DIC_Project_Harshit_Malpani_50608809

November 5, 2024

1 Phase 1

1.1 1: Problem Statement

1.1.1 1.1.1 Problem Statement

This project's goal is to make a detailed analysis on why road accidents are occurring a lot and in what trend, will be helpful in improving road safety measures & make the policy options which can reduce the number of accidents. This research would help to know the impacts of accident severity on the driver attributes, vehicle conditions, surface conditions and environmental conditions.

1.1.2 1.1.2 Potential Contribution & Importance

Road accidents pose a threat to health globally by resulting in significant fatalities and injuries of individuals worldwide. This evaluation plays a role in finding factors that play a vital role in accident prevention. The evidence of this review may support the implementation of measures of safety, improvement of driver education programs, and modification of road systems that can reduce accidents and save lives.

1.2 2: Ask Questions

Harshit Malpani: 50608809

Question 1: What vehicles should the authorities focus more on to reduce the cases of road accidents and the severity of road accidents Analyzing the type of vehicle involved in road accidents can help identify what vehicle type needs improvement in the technology. More technologies like Airbags, ABS brakes etc. can be augmented in those vehicles to improve their safety ratings and reduce life loss due to accidents

Question 2: Does the service period of the vehicle and ownership of the vehicle have any correlation with the accidents.The state of vehicle and the person driving it plays an important role in road safety. We need to find out how the state of the vehicle and the ownership of the vehicle affect the possibility of a vehicle to be involved in an accident. This study will help in making policies and rules to reduce road accidents and related casualties.

1.3 3: Data Retrieval

The dataset has been taken from KAGGLE. For this task, we have uploaded a copy of the dataset to a GitHub repository and downloaded the data from the GitHub repository directly to the data frame

[224]:
```python
import pandas as pd

dataset = pd.read_csv('https://raw.githubusercontent.com/hmalpani/RTA-Dataset/
↪main/RTA_Dataset.csv')
```

[225]:
```python
dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 12316 entries, 0 to 12315
Data columns (total 32 columns):
 #   Column                       Non-Null Count  Dtype 
---  ------                       --------------  ----- 
 0   Time                         12316 non-null  object
 1   Day_of_week                  12316 non-null  object
 2   Age_band_of_driver           12316 non-null  object
 3   Sex_of_driver                12316 non-null  object
 4   Educational_level            11575 non-null  object
 5   Vehicle_driver_relation      11737 non-null  object
 6   Driving_experience           11487 non-null  object
 7   Type_of_vehicle              11366 non-null  object
 8   Owner_of_vehicle             11834 non-null  object
 9   Service_year_of_vehicle      8388 non-null   object
 10  Defect_of_vehicle            7889 non-null   object
 11  Area_accident_occured        12077 non-null  object
 12  Lanes_or_Medians             11931 non-null  object
 13  Road_allignment              12174 non-null  object
 14  Types_of_Junction            11429 non-null  object
 15  Road_surface_type            12144 non-null  object
 16  Road_surface_conditions      12316 non-null  object
 17  Light_conditions             12316 non-null  object
 18  Weather_conditions           12316 non-null  object
 19  Type_of_collision            12161 non-null  object
 20  Number_of_vehicles_involved  12316 non-null  int64 
 21  Number_of_casualties         12316 non-null  int64 
 22  Vehicle_movement             12008 non-null  object
 23  Casualty_class               12316 non-null  object
 24  Sex_of_casualty              12316 non-null  object
 25  Age_band_of_casualty         12316 non-null  object
 26  Casualty_severity            12316 non-null  object
 27  Work_of_casuality            9118 non-null   object
 28  Fitness_of_casuality         9681 non-null   object
 29  Pedestrian_movement          12316 non-null  object
 30  Cause_of_accident            12316 non-null  object
 31  Accident_severity            12316 non-null  object
dtypes: int64(2), object(30)
memory usage: 3.0+ MB
```

[226]:
```python
dataset.head()
```

[226]:
```
        Time Day_of_week Age_band_of_driver Sex_of_driver   Educational_level  \
0   17:02:00      Monday              18-30          Male   Above high school
1   17:02:00      Monday              31-50          Male  Junior high school
2   17:02:00      Monday              18-30          Male  Junior high school
3    1:06:00      Sunday              18-30          Male  Junior high school
4    1:06:00      Sunday              18-30          Male  Junior high school

  Vehicle_driver_relation Driving_experience      Type_of_vehicle  \
0                Employee              1-2yr           Automobile
1                Employee         Above 10yr  Public (> 45 seats)
2                Employee              1-2yr      Lorry (41?100Q)
3                Employee             5-10yr  Public (> 45 seats)
4                Employee              2-5yr                  NaN

  Owner_of_vehicle Service_year_of_vehicle Defect_of_vehicle  \
0            Owner              Above 10yr         No defect
1            Owner                 5-10yrs         No defect
2            Owner                     NaN         No defect
3     Governmental                     NaN         No defect
4            Owner                 5-10yrs         No defect

  Area_accident_occured   Lanes_or_Medians  \
0     Residential areas                NaN
1          Office areas  Undivided Two way
2    Recreational areas              other
3          Office areas              other
4      Industrial areas              other

                                Road_allignment Types_of_Junction  \
0                 Tangent road with flat terrain       No junction
1                 Tangent road with flat terrain       No junction
2                                            NaN       No junction
3  Tangent road with mild grade and flat terrain           Y Shape
4                 Tangent road with flat terrain           Y Shape

  Road_surface_type Road_surface_conditions       Light_conditions  \
0     Asphalt roads                     Dry               Daylight
1     Asphalt roads                     Dry               Daylight
2     Asphalt roads                     Dry               Daylight
3       Earth roads                     Dry  Darkness - lights lit
4     Asphalt roads                     Dry  Darkness - lights lit

  Weather_conditions                            Type_of_collision  \
0             Normal  Collision with roadside-parked vehicles
1             Normal           Vehicle with vehicle collision
2             Normal          Collision with roadside objects
3             Normal           Vehicle with vehicle collision
```

```
4            Normal          Vehicle with vehicle collision

   Number_of_vehicles_involved  Number_of_casualties Vehicle_movement  \
0                            2                     2   Going straight
1                            2                     2   Going straight
2                            2                     2   Going straight
3                            2                     2   Going straight
4                            2                     2   Going straight

    Casualty_class Sex_of_casualty Age_band_of_casualty Casualty_severity  \
0               na              na                   na                na
1               na              na                   na                na
2  Driver or rider            Male                31-50                 3
3       Pedestrian          Female                18-30                 3
4               na              na                   na                na

  Work_of_casuality Fitness_of_casuality Pedestrian_movement  \
0               NaN                  NaN    Not a Pedestrian
1               NaN                  NaN    Not a Pedestrian
2            Driver                  NaN    Not a Pedestrian
3            Driver               Normal    Not a Pedestrian
4               NaN                  NaN    Not a Pedestrian

            Cause_of_accident Accident_severity
0             Moving Backward     Slight Injury
1                  Overtaking     Slight Injury
2   Changing lane to the left    Serious Injury
3  Changing lane to the right     Slight Injury
4                  Overtaking     Slight Injury
```

1.4 4: Data Cleaning

1.4.1 1) Remove Duplicate Values:

Removing duplicate values is an essential step of data cleaning for any data science project. It helps in reducing the bias where certain data points are represented multiple times. If the duplicate values are not removed, it can skew the results and therefore lead to incorrect conclusions

[227]:
```
# Remove duplicates
cleaned_dataset = dataset.drop_duplicates()
```

1.4.2 2) Validation

This step of data cleaning is done to validate that the data in the dataset is useful for the problem we are solving

[228]:

```
# Remove entries with 'Number_of_vehicles_involved' = 0
cleaned_dataset =␣
↪cleaned_dataset[cleaned_dataset['Number_of_vehicles_involved'] != 0]
```

1.4.3 3) Detection and Removal of Outliers

Outliers in the data can impact the decision making using the analytics from the data. We should detect and process the outliers

[229]:
```
numerical_columns = ['Number_of_vehicles_involved', 'Number_of_casualties']
for column in numerical_columns:
    if not pd.api.types.is_numeric_dtype(cleaned_dataset[column]):
        print(f"Column '{column}' should be numeric but contains non-numeric␣
↪data.")

def detect_outliers(column):
    Q1 = cleaned_dataset[column].quantile(0.05)
    Q3 = cleaned_dataset[column].quantile(0.95)
    IQR = Q3 - Q1
    outliers = cleaned_dataset[(cleaned_dataset[column] < (Q1 - 1.5 * IQR)) |␣
↪(cleaned_dataset[column] > (Q3 + 1.5 * IQR))]
    return outliers

for column in numerical_columns:
    outliers = detect_outliers(column)
    if not outliers.empty:
        print(f"Outliers detected in column '{column}':\n", outliers.shape)

def remove_outliers(df, column):
    Q1 = cleaned_dataset[column].quantile(0.05)
    Q3 = cleaned_dataset[column].quantile(0.95)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    return cleaned_dataset[(cleaned_dataset[column] >= lower_bound) &␣
↪(cleaned_dataset[column] <= upper_bound)]

print("Shape before removing outliers:", cleaned_dataset.shape)
cleaned_dataset = remove_outliers(cleaned_dataset,␣
↪'Number_of_vehicles_involved')
cleaned_dataset = remove_outliers(cleaned_dataset, 'Number_of_casualties')

print("Shape after removing outliers:", cleaned_dataset.shape)
```

```
Outliers detected in column 'Number_of_vehicles_involved':
 (7, 32)
Shape before removing outliers: (12316, 32)
Shape after removing outliers: (12309, 32)
```

1.4.4 4) Handling Missing Values:

In this step of Data Cleaning, we either remove or impute the missing values in the dataset

[230]:
```python
# Number of missing values
missing_value_count = cleaned_dataset.isnull().sum()
missing_value_count
```

[230]:
```
Time                          0
Day_of_week                   0
Age_band_of_driver            0
Sex_of_driver                 0
Educational_level           741
Vehicle_driver_relation     579
Driving_experience          829
Type_of_vehicle             950
Owner_of_vehicle            482
Service_year_of_vehicle    3923
Defect_of_vehicle          4427
Area_accident_occured       239
Lanes_or_Medians            385
Road_allignment             142
Types_of_Junction           887
Road_surface_type           172
Road_surface_conditions       0
Light_conditions              0
Weather_conditions            0
Type_of_collision           155
Number_of_vehicles_involved   0
Number_of_casualties          0
Vehicle_movement            306
Casualty_class                0
Sex_of_casualty               0
Age_band_of_casualty          0
Casualty_severity             0
Work_of_casuality          3197
Fitness_of_casuality       2634
Pedestrian_movement           0
Cause_of_accident             0
Accident_severity             0
dtype: int64
```

[231]:
```python
dataset_columns = cleaned_dataset.columns.tolist()
missing_values_columns = missing_value_count[missing_value_count > 0].index.
  ↪tolist()
print(missing_values_columns)
```

```
['Educational_level', 'Vehicle_driver_relation', 'Driving_experience',
'Type_of_vehicle', 'Owner_of_vehicle', 'Service_year_of_vehicle',
```

```
'Defect_of_vehicle', 'Area_accident_occured', 'Lanes_or_Medians',
'Road_allignment', 'Types_of_Junction', 'Road_surface_type',
'Type_of_collision', 'Vehicle_movement', 'Work_of_casuality',
'Fitness_of_casuality']
```

[232]:

```
# Replace missing values
cleaned_dataset['Educational_level'].
  ↪fillna(cleaned_dataset['Educational_level'].mode()[0], inplace=True)
cleaned_dataset['Vehicle_driver_relation'].fillna('Unknown', inplace=True)
cleaned_dataset['Driving_experience'].
  ↪fillna(cleaned_dataset['Driving_experience'].mode()[0], inplace=True)
cleaned_dataset['Type_of_vehicle'].fillna('Unknown', inplace=True)
cleaned_dataset['Owner_of_vehicle'].fillna('Unknown', inplace=True)
cleaned_dataset['Service_year_of_vehicle'].fillna('Unknown', inplace=True)
cleaned_dataset['Defect_of_vehicle'].fillna('No defect', inplace=True)
cleaned_dataset['Area_accident_occured'].fillna('Unknown', inplace=True)
cleaned_dataset['Lanes_or_Medians'].fillna('Unknown', inplace=True)
cleaned_dataset['Road_allignment'].fillna('Unknown', inplace=True)
cleaned_dataset['Types_of_Junction'].fillna('Unknown', inplace=True)
cleaned_dataset['Road_surface_type'].fillna('Unknown', inplace=True)
cleaned_dataset['Type_of_collision'].fillna('Unknown', inplace=True)
cleaned_dataset['Vehicle_movement'].fillna('Unknown', inplace=True)
cleaned_dataset['Work_of_casuality'].fillna('Unknown', inplace=True)
cleaned_dataset['Fitness_of_casuality'].fillna('Unknown', inplace=True)
```

```
/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:2
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:3
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.
```

```
For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:4
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:5
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:6
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
```

```
instead, to perform the operation inplace on the original object.


/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:7
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.


/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:8
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.


/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:9
: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.
```

```
/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
0: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
1: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
2: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
3: FutureWarning:
```

```
A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
4: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
5: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
6: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
```

```
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.



/var/folders/75/vdppt_x106x0z977clxb5xh00000gn/T/ipykernel_46121/3289919421.py:1
7: FutureWarning:

A value is trying to be set on a copy of a DataFrame or Series through chained
assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work
because the intermediate object on which we are setting values always behaves as
a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using
'df.method({col: value}, inplace=True)' or df[col] = df[col].method(value)
instead, to perform the operation inplace on the original object.
```

1.4.5 5) Correcting Errors:

In this data cleaning, we identify and fix the errors or incosistencies present in the data

[233]:

```python
cleaned_dataset['Type_of_vehicle'] = cleaned_dataset['Type_of_vehicle'].
 ↪replace('Lorry (41?100Q)', 'Lorry (41 - 100 Q)')
cleaned_dataset['Type_of_vehicle'] = cleaned_dataset['Type_of_vehicle'].
 ↪replace('Lorry (11?40Q)', 'Lorry (11 - 40 Q)')
cleaned_dataset['Type_of_vehicle'] = cleaned_dataset['Type_of_vehicle'].
 ↪replace('Public (13?45 seats)', 'Public (13 - 45 seats)')
cleaned_dataset['Area_accident_occured'] =␣
 ↪cleaned_dataset['Area_accident_occured'].replace('  Recreational areas',␣
 ↪'Recreational areas')
cleaned_dataset['Area_accident_occured'] =␣
 ↪cleaned_dataset['Area_accident_occured'].replace('  Market areas', 'Market␣
 ↪areas')
cleaned_dataset['Area_accident_occured'] =␣
 ↪cleaned_dataset['Area_accident_occured'].replace(' Church areas', 'Church␣
 ↪areas')
```

```
cleaned_dataset['Area_accident_occured'] =␣
↪cleaned_dataset['Area_accident_occured'].replace(' Hospital areas',␣
↪'Hospital areas')
cleaned_dataset['Area_accident_occured'] =␣
↪cleaned_dataset['Area_accident_occured'].replace(' Industrial areas',␣
↪'Industrial areas')
cleaned_dataset['Area_accident_occured'] =␣
↪cleaned_dataset['Area_accident_occured'].replace(' Outside rural areas',␣
↪'Outside rural areas')
cleaned_dataset['Area_accident_occured'] =␣
↪cleaned_dataset['Area_accident_occured'].replace('Rural village areasOffice␣
↪areas', 'Rural Office areas')
cleaned_dataset['Road_allignment'] = cleaned_dataset['Road_allignment'].
↪replace('Tangent road with mountainous terrain and', 'Tangent road with␣
↪mountainous terrain')
cleaned_dataset['Fitness_of_casuality'] =␣
↪cleaned_dataset['Fitness_of_casuality'].replace('NormalNormal', 'Normal')
cleaned_dataset['Casualty_severity'] = cleaned_dataset['Casualty_severity'].
↪replace('na', 'Unknown')
```

1.4.6 6) Standardize the Data

a) Convert all the entries in `Time` column to a consistent format.
b) Convert `Over 51` to `51 and Over` in the `Age_band_of_driver` column

[234]:
```
# Standardize the 'Time' column
cleaned_dataset['Time'] = pd.to_datetime(cleaned_dataset['Time'], format='%H:%M:
↪%S').dt.time
# Make 'Over 51' to '51 and Over' for Driver Age band
cleaned_dataset['Age_band_of_driver'] = cleaned_dataset['Age_band_of_driver'].
↪replace('Over 51', '51 and Over')
```

1.4.7 7) Parsing the data

Convert all the text in the dataset to lowercase to ensure consistency. This helps in avoiding the situations where same words with different cases are considered different

[235]:
```
# Make all the characters to lowercase
cleaned_dataset = cleaned_dataset.map(lambda x: x.lower() if isinstance(x, str)␣
↪else x)
```

1.4.8 8) Feature Engineering

Using the existing columns, we create new features which helps in finding new patterns in the data

[236]:
```
print(cleaned_dataset['Time'].head())
cleaned_dataset['Hour'] = pd.to_datetime(cleaned_dataset['Time'], format='%H:%M:
↪%S').dt.hour
```

```
Time_of_day = ['Night', 'Morning', 'Noon', 'Evening']

def categorize_time_of_day(hour):
    if 5 <= hour < 12:
        return 2
    elif 12 <= hour < 17:
        return 3
    elif 17 <= hour < 21:
        return 4
    else:
        return 1


cleaned_dataset['Time_of_day'] = cleaned_dataset['Hour'].
 ↪apply(categorize_time_of_day)

print("Data head after categorizing and encoding Time_of_day:\n")
cleaned_dataset[['Time', 'Hour', 'Time_of_day']].head()
```

```
0    17:02:00
1    17:02:00
2    17:02:00
3    01:06:00
4    01:06:00
Name: Time, dtype: object
Data head after categorizing and encoding Time_of_day:
```

[236]:

	Time	Hour	Time_of_day
0	17:02:00	17	4
1	17:02:00	17	4
2	17:02:00	17	4
3	01:06:00	1	1
4	01:06:00	1	1

1.4.9 9) Ordinal Encoding

Categorical data should be converted so that they can be fed to the algorithms that are used on the data

[237]:

```
from sklearn.preprocessing import OneHotEncoder

encoding_dict = {
    'Day_of_week': 'ordinal',
    'Age_band_of_driver': 'ordinal',
    'Sex_of_driver': 'one_hot',
    'Educational_level': 'ordinal',
    'Vehicle_driver_relation': 'one_hot',
```

```
    'Driving_experience': 'ordinal',
    'Type_of_vehicle': 'one_hot',
    'Owner_of_vehicle': 'one_hot',
    'Service_year_of_vehicle': 'ordinal',
    'Defect_of_vehicle': 'one_hot',
    'Area_accident_occured': 'one_hot',
    'Lanes_or_Medians': 'one_hot',
    'Road_allignment': 'one_hot',
    'Types_of_Junction': 'one_hot',
    'Road_surface_type': 'one_hot',
    'Road_surface_conditions': 'ordinal',
    'Light_conditions': 'one_hot',
    'Weather_conditions': 'one_hot',
    'Type_of_collision': 'one_hot',
    'Vehicle_movement': 'one_hot',
    'Casualty_class': 'one_hot',
    'Sex_of_casualty': 'one_hot',
    'Age_band_of_casualty': 'ordinal',
    'Casualty_severity': 'ordinal',
    'Work_of_casuality': 'one_hot',
    'Fitness_of_casuality': 'one_hot',
    'Pedestrian_movement': 'one_hot',
    'Cause_of_accident': 'one_hot',
    'Accident_severity': 'ordinal'
}

ordinal_mappings = {
    'Day_of_week': {
        'Monday': 0, 'Tuesday': 1, 'Wednesday': 2, 'Thursday': 3,
        'Friday': 4, 'Saturday': 5, 'Sunday': 6, 'Unknown': -1
    },
    'Age_band_of_driver': {
        'Under 18': 0, '18-30': 1, '31-50': 2, 'Over 51': 3, 'Unknown': -1
    },
    'Educational_level': {
        'Illiterate': 0, 'Writing & reading': 1, 'Elementary school': 2,
        'Junior high school': 3, 'High school': 4, 'Above high school': 5,
        'Unknown': -1
    },
    'Driving_experience': {
        'No Licence': 0, 'Below 1yr': 1, '1-2yr': 2, '2-5yr': 3, '5-10yr': 4,
        'Above 10yr': 5, 'unknown': -1
    },
    'Service_year_of_vehicle': {
        'Below 1yr': 0, '1-2yr': 1, '2-5yrs': 2, '5-10yrs': 3,
        'Above 10yr': 4, 'Unknown': -1
    },
```

```
    'Road_surface_conditions': {
        'Dry': 0, 'Wet or damp': 1, 'Snow': 2, 'Flood over 3cm. deep': 3,␣
↪'Unknown': -1
    },
    'Age_band_of_casualty': {
        'Under 18': 0, '18-30': 1, '31-50': 2, 'Over 51': 3, '5': 4, 'na': -1,␣
↪'Unknown': -1
    },
    'Casualty_severity': {
        '3': 0, '2': 1, '1': 2, 'na': -1, 'Unknown': -1
    },
    'Accident_severity': {
        'Slight Injury': 0, 'Serious Injury': 1, 'Fatal injury': 2, 'Unknown':␣
↪-1
    }
}

def apply_ordinal_encoding(df, encoding_dict, ordinal_mappings):
    for column, encoding_type in encoding_dict.items():
        if encoding_type == 'ordinal':
            if column in ordinal_mappings:
                df[f"{column}_ordinal"] = df[column].
↪map(ordinal_mappings[column])
            else:
                print(f"No ordinal mapping provided for column: {column}")
    return df

cleaned_dataset = apply_ordinal_encoding(cleaned_dataset, encoding_dict,␣
↪ordinal_mappings)

cleaned_dataset.head()
```

[237]:

```
       Time Day_of_week Age_band_of_driver Sex_of_driver   Educational_level  \
0  17:02:00      monday              18-30          male   above high school
1  17:02:00      monday              31-50          male  junior high school
2  17:02:00      monday              18-30          male  junior high school
3  01:06:00      sunday              18-30          male  junior high school
4  01:06:00      sunday              18-30          male  junior high school

  Vehicle_driver_relation Driving_experience      Type_of_vehicle  \
0                employee              1-2yr           automobile
1                employee         above 10yr  public (> 45 seats)
2                employee              1-2yr    lorry (41 - 100 q)
3                employee             5-10yr  public (> 45 seats)
4                employee              2-5yr              unknown

  Owner_of_vehicle Service_year_of_vehicle Defect_of_vehicle  \
```

```
0            owner             above 10yr         no defect
1            owner                5-10yrs         no defect
2            owner                unknown         no defect
3     governmental                unknown         no defect
4            owner                5-10yrs         no defect

  Area_accident_occured   Lanes_or_Medians  \
0    residential areas             unknown
1         office areas  undivided two way
2   recreational areas               other
3         office areas               other
4     industrial areas               other

                               Road_allignment Types_of_Junction  \
0                tangent road with flat terrain       no junction
1                tangent road with flat terrain       no junction
2                                      unknown       no junction
3  tangent road with mild grade and flat terrain           y shape
4                tangent road with flat terrain           y shape

  Road_surface_type Road_surface_conditions       Light_conditions  \
0     asphalt roads                     dry                daylight
1     asphalt roads                     dry                daylight
2     asphalt roads                     dry                daylight
3       earth roads                     dry  darkness - lights lit
4     asphalt roads                     dry  darkness - lights lit

  Weather_conditions                        Type_of_collision  \
0             normal  collision with roadside-parked vehicles
1             normal           vehicle with vehicle collision
2             normal          collision with roadside objects
3             normal           vehicle with vehicle collision
4             normal           vehicle with vehicle collision

   Number_of_vehicles_involved  Number_of_casualties Vehicle_movement  \
0                            2                     2   going straight
1                            2                     2   going straight
2                            2                     2   going straight
3                            2                     2   going straight
4                            2                     2   going straight

    Casualty_class Sex_of_casualty Age_band_of_casualty Casualty_severity  \
0               na              na                   na           unknown
1               na              na                   na           unknown
2  driver or rider            male                31-50                 3
3       pedestrian          female                18-30                 3
4               na              na                   na           unknown
```

```
  Work_of_casuality Fitness_of_casuality Pedestrian_movement  \
0           unknown              unknown    not a pedestrian
1           unknown              unknown    not a pedestrian
2            driver              unknown    not a pedestrian
3            driver               normal    not a pedestrian
4           unknown              unknown    not a pedestrian

           Cause_of_accident Accident_severity  Hour  Time_of_day  \
0            moving backward     slight injury    17            4
1                 overtaking     slight injury    17            4
2   changing lane to the left    serious injury    17            4
3  changing lane to the right     slight injury     1            1
4                 overtaking     slight injury     1            1

   Day_of_week_ordinal  Age_band_of_driver_ordinal  Educational_level_ordinal  \
0                  NaN                         1.0                        NaN
1                  NaN                         2.0                        NaN
2                  NaN                         1.0                        NaN
3                  NaN                         1.0                        NaN
4                  NaN                         1.0                        NaN

   Driving_experience_ordinal  Service_year_of_vehicle_ordinal  \
0                         2.0                              NaN
1                         NaN                              3.0
2                         2.0                              NaN
3                         4.0                              NaN
4                         3.0                              3.0

   Road_surface_conditions_ordinal  Age_band_of_casualty_ordinal  \
0                              NaN                          -1.0
1                              NaN                          -1.0
2                              NaN                           2.0
3                              NaN                           1.0
4                              NaN                          -1.0

   Casualty_severity_ordinal  Accident_severity_ordinal
0                        NaN                        NaN
1                        NaN                        NaN
2                        0.0                        NaN
3                        0.0                        NaN
4                        NaN                        NaN
```

1.4.10 10) One Hot Encoding

Categorical data should be converted so that they can be fed to the algorithms that are used on the data

[238]:
```python
def apply_onehot_encoding(df, encoding_dict, ordinal_mappings):
    one_hot_encoder = OneHotEncoder(sparse_output=False, drop='first')

    for column, encoding_type in encoding_dict.items():
        if encoding_type == 'one_hot':
            one_hot_encoded_df = pd.get_dummies(df[column], prefix=column,␣
 ↪drop_first=True)
            df = pd.concat([df, one_hot_encoded_df], axis=1)
    return df

cleaned_dataset = apply_onehot_encoding(cleaned_dataset, encoding_dict,␣
 ↪ordinal_mappings)

cleaned_dataset.head()
```

[238]:
```
       Time Day_of_week Age_band_of_driver Sex_of_driver   Educational_level  \
0  17:02:00      monday              18-30          male   above high school
1  17:02:00      monday              31-50          male  junior high school
2  17:02:00      monday              18-30          male  junior high school
3  01:06:00      sunday              18-30          male  junior high school
4  01:06:00      sunday              18-30          male  junior high school

  Vehicle_driver_relation Driving_experience      Type_of_vehicle  \
0                employee              1-2yr           automobile
1                employee         above 10yr  public (> 45 seats)
2                employee              1-2yr   lorry (41 - 100 q)
3                employee             5-10yr  public (> 45 seats)
4                employee              2-5yr              unknown

  Owner_of_vehicle Service_year_of_vehicle Defect_of_vehicle  \
0            owner              above 10yr         no defect
1            owner                 5-10yrs         no defect
2            owner                 unknown         no defect
3     governmental                 unknown         no defect
4            owner                 5-10yrs         no defect

  Area_accident_occured   Lanes_or_Medians  \
0     residential areas            unknown
1          office areas  undivided two way
2    recreational areas              other
3          office areas              other
4      industrial areas              other

                                Road_allignment Types_of_Junction  \
0                 tangent road with flat terrain       no junction
1                 tangent road with flat terrain       no junction
2                                        unknown       no junction
```

```
3  tangent road with mild grade and flat terrain           y shape
4                tangent road with flat terrain           y shape

  Road_surface_type Road_surface_conditions       Light_conditions  \
0     asphalt roads                     dry               daylight
1     asphalt roads                     dry               daylight
2     asphalt roads                     dry               daylight
3       earth roads                     dry  darkness - lights lit
4     asphalt roads                     dry  darkness - lights lit

  Weather_conditions                        Type_of_collision  \
0             normal  collision with roadside-parked vehicles
1             normal           vehicle with vehicle collision
2             normal          collision with roadside objects
3             normal           vehicle with vehicle collision
4             normal           vehicle with vehicle collision

   Number_of_vehicles_involved  Number_of_casualties Vehicle_movement  \
0                            2                     2   going straight
1                            2                     2   going straight
2                            2                     2   going straight
3                            2                     2   going straight
4                            2                     2   going straight

    Casualty_class Sex_of_casualty Age_band_of_casualty Casualty_severity  \
0               na              na                   na           unknown
1               na              na                   na           unknown
2  driver or rider            male                31-50                 3
3       pedestrian          female                18-30                 3
4               na              na                   na           unknown

  Work_of_casuality Fitness_of_casuality Pedestrian_movement  \
0           unknown              unknown    not a pedestrian
1           unknown              unknown    not a pedestrian
2            driver              unknown    not a pedestrian
3            driver               normal    not a pedestrian
4           unknown              unknown    not a pedestrian

           Cause_of_accident Accident_severity  Hour  Time_of_day  \
0            moving backward     slight injury    17            4
1                 overtaking     slight injury    17            4
2   changing lane to the left    serious injury    17            4
3  changing lane to the right     slight injury     1            1
4                 overtaking     slight injury     1            1

   Day_of_week_ordinal  Age_band_of_driver_ordinal  Educational_level_ordinal  \
0                  NaN                         1.0                        NaN
```

```
1                 NaN                           2.0                            NaN
2                 NaN                           1.0                            NaN
3                 NaN                           1.0                            NaN
4                 NaN                           1.0                            NaN

   Driving_experience_ordinal  Service_year_of_vehicle_ordinal  \
0                         2.0                              NaN
1                         NaN                              3.0
2                         2.0                              NaN
3                         4.0                              NaN
4                         3.0                              3.0

   Road_surface_conditions_ordinal  Age_band_of_casualty_ordinal  \
0                              NaN                          -1.0
1                              NaN                          -1.0
2                              NaN                           2.0
3                              NaN                           1.0
4                              NaN                          -1.0

   Casualty_severity_ordinal  Accident_severity_ordinal  Sex_of_driver_male  \
0                        NaN                        NaN                True
1                        NaN                        NaN                True
2                        0.0                        NaN                True
3                        0.0                        NaN                True
4                        NaN                        NaN                True

   Sex_of_driver_unknown  Vehicle_driver_relation_other  \
0                  False                          False
1                  False                          False
2                  False                          False
3                  False                          False
4                  False                          False

   Vehicle_driver_relation_owner  Vehicle_driver_relation_unknown  \
0                          False                            False
1                          False                            False
2                          False                            False
3                          False                            False
4                          False                            False

   Type_of_vehicle_bajaj  Type_of_vehicle_bicycle  Type_of_vehicle_long lorry  \
0                  False                    False                       False
1                  False                    False                       False
2                  False                    False                       False
3                  False                    False                       False
4                  False                    False                       False
```

```
   Type_of_vehicle_lorry (11 - 40 q)  Type_of_vehicle_lorry (41 - 100 q)  \
0                              False                               False   
1                              False                               False   
2                              False                                True   
3                              False                               False   
4                              False                               False   

   Type_of_vehicle_motorcycle  Type_of_vehicle_other  \
0                       False                  False   
1                       False                  False   
2                       False                  False   
3                       False                  False   
4                       False                  False   

   Type_of_vehicle_pick up upto 10q  Type_of_vehicle_public (12 seats)  \
0                             False                              False   
1                             False                              False   
2                             False                              False   
3                             False                              False   
4                             False                              False   

   Type_of_vehicle_public (13 - 45 seats)  \
0                                   False   
1                                   False   
2                                   False   
3                                   False   
4                                   False   

   Type_of_vehicle_public (> 45 seats)  Type_of_vehicle_ridden horse  \
0                                False                         False   
1                                 True                         False   
2                                False                         False   
3                                 True                         False   
4                                False                         False   

   Type_of_vehicle_special vehicle  Type_of_vehicle_stationwagen  \
0                            False                         False   
1                            False                         False   
2                            False                         False   
3                            False                         False   
4                            False                         False   

   Type_of_vehicle_taxi  Type_of_vehicle_turbo  Type_of_vehicle_unknown  \
0                 False                  False                    False   
1                 False                  False                    False   
2                 False                  False                    False   
3                 False                  False                    False   
```

```
4              False                 False                    True

   Owner_of_vehicle_organization  Owner_of_vehicle_other  \
0                          False                   False
1                          False                   False
2                          False                   False
3                          False                   False
4                          False                   False

   Owner_of_vehicle_owner  Owner_of_vehicle_unknown  Defect_of_vehicle_7  \
0                    True                     False                False
1                    True                     False                False
2                    True                     False                False
3                   False                     False                False
4                    True                     False                False

   Defect_of_vehicle_no defect  Area_accident_occured_hospital areas  \
0                         True                                 False
1                         True                                 False
2                         True                                 False
3                         True                                 False
4                         True                                 False

   Area_accident_occured_industrial areas  Area_accident_occured_market areas  \
0                                   False                               False
1                                   False                               False
2                                   False                               False
3                                   False                               False
4                                    True                               False

   Area_accident_occured_office areas  Area_accident_occured_other  \
0                               False                        False
1                                True                        False
2                               False                        False
3                                True                        False
4                               False                        False

   Area_accident_occured_outside rural areas  \
0                                      False
1                                      False
2                                      False
3                                      False
4                                      False

   Area_accident_occured_recreational areas  \
0                                     False
1                                     False
```

```
2                                     True
3                                    False
4                                    False

   Area_accident_occured_residential areas  \
0                                     True
1                                    False
2                                    False
3                                    False
4                                    False

   Area_accident_occured_rural office areas  \
0                                     False
1                                     False
2                                     False
3                                     False
4                                     False

   Area_accident_occured_rural village areas  \
0                                      False
1                                      False
2                                      False
3                                      False
4                                      False

   Area_accident_occured_school areas  Area_accident_occured_unknown  \
0                               False                          False
1                               False                          False
2                               False                          False
3                               False                          False
4                               False                          False

   Lanes_or_Medians_one way  Lanes_or_Medians_other  \
0                     False                   False
1                     False                   False
2                     False                    True
3                     False                    True
4                     False                    True

   Lanes_or_Medians_two-way (divided with broken lines road marking)  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Lanes_or_Medians_two-way (divided with solid lines road marking)  \
```

```
0                                            False
1                                            False
2                                            False
3                                            False
4                                            False

   Lanes_or_Medians_undivided two way  Lanes_or_Medians_unknown  \
0                               False                      True
1                                True                     False
2                               False                     False
3                               False                     False
4                               False                     False

   Road_allignment_gentle horizontal curve  \
0                                    False
1                                    False
2                                    False
3                                    False
4                                    False

   Road_allignment_sharp reverse curve  \
0                                False
1                                False
2                                False
3                                False
4                                False

   Road_allignment_steep grade downward with mountainous terrain  \
0                                            False
1                                            False
2                                            False
3                                            False
4                                            False

   Road_allignment_steep grade upward with mountainous terrain  \
0                                            False
1                                            False
2                                            False
3                                            False
4                                            False

   Road_allignment_tangent road with flat terrain  \
0                                             True
1                                             True
2                                            False
3                                            False
4                                             True
```

```
   Road_allignment_tangent road with mild grade and flat terrain  \
0                                              False
1                                              False
2                                              False
3                                               True
4                                              False

   Road_allignment_tangent road with mountainous terrain  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Road_allignment_tangent road with rolling terrain  Road_allignment_unknown  \
0                                              False                    False
1                                              False                    False
2                                              False                     True
3                                              False                    False
4                                              False                    False

   Types_of_Junction_no junction  Types_of_Junction_o shape  \
0                           True                      False
1                           True                      False
2                           True                      False
3                          False                      False
4                          False                      False

   Types_of_Junction_other  Types_of_Junction_t shape  \
0                    False                      False
1                    False                      False
2                    False                      False
3                    False                      False
4                    False                      False

   Types_of_Junction_unknown  Types_of_Junction_x shape  \
0                      False                      False
1                      False                      False
2                      False                      False
3                      False                      False
4                      False                      False

   Types_of_Junction_y shape  \
0                      False
1                      False
2                      False
```

```
3                       True
4                       True

   Road_surface_type_asphalt roads with some distress  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Road_surface_type_earth roads  Road_surface_type_gravel roads  \
0                          False                           False
1                          False                           False
2                          False                           False
3                           True                           False
4                          False                           False

   Road_surface_type_other  Road_surface_type_unknown  \
0                    False                      False
1                    False                      False
2                    False                      False
3                    False                      False
4                    False                      False

   Light_conditions_darkness - lights unlit  \
0                                     False
1                                     False
2                                     False
3                                     False
4                                     False

   Light_conditions_darkness - no lighting  Light_conditions_daylight  \
0                                    False                       True
1                                    False                       True
2                                    False                       True
3                                    False                      False
4                                    False                      False

   Weather_conditions_fog or mist  Weather_conditions_normal  \
0                           False                       True
1                           False                       True
2                           False                       True
3                           False                       True
4                           False                       True

   Weather_conditions_other  Weather_conditions_raining  \
0                     False                       False
```

```
1                    False                        False
2                    False                        False
3                    False                        False
4                    False                        False

   Weather_conditions_raining and windy  Weather_conditions_snow  \
0                                 False                    False
1                                 False                    False
2                                 False                    False
3                                 False                    False
4                                 False                    False

   Weather_conditions_unknown  Weather_conditions_windy  \
0                       False                     False
1                       False                     False
2                       False                     False
3                       False                     False
4                       False                     False

   Type_of_collision_collision with pedestrians  \
0                                         False
1                                         False
2                                         False
3                                         False
4                                         False

   Type_of_collision_collision with roadside objects  \
0                                              False
1                                              False
2                                               True
3                                              False
4                                              False

   Type_of_collision_collision with roadside-parked vehicles  \
0                                               True
1                                              False
2                                              False
3                                              False
4                                              False

   Type_of_collision_fall from vehicles  Type_of_collision_other  \
0                                 False                    False
1                                 False                    False
2                                 False                    False
3                                 False                    False
4                                 False                    False
```

```
   Type_of_collision_rollover  Type_of_collision_unknown  \
0                       False                      False
1                       False                      False
2                       False                      False
3                       False                      False
4                       False                      False

   Type_of_collision_vehicle with vehicle collision  \
0                                             False
1                                              True
2                                             False
3                                              True
4                                              True

   Type_of_collision_with train  Vehicle_movement_getting off  \
0                         False                         False
1                         False                         False
2                         False                         False
3                         False                         False
4                         False                         False

   Vehicle_movement_going straight  Vehicle_movement_moving backward  \
0                             True                             False
1                             True                             False
2                             True                             False
3                             True                             False
4                             True                             False

   Vehicle_movement_other  Vehicle_movement_overtaking  \
0                   False                        False
1                   False                        False
2                   False                        False
3                   False                        False
4                   False                        False

   Vehicle_movement_parked  Vehicle_movement_reversing  \
0                    False                       False
1                    False                       False
2                    False                       False
3                    False                       False
4                    False                       False

   Vehicle_movement_stopping  Vehicle_movement_turnover  \
0                      False                      False
1                      False                      False
2                      False                      False
3                      False                      False
```

```
4                      False                       False

   Vehicle_movement_u-turn  Vehicle_movement_unknown  \
0                    False                     False
1                    False                     False
2                    False                     False
3                    False                     False
4                    False                     False

   Vehicle_movement_waiting to go  Casualty_class_na  \
0                           False               True
1                           False               True
2                           False              False
3                           False              False
4                           False               True

   Casualty_class_passenger  Casualty_class_pedestrian  Sex_of_casualty_male  \
0                     False                      False                 False
1                     False                      False                 False
2                     False                      False                  True
3                     False                       True                 False
4                     False                      False                 False

   Sex_of_casualty_na  Work_of_casuality_employee  Work_of_casuality_other  \
0                True                       False                    False
1                True                       False                    False
2               False                       False                    False
3               False                       False                    False
4                True                       False                    False

   Work_of_casuality_self-employed  Work_of_casuality_student  \
0                            False                      False
1                            False                      False
2                            False                      False
3                            False                      False
4                            False                      False

   Work_of_casuality_unemployed  Work_of_casuality_unknown  \
0                         False                       True
1                         False                       True
2                         False                      False
3                         False                      False
4                         False                       True

   Fitness_of_casuality_deaf  Fitness_of_casuality_normal  \
0                      False                        False
1                      False                        False
```

```
2                    False                       False
3                    False                        True
4                    False                       False

   Fitness_of_casuality_other  Fitness_of_casuality_unknown  \
0                       False                          True
1                       False                          True
2                       False                          True
3                       False                         False
4                       False                          True

   Pedestrian_movement_crossing from nearside - masked by parked or stationot a
pedestrianry vehicle  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Pedestrian_movement_crossing from offside - masked by  parked or stationot a
pedestrianry vehicle  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Pedestrian_movement_in carriageway, stationot a pedestrianry - not crossing
(standing or playing)  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Pedestrian_movement_in carriageway, stationot a pedestrianry - not crossing
(standing or playing) - masked by parked or stationot a pedestrianry vehicle  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Pedestrian_movement_not a pedestrian  Pedestrian_movement_unknown or other  \
0                                  True                                 False
1                                  True                                 False
2                                  True                                 False
```

```
3                                  True                                 False
4                                  True                                 False

   Pedestrian_movement_walking along in carriageway, back to traffic  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Pedestrian_movement_walking along in carriageway, facing traffic  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Cause_of_accident_changing lane to the right  \
0                                         False
1                                         False
2                                         False
3                                          True
4                                         False

   Cause_of_accident_driving at high speed  \
0                                    False
1                                    False
2                                    False
3                                    False
4                                    False

   Cause_of_accident_driving carelessly  \
0                                 False
1                                 False
2                                 False
3                                 False
4                                 False

   Cause_of_accident_driving to the left  \
0                                  False
1                                  False
2                                  False
3                                  False
4                                  False

   Cause_of_accident_driving under the influence of drugs  \
0                                              False
```

```
1                                            False
2                                            False
3                                            False
4                                            False

   Cause_of_accident_drunk driving  \
0                            False
1                            False
2                            False
3                            False
4                            False

   Cause_of_accident_getting off the vehicle improperly  \
0                                              False
1                                              False
2                                              False
3                                              False
4                                              False

   Cause_of_accident_improper parking  Cause_of_accident_moving backward  \
0                               False                               True
1                               False                              False
2                               False                              False
3                               False                              False
4                               False                              False

   Cause_of_accident_no distancing  \
0                            False
1                            False
2                            False
3                            False
4                            False

   Cause_of_accident_no priority to pedestrian  \
0                                        False
1                                        False
2                                        False
3                                        False
4                                        False

   Cause_of_accident_no priority to vehicle  Cause_of_accident_other  \
0                                     False                    False
1                                     False                    False
2                                     False                    False
3                                     False                    False
4                                     False                    False
```

```
   Cause_of_accident_overloading  Cause_of_accident_overspeed  \
0                          False                        False
1                          False                        False
2                          False                        False
3                          False                        False
4                          False                        False

   Cause_of_accident_overtaking  Cause_of_accident_overturning  \
0                         False                          False
1                          True                          False
2                         False                          False
3                         False                          False
4                          True                          False

   Cause_of_accident_turnover  Cause_of_accident_unknown
0                       False                      False
1                       False                      False
2                       False                      False
3                       False                      False
4                       False                      False
```

1.5 5: Exploratory Data Analysis (EDA)

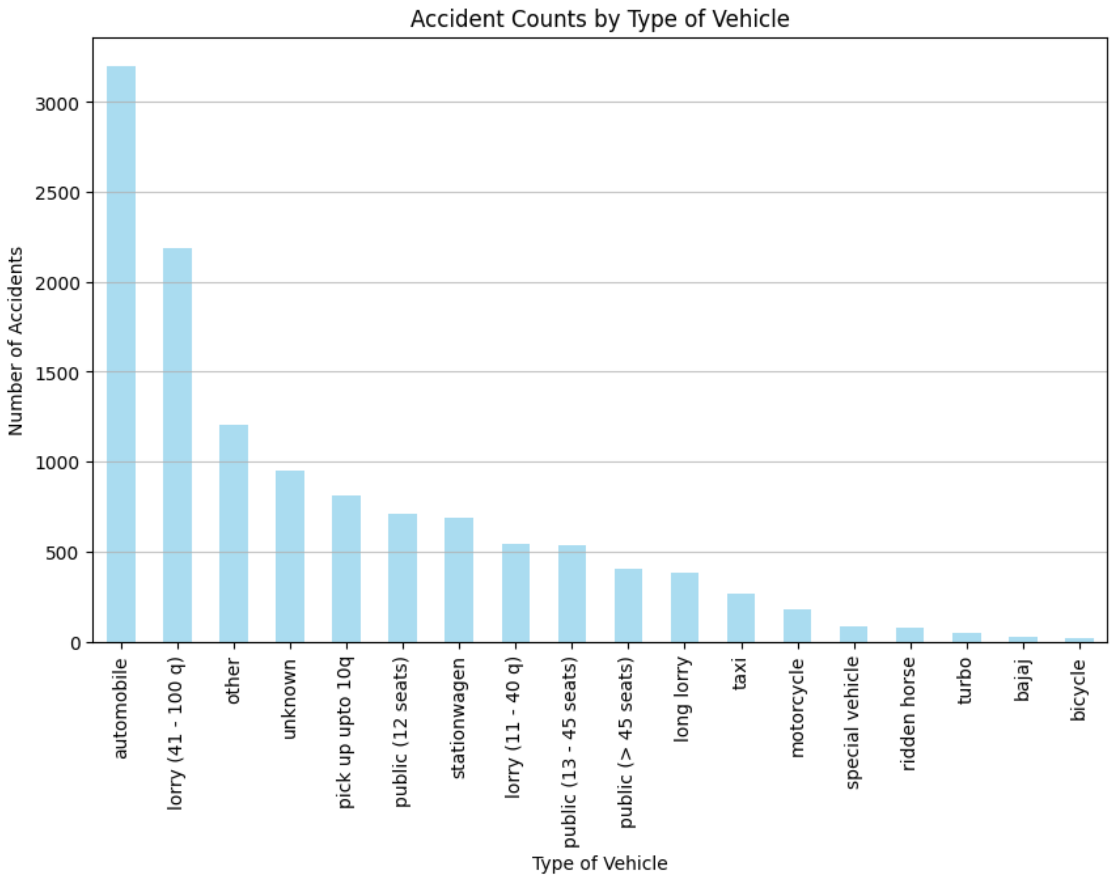
1.5.1 Harshit Malpani: 50608809

Question 1: What vehicles should the authorities focus more on to reduce the cases of road accidents and the severity of road accidents

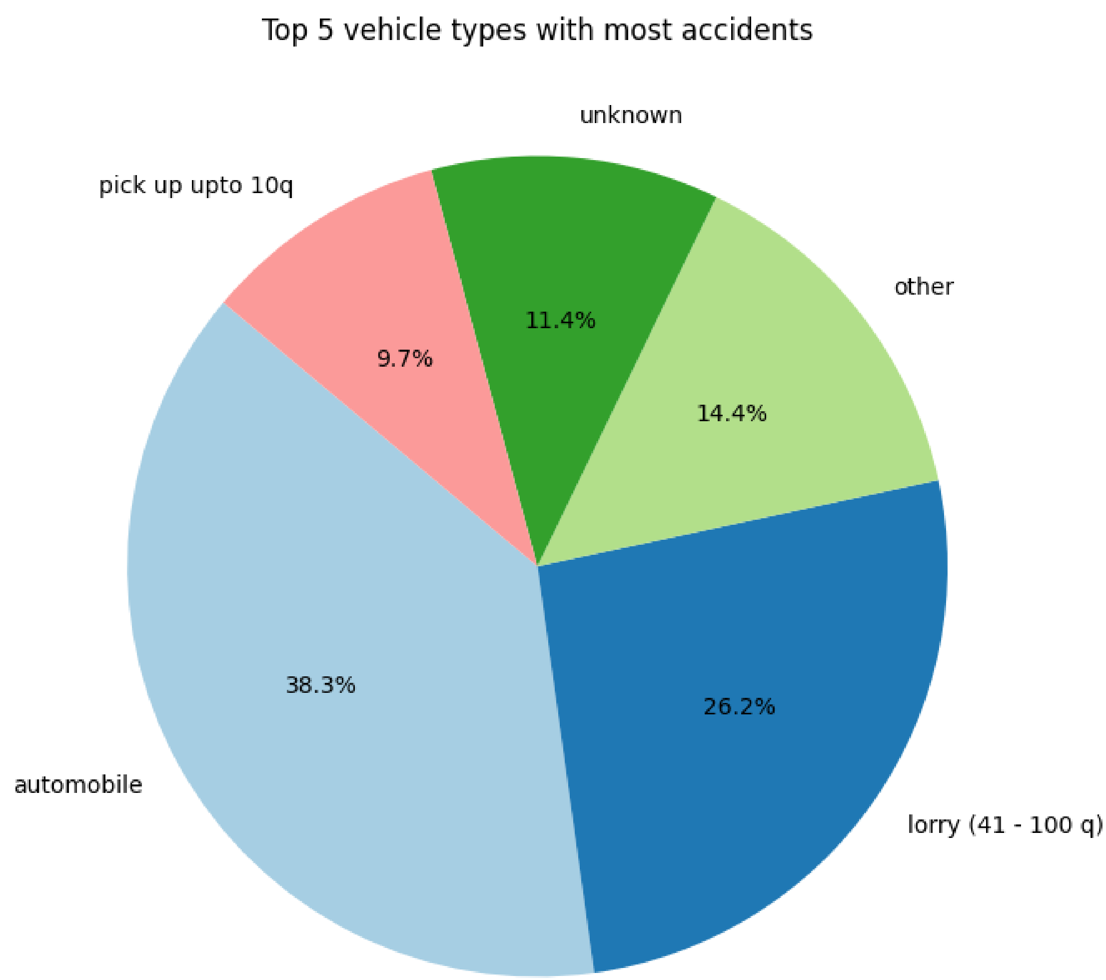
Hypothesis 1: Not all vehicles are involved in road accidents equally. Some vehicles have higher tendency to be involved in any road accident

[239]:
```python
import matplotlib.pyplot as plt
import seaborn as sns
```

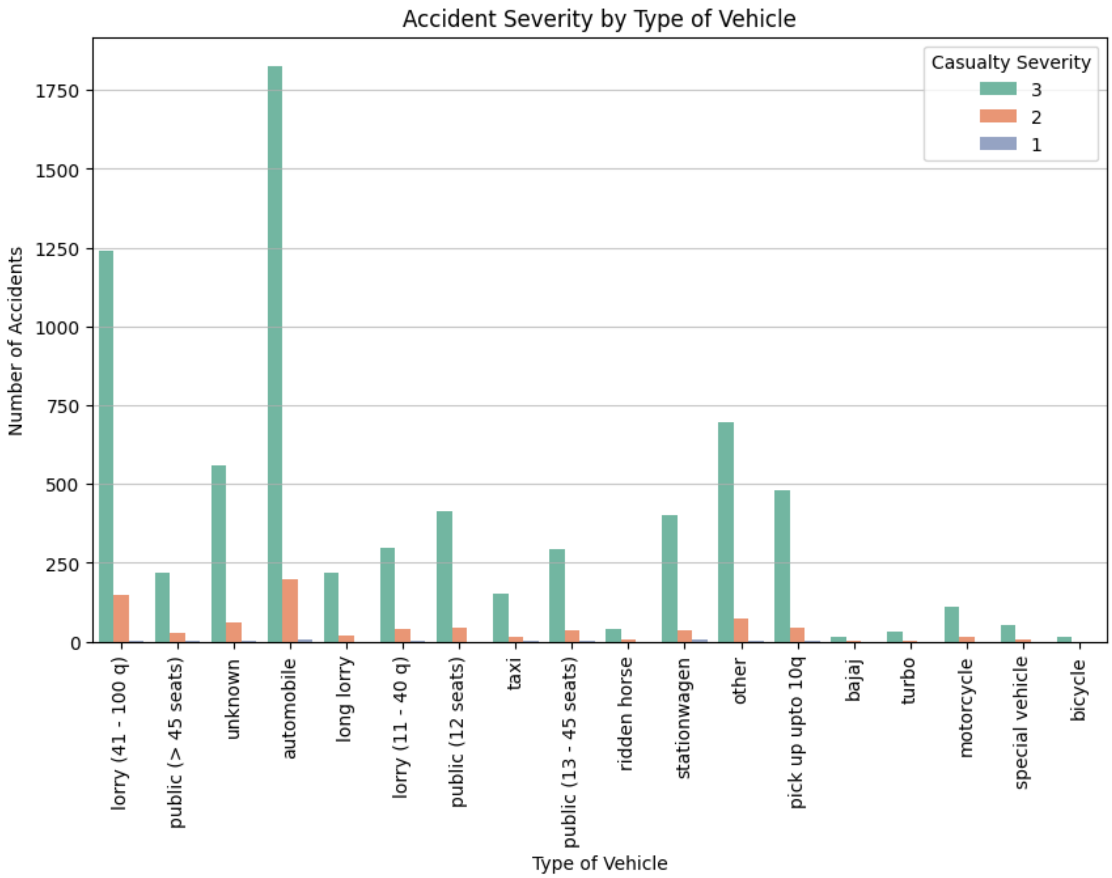
[240]:
```python
vehicle_counts = cleaned_dataset['Type_of_vehicle'].value_counts()
plt.figure(figsize=(10, 6))
vehicle_counts.plot(kind='bar', color='skyblue', alpha=0.7)
plt.title('Accident Counts by Type of Vehicle')
plt.xlabel('Type of Vehicle')
plt.ylabel('Number of Accidents')
plt.xticks(rotation=90)
plt.grid(axis='y', alpha=0.75)
plt.show()
```



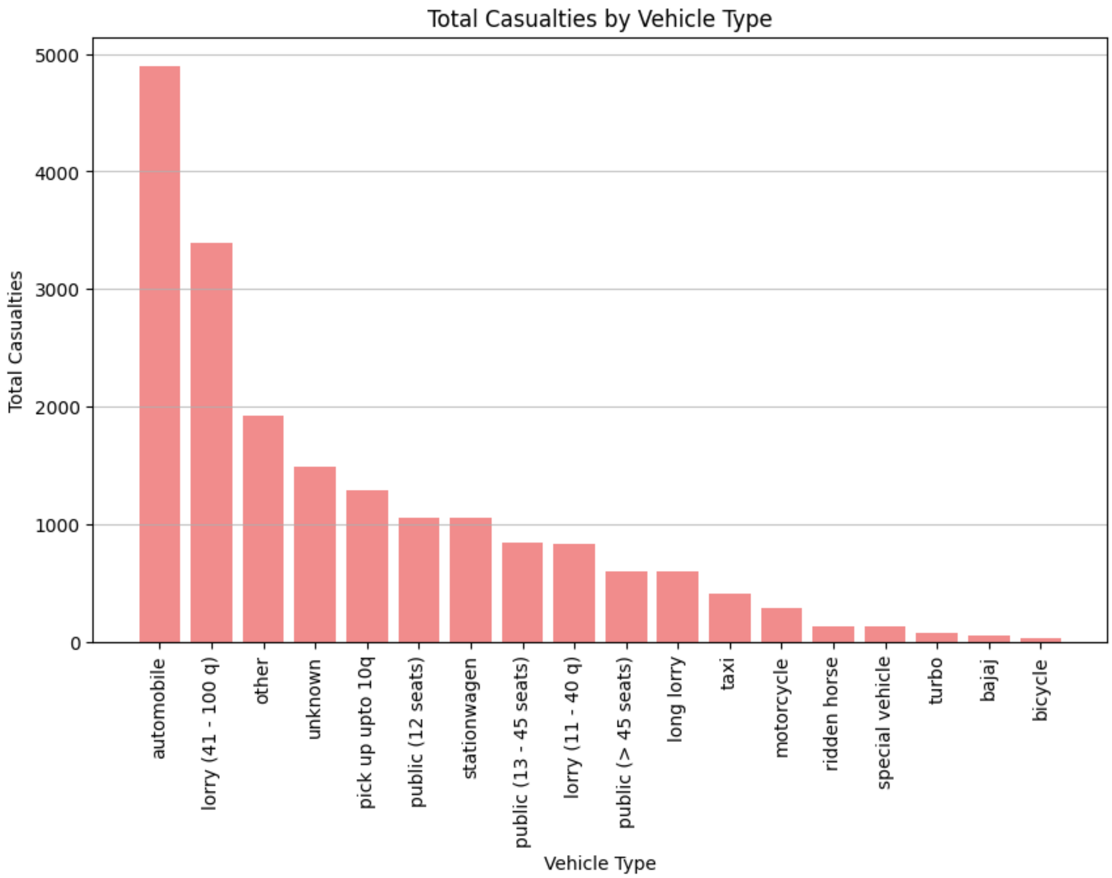
[241]:
```
accidents_per_vehicle = cleaned_dataset['Type_of_vehicle'].value_counts()
accidents_per_vehicle = accidents_per_vehicle[:5]
plt.figure(figsize=(10, 8))
plt.pie(accidents_per_vehicle, labels=accidents_per_vehicle.index, autopct='%1.
  ↪1f%%', startangle=140, colors=plt.cm.Paired.colors)
plt.title('Top 5 vehicle types with most accidents')
plt.show()
```



[242]:
```
# Without unknown severity
without_unknown_casualty = cleaned_dataset[cleaned_dataset['Casualty_severity']␣
↪!= 'unknown']
plt.figure(figsize=(10, 6))
sns.countplot(data=without_unknown_casualty, x='Type_of_vehicle',␣
↪hue='Casualty_severity', palette='Set2')
plt.title('Accident Severity by Type of Vehicle')
plt.xlabel('Type of Vehicle')
plt.ylabel('Number of Accidents')
plt.legend(title='Casualty Severity')
plt.xticks(rotation=90)
plt.grid(axis='y', alpha=0.7)
plt.show()
```



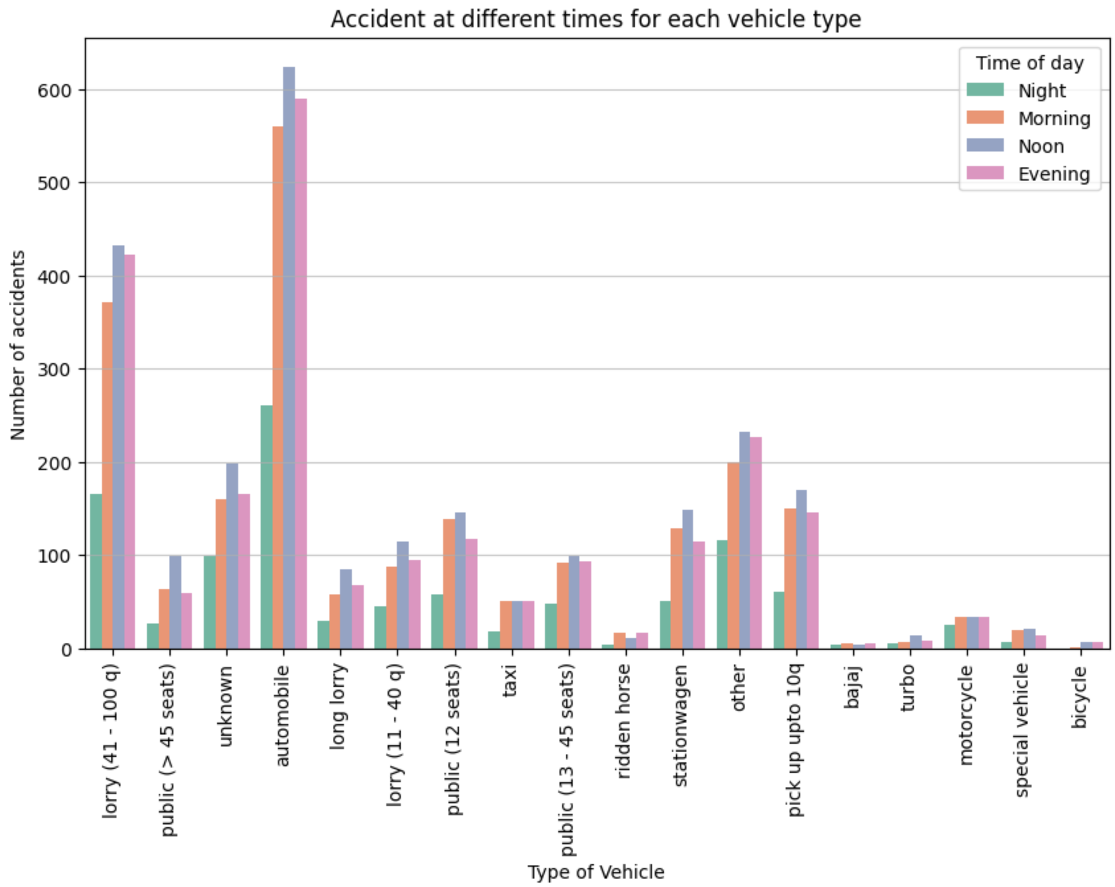
[243]:
```
total_casualties_by_vehicle = cleaned_dataset.
    ↪groupby('Type_of_vehicle')['Number_of_casualties'].sum().reset_index()
total_casualties_by_vehicle = total_casualties_by_vehicle.
    ↪sort_values(by='Number_of_casualties', ascending=False)
plt.figure(figsize=(10, 6))
plt.bar(total_casualties_by_vehicle['Type_of_vehicle'],␣
    ↪total_casualties_by_vehicle['Number_of_casualties'], color='lightcoral',␣
    ↪alpha=0.9)
plt.title('Total Casualties by Vehicle Type')
plt.xlabel('Vehicle Type')
plt.ylabel('Total Casualties')
plt.xticks(rotation=90)
plt.grid(axis='y', alpha=0.75)
plt.show()
```



From the above plots, we can cleary notice that `Automobile` and `Lorry(41 - 100 q)` are more probable to be involved in road accidents. More focus should be on these types of vehicles as fixing the reasons why they involve in accidents more will help reduce the road accidents which also reduces the casualties.

Hypothesis 2: Accidents are more likely to happen in Evening

[244]:
```python
plt.figure(figsize=(10, 6))
sns.countplot(data=without_unknown_casualty, x='Type_of_vehicle',␣
    ↪hue='Time_of_day', palette='Set2')
plt.title('Accident at different times for each vehicle type')
plt.xlabel('Type of Vehicle')
plt.ylabel('Number of accidents')
plt.legend(title='Time of day', labels=Time_of_day)
plt.xticks(rotation=90)
plt.grid(axis='y', alpha=0.7)
plt.show()
```



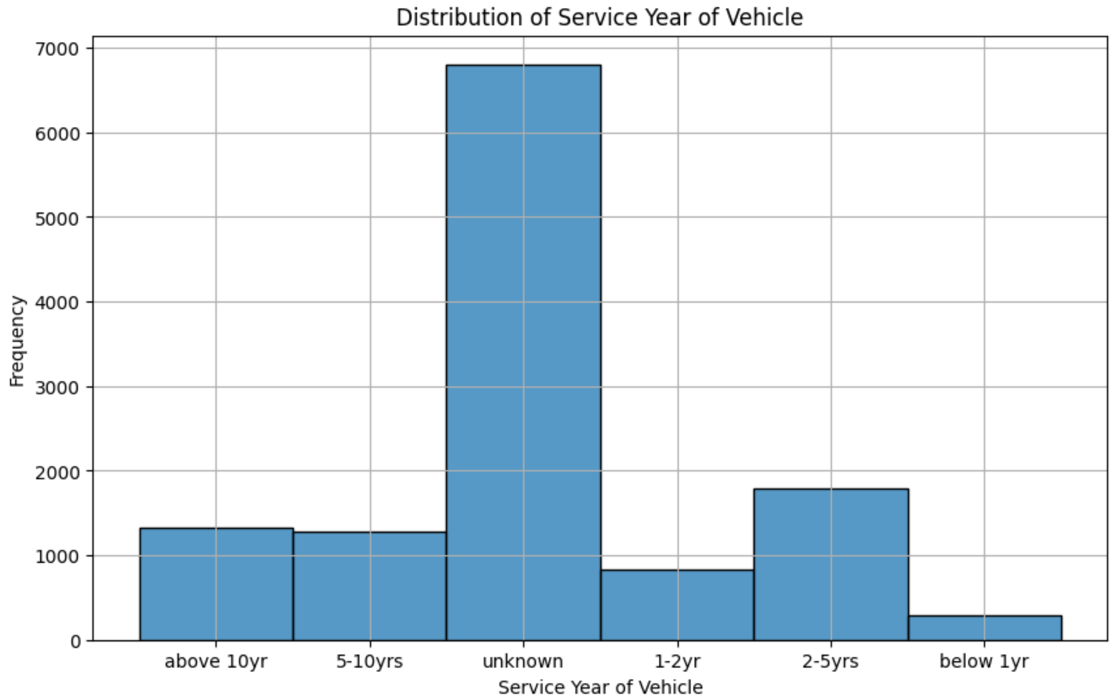
The hypothesis is wrong. From the above plot, we can see that most vehicle types are involved in a road accident during noon. Although one might think that most accidents should occur in the evening or night due to low visibility or sleepiness, but most accidents happen in the noon. This opens up the possibility of finding other factors like road type and vehicle faults, which might contribute to the accidents, and then fixing them.

Question 2: Does the service period of the vehicle and ownership of the vehicle have any correlation with the accidents The state of vehicle and the person driving it plays an important role in road safety. We need to find out how the state of the vehicle and the ownership of the vehicle affect the possibility of a vehicle to be involved in an accident. This study will help in making policies and rules to reduce road accidents and related casualties.

Hypothesis 1: The vehicles which are serviced regularly have less chances of getting involved in accidents as they are less prone to machine malfunction

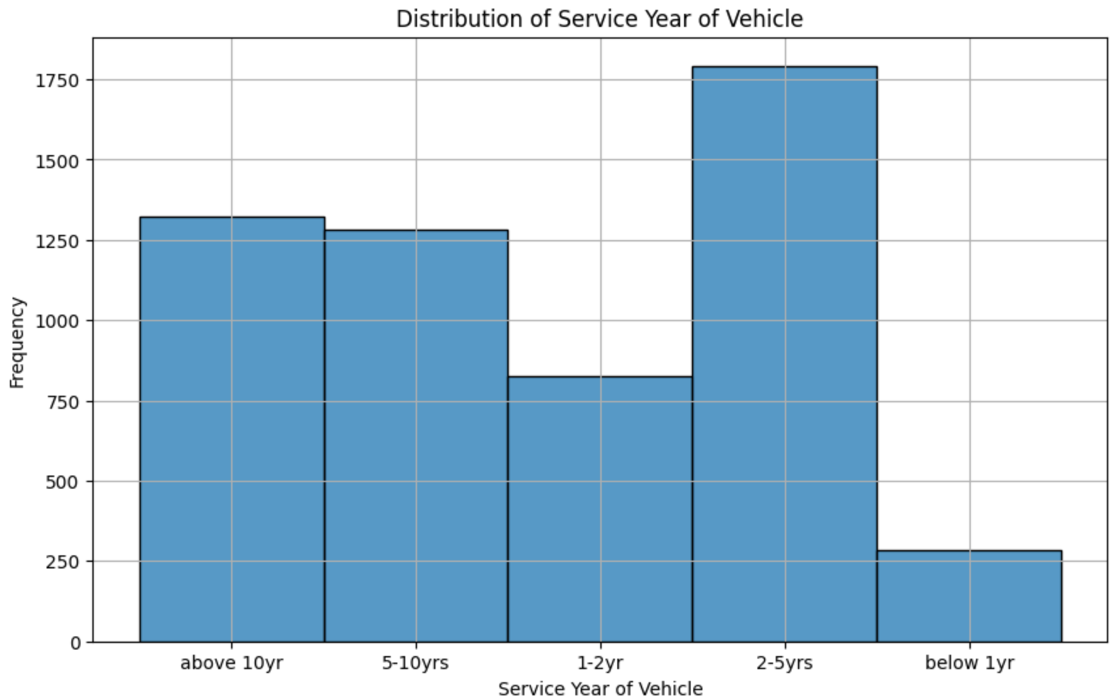
[245]:
```
plt.figure(figsize=(10, 6))
sns.histplot(cleaned_dataset['Service_year_of_vehicle'].astype(str), bins=30,␣
↪kde=False)
plt.title('Distribution of Service Year of Vehicle')
plt.xlabel('Service Year of Vehicle')
```

```
plt.ylabel('Frequency')
plt.grid()
plt.show()
```



[246]:

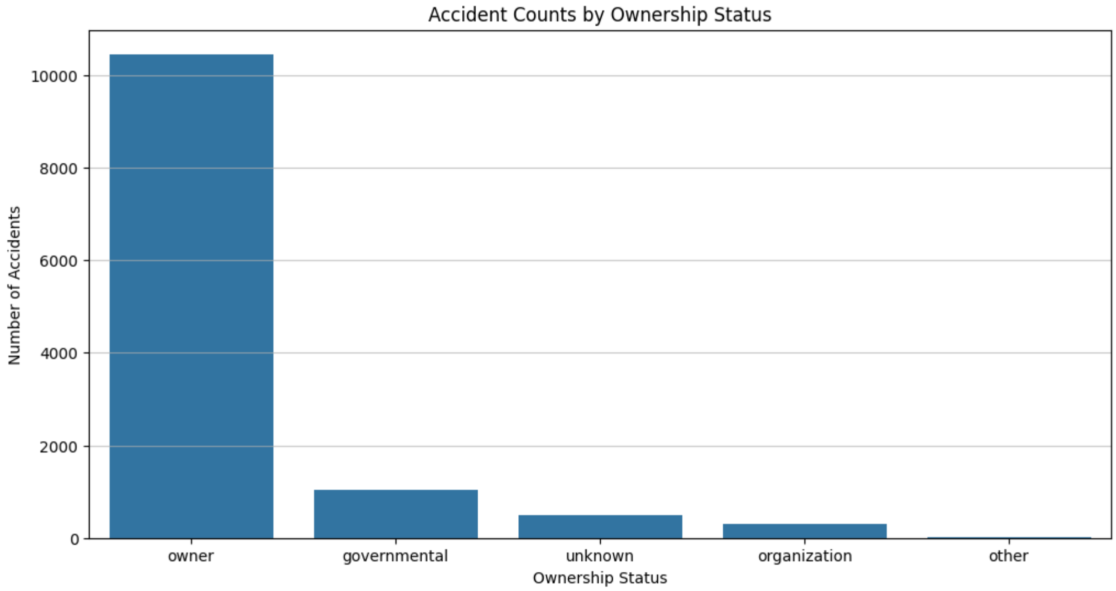
```
# remove data entries with 'unknown' service period
without_unknown_service =␣
 ↪cleaned_dataset[cleaned_dataset['Service_year_of_vehicle'] != 'unknown']
plt.figure(figsize=(10, 6))
sns.histplot(without_unknown_service['Service_year_of_vehicle'].astype(str),␣
 ↪bins=30, kde=False)
plt.title('Distribution of Service Year of Vehicle')
plt.xlabel('Service Year of Vehicle')
plt.ylabel('Frequency')
plt.grid()
plt.show()
```



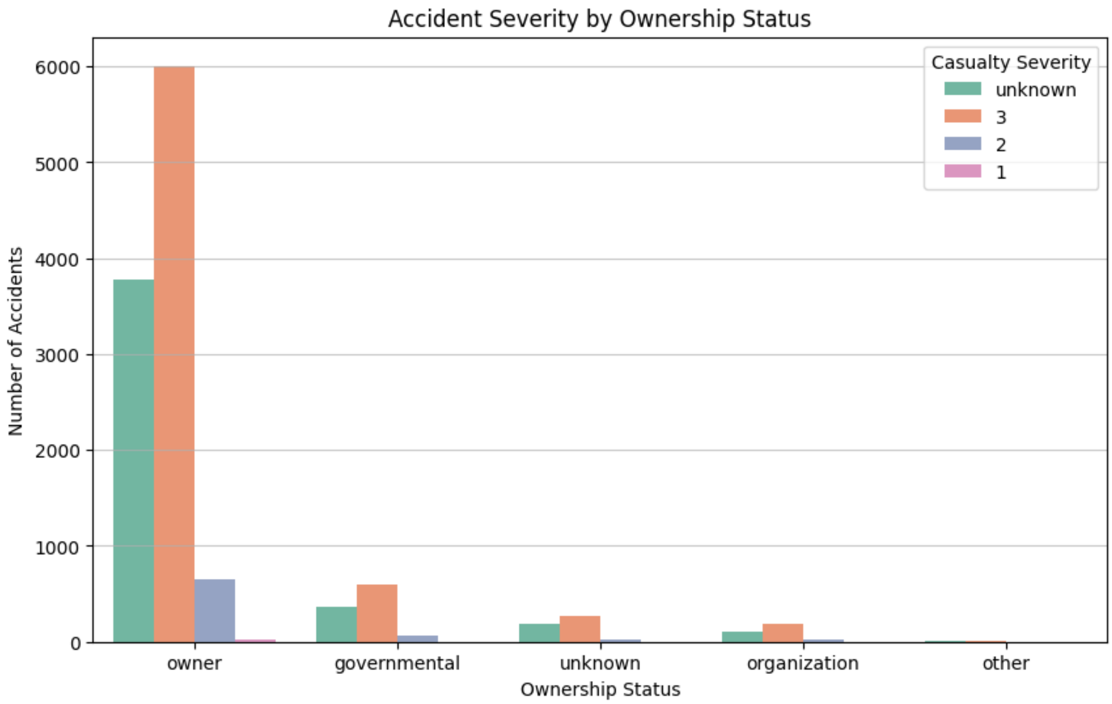
The hypothesis is correct. From the above bar graph, we can see that the vehicles with last service data less than a year ago are involved in much fewer accidents when compared to the vehicles that had last service done more than a year ago. This data is useful in implementing stricter policies in regards to the regular servicing of the vehicles.

Hypothesis 2: Ownership of the vehicle doesn't have any relation to the accidents. The person driving a vehicle is equally likely to be involved in an accident regardless of the ownership of the vehicle he/she drives

[247]:
```
plt.figure(figsize=(12, 6))
sns.countplot(data=cleaned_dataset, x='Owner_of_vehicle',␣
↪order=cleaned_dataset['Owner_of_vehicle'].value_counts().index)
plt.title('Accident Counts by Ownership Status')
plt.xlabel('Ownership Status')
plt.ylabel('Number of Accidents')
plt.grid(axis='y', alpha=0.7)
plt.show()
```



[248]:
```
plt.figure(figsize=(10, 6))
sns.countplot(data=cleaned_dataset, x='Owner_of_vehicle',␣
 ↪hue='Casualty_severity', palette='Set2')
plt.title('Accident Severity by Ownership Status')
plt.xlabel('Ownership Status')
plt.ylabel('Number of Accidents')
plt.legend(title='Casualty Severity')
plt.grid(axis='y', alpha=0.7)
plt.show()
```



The hypothesis that ownership of vehicle doesn't play role in accidents is incorrect. From the above two plots, we can see that a person is more likely to be involved in a accident if they own the vehicle.

[ ]:

```

```

2 Phase 2

What vehicles should the authorities focus more on to reduce the cases of road accidents and the severity of road accidents

1) Not all vehicles are involved in road accidents equally. Some vehicles have a higher tendency to be involved in any road accident

Using the Naive Bayes Classifier for classifying the accident's severity given the type of vehicle and other attributes related to the accident. Naive Bayes can be very useful for multiclass classification (in this case, the accident severity) based on the input features. Naive Bayes being a probabilistic classifier, predicts the probability of accident severity.

[258]:

```
from sklearn.model_selection import train_test_split
X = cleaned_dataset.drop(columns=["Time", "Day_of_week", "Age_band_of_driver",␣
↪"Sex_of_driver", "Educational_level",
                        "Vehicle_driver_relation", "Driving_experience",␣
↪"Type_of_vehicle", "Owner_of_vehicle",
                        "Service_year_of_vehicle", "Defect_of_vehicle",␣
↪"Area_accident_occured", "Lanes_or_Medians",
```

```
                        "Road_allignment", "Types_of_Junction",␣
↪"Road_surface_type", "Road_surface_conditions",
                        "Light_conditions", "Weather_conditions",␣
↪"Type_of_collision", "Number_of_vehicles_involved",
                        "Number_of_casualties", "Vehicle_movement",␣
↪"Casualty_class", "Sex_of_casualty",
                        "Age_band_of_casualty", "Work_of_casuality",␣
↪"Fitness_of_casuality", "Pedestrian_movement",
                        "Cause_of_accident", "Road_surface_conditions_ordinal",␣
↪"Day_of_week_ordinal",
                        "Accident_severity_ordinal",␣
↪"Educational_level_ordinal", "Service_year_of_vehicle_ordinal",
                        "Casualty_severity_ordinal",␣
↪"Age_band_of_driver_ordinal", "Driving_experience_ordinal",
                        "Age_band_of_casualty_ordinal", "Casualty_severity"])

y = X["Accident_severity"]
X = X.drop(columns=["Accident_severity"])
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
↪random_state=42)
```

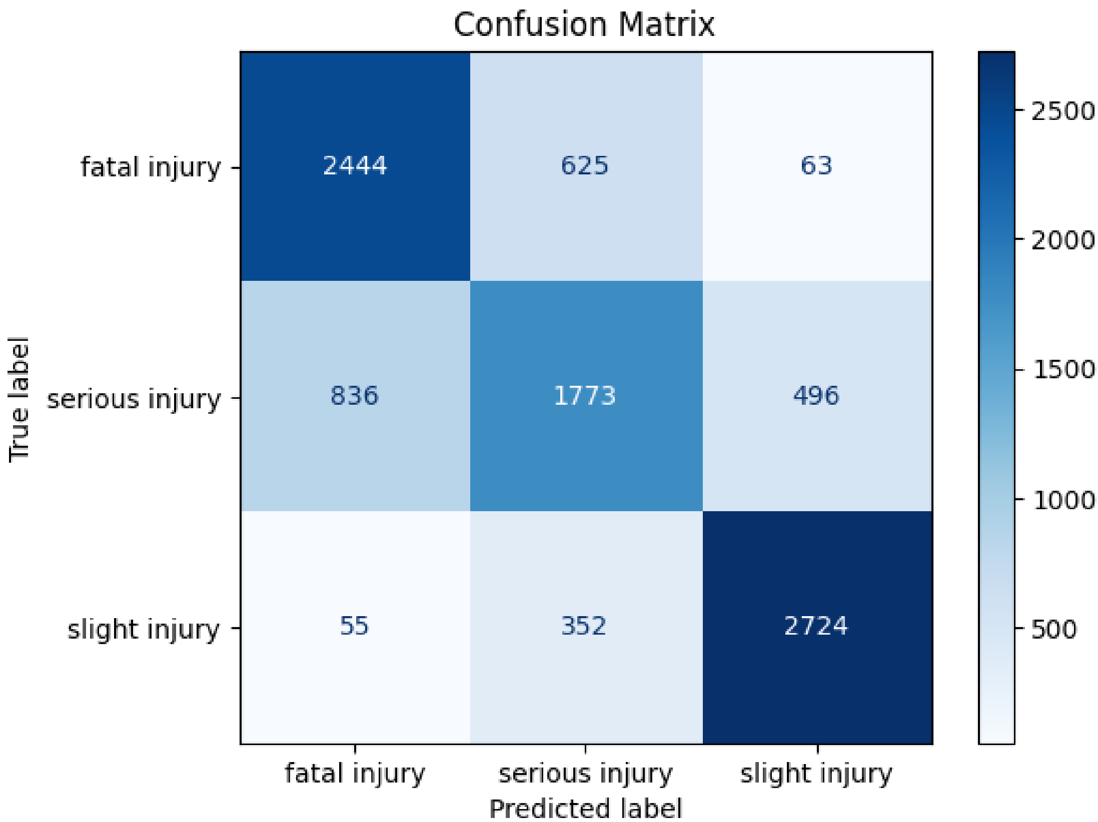
The code below splits the dataset into train and test dataset. This is useful for training the model. Naive Bayes Classifier has a hyperparameter: α. Tuning this hyperparameter can help in getting the best classifier. To tune the hyperparameter, we can train the model for different values of α and then select the classifier that performs the best. The code below trains the model for different values of alpha ranging from 0.01 to 2 with step of 0.01

[259]:
```
import numpy as np
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.naive_bayes import CategoricalNB
from sklearn.metrics import accuracy_score, classification_report
from imblearn.over_sampling import SMOTE
from sklearn.preprocessing import OrdinalEncoder, LabelEncoder


smote = SMOTE(random_state=42)
X_resampled, y_resampled = smote.fit_resample(X, y)
X_train, X_test, y_train, y_test = train_test_split(X_resampled, y_resampled,␣
↪test_size=0.3, random_state=42)

model = CategoricalNB()
param_grid = {
    'alpha': np.arange(0.01, 2, 0.01)
}

grid_search = GridSearchCV(estimator=model, param_grid=param_grid,␣
↪scoring='accuracy', cv=3)
```

```python
grid_search.fit(X_train, y_train)
best_model = grid_search.best_estimator_
y_pred = best_model.predict(X_test)

print("Best parameters found: ", grid_search.best_params_)
print("Accuracy:", accuracy_score(y_test, y_pred))
print(classification_report(y_test, y_pred))
```

```
Best parameters found:  {'alpha': np.float64(0.12)}
Accuracy: 0.7409265584970111
                precision    recall  f1-score   support

  fatal injury       0.73      0.78      0.76      3132
serious injury       0.64      0.57      0.61      3105
 slight injury       0.83      0.87      0.85      3131

      accuracy                           0.74      9368
     macro avg       0.74      0.74      0.74      9368
  weighted avg       0.74      0.74      0.74      9368
```

[260]:
```python
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import matplotlib.pyplot as plt

cm = confusion_matrix(y_test, y_pred)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=grid_search.
 ↪best_estimator_.classes_)
disp.plot(cmap=plt.cm.Blues)
plt.title("Confusion Matrix")
plt.show()
```



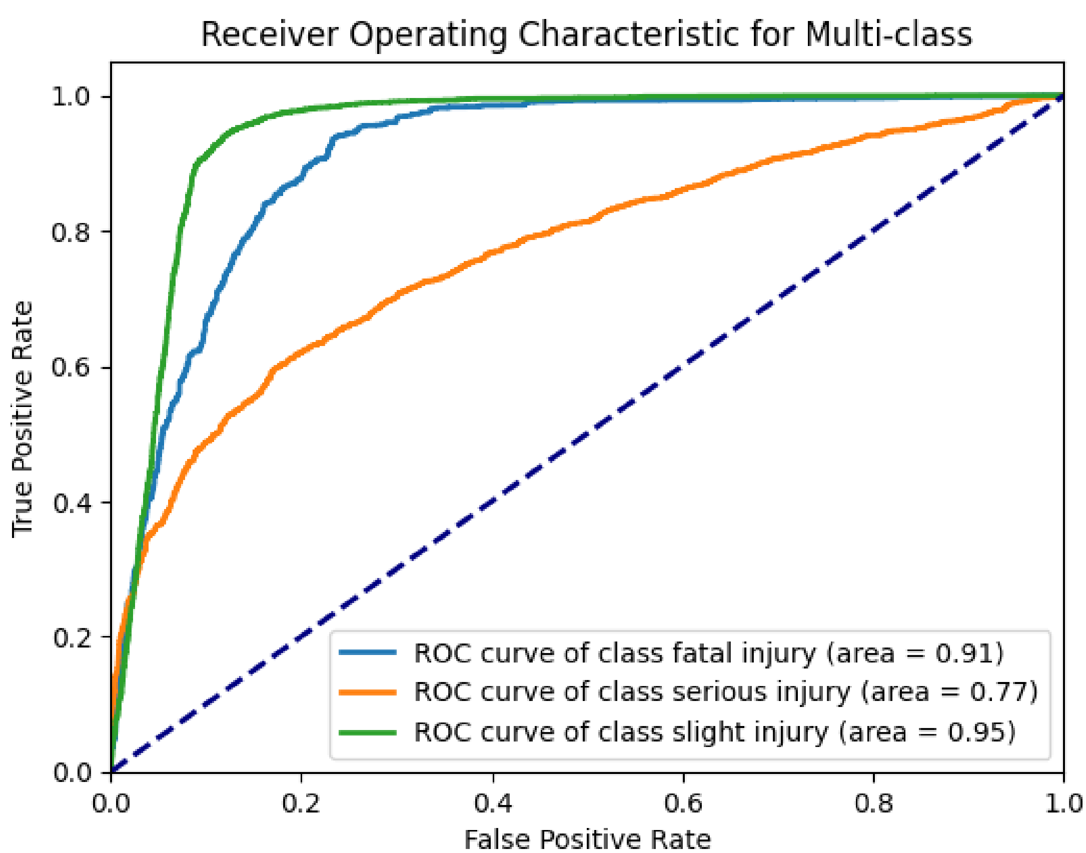
The above plot shows the confusion matrix for the model. The accuracy of the model is close to 74%

This accuracy can be improved by: - Adding more data to the dataset - Adding data that is equally distributed across various classes. In the case above, the dataset has very few entries for slight injury. For this, I used SMOTE technique to address the class imbalance. However, this may not always give accurate results as the technique creates synthetic cases for minority classes. Having actual cases in the dataset will help in making the model more robust.

[261]:

```
from sklearn.metrics import roc_curve, auc
from sklearn.preprocessing import label_binarize

model.fit(X_train, y_train)
y_pred_proba = model.predict_proba(X_test)

y_test_bin = label_binarize(y_test, classes=['fatal injury', 'serious injury',␣
↪'slight injury'])
n_classes = y_test_bin.shape[1]
fpr = dict()
tpr = dict()
roc_auc = dict()
```

```
for i in range(n_classes):
    fpr[i], tpr[i], _ = roc_curve(y_test_bin[:, i], y_pred_proba[:, i])
    roc_auc[i] = auc(fpr[i], tpr[i])

plt.figure()
for i in range(n_classes):
    plt.plot(fpr[i], tpr[i], lw=2, label='ROC curve of class {0} (area = {1:0.
↪2f})'
                                              ''.format(['fatal injury', 'serious␣
↪injury', 'slight injury'][i], roc_auc[i]))

plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic for Multi-class')
plt.legend(loc="lower right")
plt.show()
```



The plot above shows ROC curve for the NB classifier.

[262]:
```
import ipywidgets as widgets
from IPython.display import display

alpha_slider = widgets.FloatSlider(value=1.0, min=0.01, max=2.0, step=0.01,␣
 ↪description='Alpha:')

def update_model(alpha):
    model = CategoricalNB(alpha=alpha)
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)
    print("Accuracy:", accuracy_score(y_test, y_pred))

widgets.interactive(update_model, alpha=alpha_slider)
```

[262]:
```
interactive(children=(FloatSlider(value=1.0, description='Alpha:', max=2.0,
min=0.01, step=0.01), Output()), _…
```

The slider above shows the accuracy for various values of α for Naive Bayes Classifier

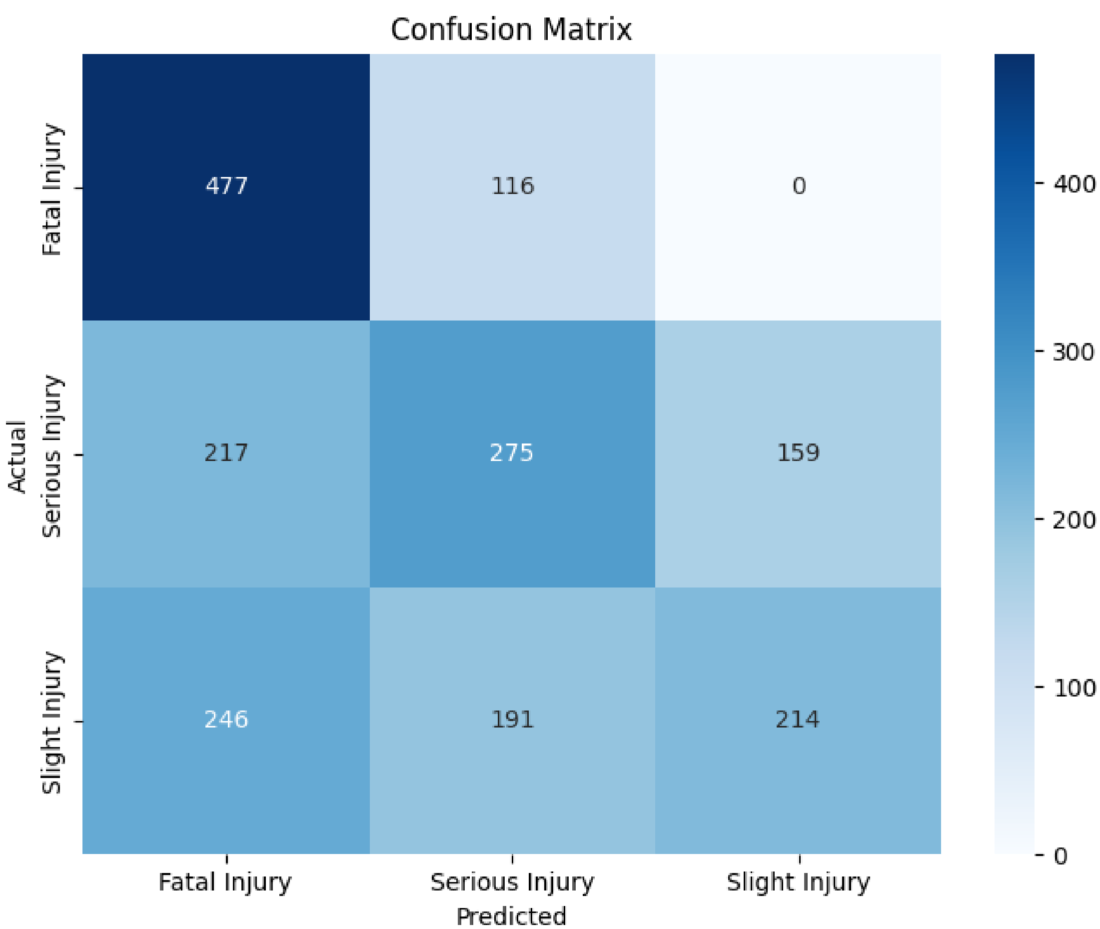
Does the service period of the vehicle and ownership of the vehicle have any correlation with the accidents The code below implements Random Forest Classifier. A Random Forest Classifier is a machine-learning algorithm that uses multiple decision trees to classify data and produce a single result. This

[284]:
```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier
from sklearn.metrics import classification_report, confusion_matrix
from imblearn.ensemble import EasyEnsembleClassifier
from imblearn.over_sampling import SMOTE



data = cleaned_dataset[["Owner_of_vehicle",
                       "Service_year_of_vehicle",
                       "Number_of_casualties",␣
 ↪"Service_year_of_vehicle_ordinal",
                       "Casualty_severity", "Number_of_vehicles_involved",␣
 ↪"Number_of_casualties"]]
data = data[data['Service_year_of_vehicle'] != 'unknown']
data["Service_year_of_vehicle_ordinal"] = data["Service_year_of_vehicle"].
 ↪map(ord_mapping)
data = data.drop("Service_year_of_vehicle", axis=1)
```

```python
owner_ord_mapping = {'owner':0, 'governmental':1, 'unknown':2, 'organization':
    3, 'other':4}

data["Owner_of_vehicle_ordinal"] = data["Owner_of_vehicle"].
    map(owner_ord_mapping)
data = data.drop("Owner_of_vehicle", axis=1)
data = data[data["Casualty_severity"] != "unknown"]
X = data.drop('Casualty_severity', axis=1)
X = X.drop('Number_of_casualties', axis=1)

severity_ord_mapping = {'1':0, '2':1, '3':2}
y = data['Casualty_severity'].map(severity_ord_mapping)

smote = SMOTE(random_state=42)
X_resampled, y_resampled = smote.fit_resample(X, y)

X_train, X_test, y_train, y_test = train_test_split(X_resampled, y_resampled,
    test_size=0.2, random_state=31)

rf_model = RandomForestClassifier(n_estimators=100, random_state=42)
rf_model.fit(X_train, y_train)
y_pred_rf = rf_model.predict(X_test)

print("Accuracy Random Forest with class weights:", accuracy_score(y_test,
    y_pred_rf))
print("Random Forest (with class weights) Classification Report:\n",
    classification_report(y_test, y_pred_rf, zero_division=0))
print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred_rf))


import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(y_test, y_pred_rf)
plt.figure(figsize=(8, 6))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=['Fatal Injury',
    'Serious Injury', 'Slight Injury'], yticklabels=['Fatal Injury', 'Serious
    Injury', 'Slight Injury'])
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.title('Confusion Matrix')
plt.show()
```

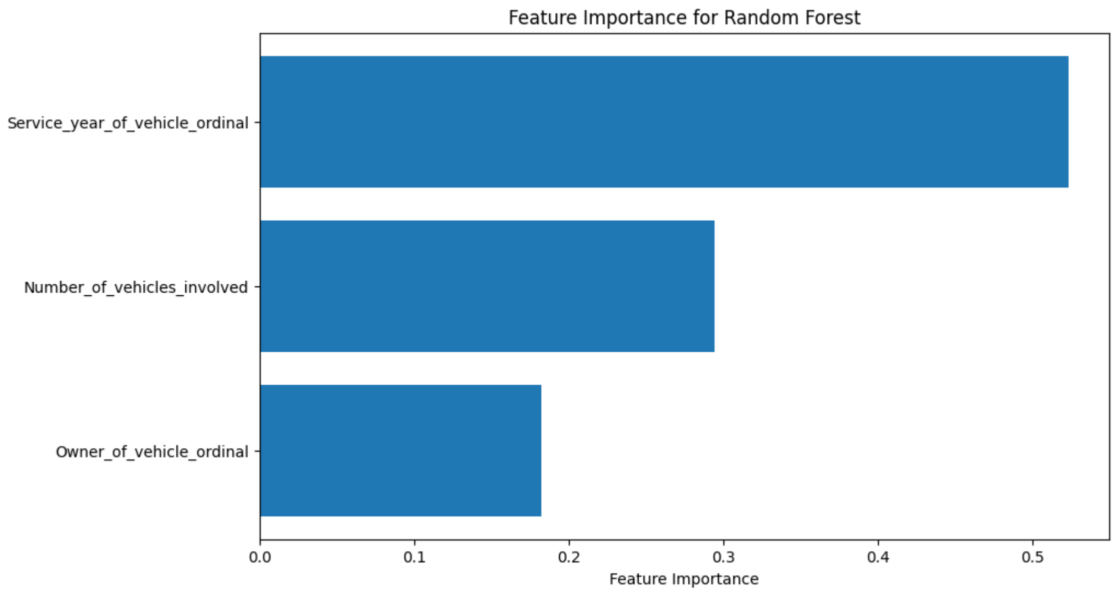
```
Accuracy Random Forest with class weights: 0.5097625329815303
Random Forest (with class weights) Classification Report:
```

```
              precision    recall  f1-score   support

           0       0.51      0.80      0.62       593
           1       0.47      0.42      0.45       651
           2       0.57      0.33      0.42       651

    accuracy                           0.51      1895
   macro avg       0.52      0.52      0.50      1895
weighted avg       0.52      0.51      0.49      1895

Confusion Matrix:
 [[477 116   0]
 [217 275 159]
 [246 191 214]]
```



This Random Forest Classifier doesn't work well on the synthesised dataset. Using SMOTE doesn't help to address the class imbalance.

[283]:
```
import numpy as np

feature_importance = rf_model.feature_importances_
indices = np.argsort(feature_importance)
plt.figure(figsize=(10, 6))
plt.barh(range(len(indices)), feature_importance[indices], align='center')
plt.yticks(range(len(indices)), [X.columns[i] for i in indices])
plt.xlabel('Feature Importance')
plt.title('Feature Importance for Random Forest')
plt.show()
```



[282]:
```
import plotly.graph_objs as go
import pandas as pd

a = X["Service_year_of_vehicle_ordinal"]
b = X["Owner_of_vehicle_ordinal"]

fig = go.Figure(data=[go.Scatter3d(x=a, y=b, z=y, mode='markers', marker=dict(
                                                                    size=5,
                                                                    color=y,
                                                                   ␣
 ↪colorscale='Viridis',
                                                                    opacity=0.8
                                                                )
    )])

fig.update_layout(
```

```
    title='3D Scatter Plot of Service Year, Vehicle Ownership, and Accident Severity',
    scene=dict(
        xaxis_title='Service Year of Vehicle',
        yaxis_title='Owner of Vehicle (Ordinal)',
        zaxis_title='Accident Severity'
    ),
)

fig.show()
```

In the above trial to create a Random Forest Classifier to find the accident severity based on ownership and service history of the vehicle didn't perform well on the given dataset. Using more attributes from the dataset and then creating the model might help in improving the effectiveness of the model.