',
                                                                   OneHot
Encoder(handle_unknown='ignore'))]),
                                                  ['ROAD_CLASS', 'DISTRIC
T',
                                                   'LOCCOORD', 'ACCLOC',
                                                   'TRAFFCTL', 'VISIBILIT
Y',
                                                   'LIGHT', 'RDSFCOND',
                                                   'IMPACTYPE', 'INVTYPE
',
                                                   'INJURY', 'VEHTYPE
'])])),
                ('classifier',
                 DecisionTreeClassifier(class_weight={0: 1, 1: 5}, max_de
pth=25,
                                        max_leaf_nodes=20, random_state=4
2))])
Best Params: {'classifier__class_weight': {0: 1, 1: 5}, 'classifier__crit
erion': 'gini', 'classifier__max_depth': 25, 'classifier__max_leaf_nodes
': 20, 'classifier__min_samples_leaf': 1, 'classifier__min_samples_split
': 2}
Best Score: 0.8598009998688164
Test Precision: 0.6745843230403801
Test Recall: 0.4158125915080527
```

```
Test ROC AUC Score: 0.678632791480522
Test Accuracy Score =  0.8226926893814092
Test Confusion Matrix =
 [[2203  137]
 [ 399  284]]
Test Classification Report =
              precision    recall  f1-score   support
```



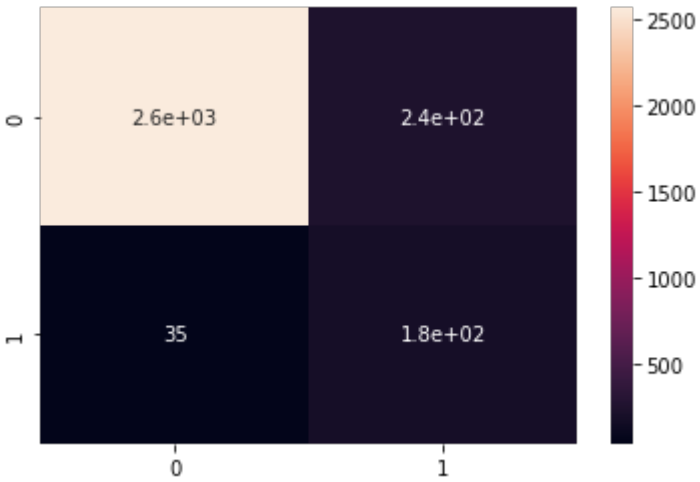


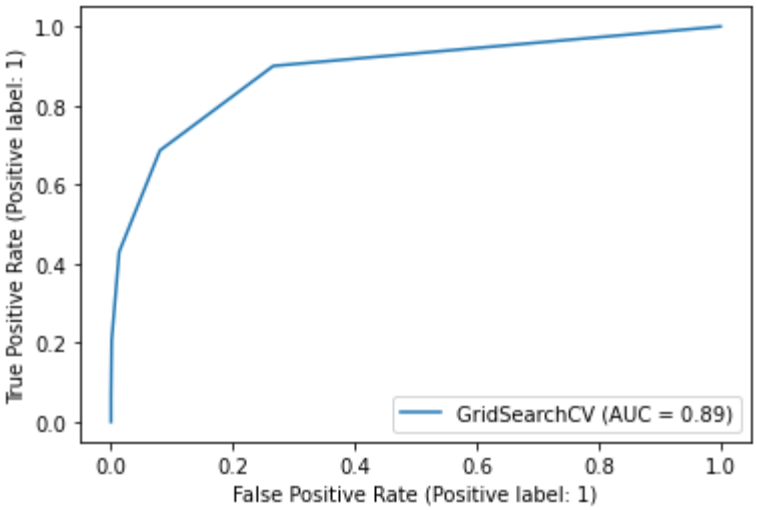
KNeighborsClassifier

In [84]:

```
**********************************************************
Get Best Estimator/Params of the Model for  KNeighborsClassifier
Best Estimator: Pipeline(steps=[('preprocessing',
                 ColumnTransformer(transformers=[('num',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(strategy='median')),
                                                                  ('std_s
caler',
                                                                   Standa
rdScaler())]),
                                                  ['HOUR', 'CYCLIST',
                                                   'AUTOMOBILE', 'MOTORCY
CLE',
                                                   'TRUCK', 'TRSN_CITY_VE
H',
                                                   'EMERG_VEH', 'SPEEDING
',
                                                   'AG_DRIV', 'REDLIGHT',
                                                   'ALCOHOL', 'DISABILITY
',
                                                   'PEDESTRIAN', 'PASSENG
ER',
                                                   'POLICE_DIVISION', 'HO
OD_ID',
                                                   'month']),
                                                 ('cat',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(fill_value='missing',

strategy='constant')),
                                                                  ('encod
er',
                                                                   OneHot
Encoder(handle_unknown='ignore'))]),
                                                  ['ROAD_CLASS', 'DISTRIC
T',
                                                   'LOCCOORD', 'ACCLOC',
                                                   'TRAFFCTL', 'VISIBILIT
Y',
                                                   'LIGHT', 'RDSFCOND',
                                                   'IMPACTYPE', 'INVTYPE
',
                                                   'INJURY', 'VEHTYPE
'])])),
                ('classifier', KNeighborsClassifier())])
Best Params: {'classifier__n_neighbors': 5}
Best Score: 0.8504230246806003
Test Precision: 0.42992874109263657
Test Recall: 0.8379629629629629
Test ROC AUC Score: 0.8762312142923115
Test Accuracy Score =  0.9090307641415812
Test Confusion Matrix =
```

[[2567 240]

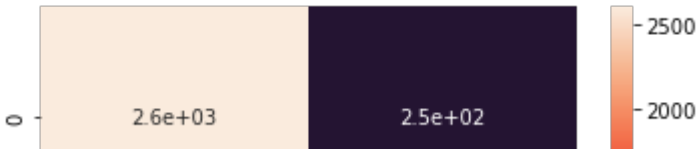


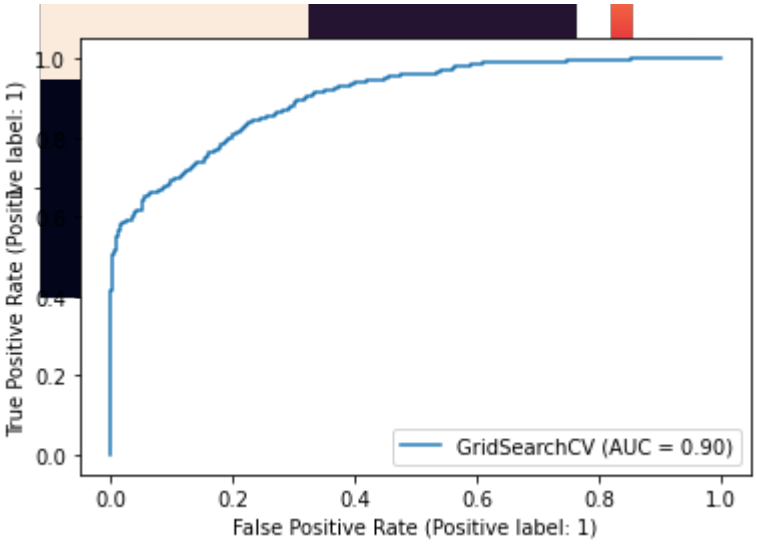


SVC

In [85]:
```
gs_svc = get_best_model(data, 'SVC', full_pipeline_transformer, X_train, X
```

```
**********************************************************
Get Best Estimator/Params of the Model for  SVC
Best Estimator: Pipeline(steps=[('preprocessing',
                 ColumnTransformer(transformers=[('num',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(strategy='median')),
                                                                  ('std_s
caler',
                                                                   Standa
rdScaler())]),
                                                  ['HOUR', 'CYCLIST',
                                                   'AUTOMOBILE', 'MOTORCY
CLE',
                                                   'TRUCK', 'TRSN_CITY_VE
H',
                                                   'EMERG_VEH', 'SPEEDING
',
                                                   'AG_DRIV', 'REDLIGHT',
                                                   'ALCOHOL', 'DISABILITY
',
                                                   'PEDESTRIAN', 'PASSENG
ER',
                                                   'POLICE_DIVISION', 'HO
OD...
                                                   'month']),
                                                 ('cat',
                                                  Pipeline(steps=[('imput
er',
                                                                   Simple
Imputer(fill_value='missing',

strategy='constant')),
                                                                  ('encod
er',
                                                                   OneHot
Encoder(handle_unknown='ignore'))]),
                                                  ['ROAD_CLASS', 'DISTRIC
T',
                                                   'LOCCOORD', 'ACCLOC',
                                                   'TRAFFCTL', 'VISIBILIT
Y',
                                                   'LIGHT', 'RDSFCOND',
                                                   'IMPACTYPE', 'INVTYPE
',
                                                   'INJURY', 'VEHTYPE
'])])),
                ('classifier',
                 SVC(gamma='auto', probability=True, random_state=42))])
Best Params: {'classifier__gamma': 'auto', 'classifier__kernel': 'rbf'}
Best Score: 0.8857828761006091
```




True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
GridSearchCV (AUC = 0.90)
0.0
0.2
0.4
0.6
0.8
1.0

In [ ]: