CIND 820 Traffic Collision Data Analysis and Prediction

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Initial Results and Code

Intro

This project aims to analyze road accident data from 2017-2023 to gain insights into the factors contributing to accidents, identify patterns, and propose data-driven recommendations for improving road safety. The dataset used in this project contains information about various aspects of road accidents, such as location, time, weather conditions, and severity.

Github Repo

https://github.com/mkleung/traffic-collision-analysis

Table of Contents

Dataset Overview

- **Source:** https://open.ottawa.ca/datasets/ottawa::traffic-collision-data/about
- **Size:** 74,613 rows, 29 columns
- **Date Range:** 2017-2023
- **Format:** CSV
- **Copyright:** Open Data Licence Version 2.0 (worldwide, royalty-free, perpetual, non-exclusive licence to copy, modify, publish, translate, adapt and distribute

Goal of project

- **Use Case:** Predicting Traffic Collision
- **Industry:** Transportation Safety and Traffic management
- **Users:** City planners, Law enforcement, General public, Cyclists
- **Result:** Develop an application that can predict collision probability from a user input location or a planned route (tentative).

Questions

These are some of the questions we will be investigating during this project

- **What are the locations where the most frequent accidents occur?**
- **Do weather and environmental conditions affect traffic collisions?**
- **Do traffic measures decrease traffic collisions?**

In [60]:

```
%reset -f
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [61]:

```
# Packages to install
# mlxtend for apriori
# Y-data-profiling for eda report

%%capture

!pip install pandas mlxtend -q
!pip install ydata-profiling -q
!pip install pandas folium -q
!pip install scikit-learn --upgrade -q
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Section 1. Data Import and Description

In [66]:

```
# Import Libraries and load the dataset
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from datetime import timedelta
%matplotlib inline

pd.pandas.set_option('display.max_columns', None)
data=pd.read_csv("Traffic_Collision_Data.csv")
data.head(10)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[66]:

	X	Y	ID	Geo_ID	Accident_Year	Accident_Date	Accident_Time	Location	Location_Type
0	-8.452607e+06	5.661674e+06	2017--1	__5RG32N	NaN	2017/01/01	1:28	WEST RIDGE DR btwn PARLOR PL & BERT G. ARGUE D...	Midblock
1	-8.422792e+06	5.689206e+06	2017--2	__3Z07B5	NaN	2017/01/01	3:16	VANIER PKWY SB btwn DONALD ST & MCARTHUR AVE (...	Midblock
2	-8.440990e+06	5.672790e+06	2017--3	639	NaN	2017/01/01	7:17	OLD RICHMOND RD @ ROBERTSON	Intersection

	X	Y	ID	Geo_ID	Accident_Year	Accident_Date	Accident_Time	RD (0000639) Location	Location_Type
3	-8.429778e+06	5.674892e+06	2017--4	9776	NaN	2017/01/01	8:58	MERIVALE RD @ WOODFIELD DR/ROYDON PL (0009776)	Intersection
4	-8.423751e+06	5.682144e+06	2017--5	7208	NaN	2017/01/01	11:41	BANK ST @ BELANGER AVE/LAMIRA ST (0007208)	Intersection
5	-8.437041e+06	5.678668e+06	2017--6	2748	NaN	2017/01/01	12:08	POULIN AVE @ RICHMOND RD (0002748)	Intersection
6	-8.415138e+06	5.692987e+06	2017--7	__3Z0CDR	NaN	2017/01/01	Unknown	EASTVALE DR btwn OGILVIE RD & LOYOLA AVE (__3Z...	Midblock
7	-8.436077e+06	5.672019e+06	2017--8	__3Z07PT	NaN	2017/01/01	20:26	WEST HUNT CLUB RD EB btwn CEDARVIEW RD & GREEN...	Midblock
8	-8.422145e+06	5.688649e+06	2017--9	8259	NaN	2017/01/01	20:43	QUEEN MARY ST @ QUILL ST (0008259)	Intersection
9	-8.432027e+06	5.678159e+06	2017--10	3209	NaN	2017/01/01	21:40	ERINDALE DR @ BASELINE RD (0003209)	Intersection

In [67]:

```
# Print a summary of the data attributes
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 74612 entries, 0 to 74611
Data columns (total 30 columns):
 #   Column                        Non-Null Count  Dtype
---  ------                        --------------  -----
 0   X                             74612 non-null  float64
 1   Y                             74612 non-null  float64
 2   ID                            74612 non-null  object
 3   Geo_ID                        74612 non-null  object
 4   Accident_Year                 0 non-null      float64
 5   Accident_Date                 74612 non-null  object
 6   Accident_Time                 74612 non-null  object
 7   Location                      74612 non-null  object
 8   Location_Type                 74612 non-null  object
 9   Classification_Of_Accident    74612 non-null  object
 10  Initial_Impact_Type           74607 non-null  object
 11  Road_Surface_Condition        74611 non-null  object
 12  Environment_Condition         74610 non-null  object
 13  Light                         74612 non-null  object
 14  Traffic_Control               74611 non-null  object
 15  Num_of_Vehicle                74612 non-null  int64
 16  Num_Of_Pedestrians            74612 non-null  int64
 17  Num_of_Bicycles               1347 non-null   float64
 18  Num_of_Motorcycles            637 non-null    float64
 19  Max_Injury                    13469 non-null  object
 20  Num_of_Injuries               13417 non-null  float64
 21  Num_of_Minimal_Injuries       5733 non-null   float64
 22  Num_of_Minor_Injuries         7804 non-null   float64
 23  Num_of_Major_Injuries         671 non-null    float64
```

```
 24  Num_of_Fatal_Injuries       141 non-null    float64
 25  X_Coordinate                74612 non-null  float64
 26  Y_Coordinate                74612 non-null  float64
 27  Lat                         74612 non-null  float64
 28  Long                        74612 non-null  float64
 29  ObjectId                    74612 non-null  int64
dtypes: float64(14), int64(3), object(13)
memory usage: 17.1+ MB
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [68]:

```
# Show the descriptive statistics
data.describe()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[68]:

	X	Y	Accident_Year	Num_of_Vehicle	Num_Of_Pedestrians	Num_of_Bicycles	Num_of_Motorcyc
count	7.461200e+04	7.461200e+04	0.0	74612.000000	74612.000000	1347.000000	637.0000
mean	-8.428035e+06	5.670130e+06	NaN	1.841219	0.022289	1.010393	1.0156
std	1.870145e+04	2.316663e+05	NaN	0.586512	0.153846	0.115173	0.1364
min	-8.820655e+06	0.000000e+00	NaN	1.000000	0.000000	1.000000	1.0000
25%	-8.433028e+06	5.674170e+06	NaN	2.000000	0.000000	1.000000	1.0000
50%	-8.426515e+06	5.681383e+06	NaN	2.000000	0.000000	1.000000	1.0000
75%	-8.420483e+06	5.687619e+06	NaN	2.000000	0.000000	1.000000	1.0000
max	-8.378081e+06	5.704542e+06	NaN	25.000000	3.000000	3.000000	3.0000

In [69]:

```
# Check for missing values
print("Missing Values:")
print(data.isnull().sum())
```

```
Missing Values:
X                              0
Y                              0
ID                             0
Geo_ID                         0
Accident_Year                  74612
Accident_Date                  0
Accident_Time                  0
Location                       0
Location_Type                  0
Classification_Of_Accident     0
Initial_Impact_Type            5
Road_Surface_Condition         1
Environment_Condition          2
Light                          0
Traffic_Control                1
```

```
Num_of_Vehicle                   0
Num_Of_Pedestrians               0
Num_of_Bicycles              73265
Num_of_Motorcycles           73975
Max_Injury                   61143
Num_of_Injuries              61195
Num_of_Minimal_Injuries      68879
Num_of_Minor_Injuries        66808
Num_of_Major_Injuries        73941
Num_of_Fatal_Injuries        74471
X_Coordinate                     0
Y_Coordinate                     0
Lat                              0
Long                             0
ObjectId                         0
dtype: int64
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Summary of Data Description

- **Accident_Year has 100% missing values**
- **These attributes all have >80% missing values:**
  - **Num_of_Bicycles, Num_of_Motorcycles, Max_Injury, Num_of_Injuries, Num_of_Minimal_Injuries, Num_of_Minor_Injuries, Num_of_Major_Injuries, Num_of_Fatal_Injuries**
- **These have < 5 missing values**
  - **Traffic_Control, Initial_Impact_Type, Road_Surface_Condition, environmental condition**
- **The column Accident_Time contains some "Unknown" or Null values**
- **X, Y, GeoID, X_Cordinate, Y_Coordinate are duplicates and not needed**
- **ID, GEOID are metadata**
- **Classification_Of_Accident, etc contains numbers corresponding categorical data**

Section 2. Data Cleaning and Preprocessing

In [70]:

```
df = data.copy()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [72]:

```
# Drop Redundant Columns

# Accident_Year contains only null values
# ObjectID, Geo_ID, ID are database primary keys
# X_Coordinate, Y_Coordinate, X , Y are duplicates of long, lat
# Location column is irrelevant as lat and long are going to be used in this project
# Num_of_Minimal_Injuries, Num_of_Minor_Injuries, Num_of_Major_Injuries are not required
# as we will use num_of_injuries and fatal injuries
# Location_Type, Classification_Of_Accident both contain only 2 unique values
# which are not descriptive enought for our analysis

columns_to_drop = [
     "Accident_Year",
     "Geo_ID", "ObjectId", "ID",
     "X", "Y", "X_Coordinate", "Y_Coordinate",
```

```
    "Location",
    "Num_of_Minimal_Injuries", "Num_of_Minor_Injuries", "Num_of_Major_Injuries",
    "Location_Type", "Classification_Of_Accident"
]
df = df.drop(columns=columns_to_drop)
df.head()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
<ipython-input-72-630e3855c621> in <cell line: 20>()
     18     "Location_Type", "Classification_Of_Accident"
     19 ]
---> 20 df = df.drop(columns=columns_to_drop)
     21 df.head()

/usr/local/lib/python3.10/dist-packages/pandas/core/frame.py in drop(self, labels, axis,
index, columns, level, inplace, errors)
   5579                 weight  1.0     0.8
   5580         """
-> 5581         return super().drop(
   5582             labels=labels,
   5583             axis=axis,

/usr/local/lib/python3.10/dist-packages/pandas/core/generic.py in drop(self, labels, axis
, index, columns, level, inplace, errors)
   4786         for axis, labels in axes.items():
   4787             if labels is not None:
-> 4788                 obj = obj._drop_axis(labels, axis, level=level, errors=errors)
   4789
   4790         if inplace:

/usr/local/lib/python3.10/dist-packages/pandas/core/generic.py in _drop_axis(self, labels
, axis, level, errors, only_slice)
   4828                 new_axis = axis.drop(labels, level=level, errors=errors)
   4829             else:
-> 4830                 new_axis = axis.drop(labels, errors=errors)
   4831             indexer = axis.get_indexer(new_axis)
   4832

/usr/local/lib/python3.10/dist-packages/pandas/core/indexes/base.py in drop(self, labels,
errors)
   7068         if mask.any():
   7069             if errors != "ignore":
-> 7070                 raise KeyError(f"{labels[mask].tolist()} not found in axis")
   7071             indexer = indexer[~mask]
   7072         return self.delete(indexer)

KeyError: "['Accident_Year', 'Geo_ID', 'ObjectId', 'ID', 'X', 'Y', 'X_Coordinate', 'Y_Coo
rdinate', 'Location', 'Num_of_Minimal_Injuries', 'Num_of_Minor_Injuries', 'Num_of_Major_I
njuries', 'Location_Type', 'Classification_Of_Accident'] not found in axis"
```

In [73]:

```
# Remove Unknown values from te Accident_Time and replace with median
# For example, row number 6 has an unknown time

df['Accident_Time1'] = pd.to_datetime(df['Accident_Time'], errors='coerce', format='%H:%
M')
median_time = df['Accident_Time1'].dropna().median()
if pd.notnull(median_time):
    median_time_str = median_time.strftime('%H:%M')

df['Accident_Time'] = df['Accident_Time'].replace("Unknown", median_time_str)
df = df.drop(columns=['Accident_Time1'])
df.head(10)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
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  and should_run_async(code)
```

Out[73]:

	Accident_Date	Accident_Time	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Cont
0	2017/01/01	1:28	07 - SMV other	03 - Loose snow	02 - Rain	07 - Dark	10 - No cont
1	2017/01/01	3:16	04 - Sideswipe	03 - Loose snow	03 - Snow	07 - Dark	10 - No cont
2	2017/01/01	7:17	07 - SMV other	01 - Dry	05 - Drifting Snow	03 - Dawn	01 - Traf sig
3	2017/01/01	8:58	03 - Rear end	03 - Loose snow	03 - Snow	01 - Daylight	01 - Traf sig
4	2017/01/01	11:41	99 - Other	02 - Wet	01 - Clear	01 - Daylight	01 - Traf sig
5	2017/01/01	12:08	03 - Rear end	02 - Wet	03 - Snow	01 - Daylight	01 - Traf sig
6	2017/01/01	14:39	06 - SMV unattended vehicle	04 - Slush	03 - Snow	00 - Unknown	10 - No cont
7	2017/01/01	20:26	04 - Sideswipe	02 - Wet	01 - Clear	07 - Dark	10 - No cont
8	2017/01/01	20:43	07 - SMV other	03 - Loose snow	01 - Clear	07 - Dark	02 - Stop s
9	2017/01/01	21:40	07 - SMV other	02 - Wet	01 - Clear	07 - Dark	02 - Stop s

In [74]:

```
# Combine the date and time into one column
def combine_date_time(row):
    try:
        return pd.to_datetime(f"{row['Accident_Date']} {row['Accident_Time']}")
    except Exception:
        return pd.NaT
df['Accident_Timestamp'] = df.apply(combine_date_time, axis=1)
df = df.drop(columns=['Accident_Date','Accident_Time'])
df.head(1)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[74]:

	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Control	Num_of_Vehicle	Num_Of_Pedes
0	07 - SMV other	03 - Loose snow	02 - Rain	07 - Dark	10 - No control	1	

In [75]:

```
# Clean data inside category columns

df['Initial_Impact_Type'] = df['Initial_Impact_Type'].str.replace(r'^\d+\s*-\s*', '', re
gex=True)
df['Road_Surface_Condition'] = df['Road_Surface_Condition'].str.replace(r'^\d+\s*-\s*',
'', regex=True)
```

```
df['Environment_Condition'] = df['Environment_Condition'].str.replace(r'^\d+\s*-\s*', ''
, regex=True)
df['Light'] = df['Light'].str.replace(r'^\d+\s*-\s*', '', regex=True)
df['Traffic_Control'] = df['Traffic_Control'].str.replace(r'^\d+\s*-\s*', '', regex=True
)
df['Max_Injury'] = df['Max_Injury'].str.replace(r'^\d+\s*-\s*', '', regex=True)
df.head(1)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[75]:

	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Control	Num_of_Vehicle	Num_Of_Pedes
0	SMV other	Loose snow	Rain	Dark	No control	1	

In [76]:

```
# Remove Null Values

# Replace null values with zero in these columns that have 80% null values
# Context: these null values should be zero because there are no injuries.
columns_to_fill = [
    'Num_of_Bicycles',
    'Num_of_Motorcycles',
    'Num_of_Injuries',
    'Num_of_Fatal_Injuries'
]
for column in columns_to_fill:
    df[column] = df[column].fillna(0)

# Remove the rows that have less than 5 null values
df.dropna(subset=['Initial_Impact_Type'], inplace=True)
df.dropna(subset=['Road_Surface_Condition'], inplace=True)
df.dropna(subset=['Environment_Condition'], inplace=True)
df.dropna(subset=['Traffic_Control'], inplace=True)

# Max_Injury (Categorical) - null values means no injury sustained will be filled with No
ne
df['Max_Injury'] = df['Max_Injury'].fillna("None")

df.head()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[76]:

	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Control	Num_of_Vehicle	Num_Of_Pe
0	SMV other	Loose snow	Rain	Dark	No control	1	
1	Sideswipe	Loose snow	Snow	Dark	No control	2	
2	SMV other	Dry	Drifting Snow	Dawn	Traffic signal	1	
3	Rear end	Loose snow	Snow	Daylight	Traffic signal	2	
4	Other	Wet	Clear	Daylight	Traffic signal	2	

In [77]:

```
# Check if there are any missing values remaining
print(df.isnull().sum())
```

```
Initial_Impact_Type       0
Road_Surface_Condition    0
Environment_Condition     0
Light                     0
Traffic_Control           0
Num_of_Vehicle            0
Num_Of_Pedestrians        0
Num_of_Bicycles           0
Num_of_Motorcycles        0
Max_Injury                0
Num_of_Injuries           0
Num_of_Fatal_Injuries     0
Lat                       0
Long                      0
Accident_Timestamp        0
dtype: int64
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [78]:

```
# Drop duplicates
Num_of_duplicates = sum(df.duplicated())
df = df.drop_duplicates()
print("Duplicates rows dropped:\n", Num_of_duplicates)
```

```
Duplicates rows dropped:
 8
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [79]:

```
# Standardize column names
# Some column names have missing 's' and wrong capital letters
# Max_Injury is a confusing column title and is renamed to Injury_Type

df.rename(columns={'Num_of_Vehicle': 'Num_of_Vehicles'}, inplace=True)
df.rename(columns={'Num_Of_Pedestrians': 'Num_of_Pedestrians'}, inplace=True)
df.rename(columns={'Max_Injury': 'Injury_Type'}, inplace=True)
df.head(1)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[79]:

	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Control	Num_of_Vehicles	Num_of_Pedes
0	**SMV other**	**Loose snow**	**Rain**	**Dark**	**No control**	**1**	

In [80]:

In [80]:

```
# Detect and Remove Outliers

# Lat contains some outliers because the min is 0
# Num_of_Injuries could have one outlier

# NOTE Z-Score or Interquartile range methods are not required for Lat and Long
# because their outliers are assumed to be user input errors or null values

df.describe()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[80]:

	Num_of_Vehicles	Num_of_Pedestrians	Num_of_Bicycles	Num_of_Motorcycles	Num_of_Injuries	Num_of_Fatal_Injuries
count	74595.000000	74595.000000	74595.000000	74595.000000	74595.000000	74595.000000
mean	1.841249	0.022294	0.018232	0.008674	0.233514	0.002024
min	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25%	2.000000	0.000000	0.000000	0.000000	0.000000	0.000000
50%	2.000000	0.000000	0.000000	0.000000	0.000000	0.000000
75%	2.000000	0.000000	0.000000	0.000000	0.000000	0.000000
max	25.000000	3.000000	3.000000	3.000000	38.000000	3.000000
std	0.586535	0.153863	0.135383	0.094304	0.588057	0.048116

In [82]:

```
# Investigate outliers in Num_of_Injuries
# This one value is the one off famous bus crash in 2019

column_name = 'Num_of_Injuries'
temp_injuries = df[df[column_name] > 10]
temp_injuries
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[82]:

	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Control	Num_of_Vehicles	Num_
29688	SMV other	Unknown	Clear	Daylight	No control	1	

In [83]:

```
# Delete the outlier
row_index = 29688
df = df.drop(index=row_index)
df.reset_index(drop=True, inplace=True)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should run async(code)
```

In [84]:

```
# Investigate latitude
# There are 130 rows with questionable latitudes which point to somewhere in the UK
column_name = 'Lat'
temp_lat = df[df[column_name] < 40]
temp_lat
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[84]:

	Initial_Impact_Type	Road_Surface_Condition	Environment_Condition	Light	Traffic_Control	Num_of_Vehicles	Num_
564	Turning movement	Dry	Clear	Daylight	Traffic signal	2	
1695	Sideswipe	Dry	Clear	Daylight	Traffic signal	2	
2211	Turning movement	Dry	Clear	Daylight	Traffic signal	2	
2530	Sideswipe	Dry	Clear	Daylight	Traffic signal	2	
3035	Sideswipe	Dry	Clear	Daylight	Traffic signal	2	
...	...	...	...	...	...	...	
71977	Sideswipe	Dry	Clear	Daylight	Stop sign	2	
71988	SMV other	Dry	Clear	Dark	No control	1	
72397	SMV other	Dry	Clear	Dark	No control	1	
72852	SMV other	Dry	Clear	Dawn	No control	1	
74195	Rear end	Dry	Clear	Daylight	No control	2	

130 rows × 15 columns

In [85]:

```
# Remove the questionable latitudes
df = df[df['Lat'] >= 40]
df.reset_index(drop=True, inplace=True)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

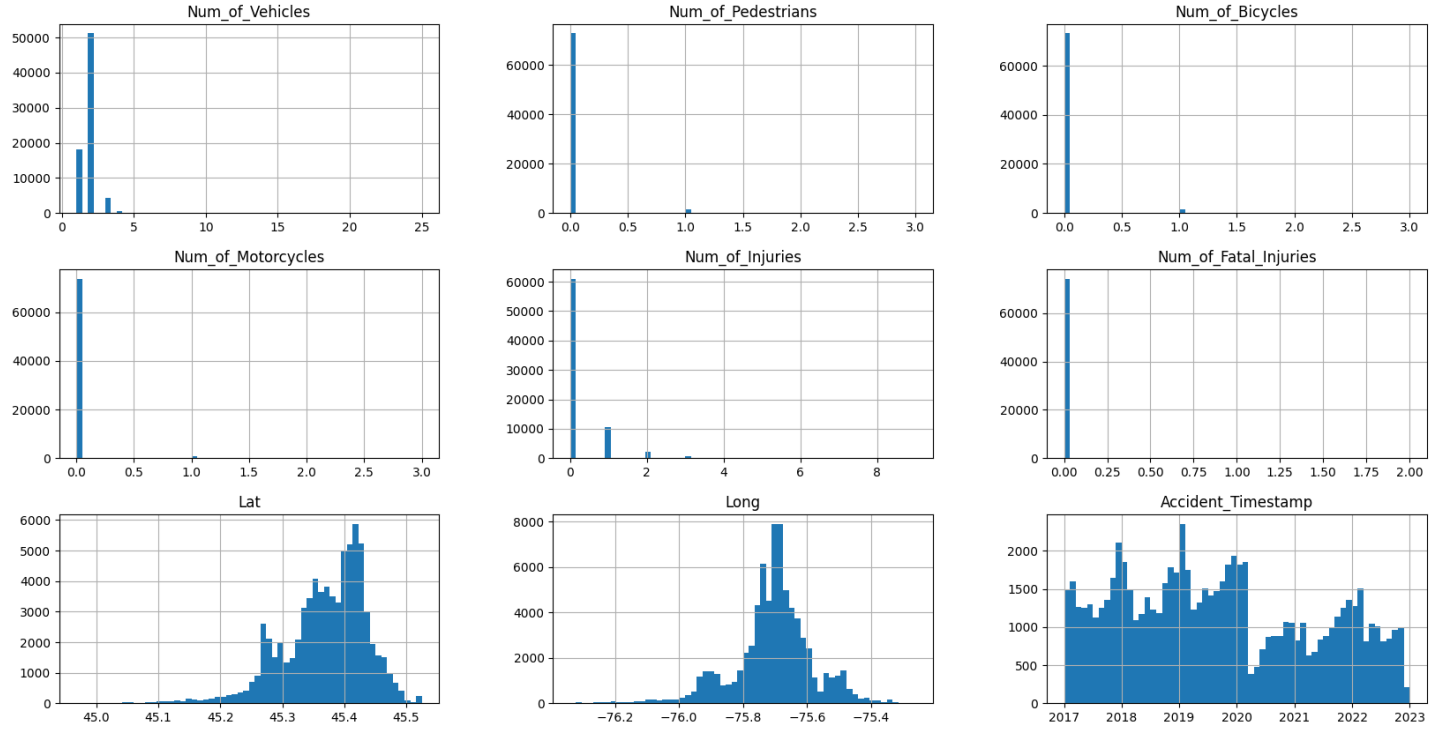
In [86]:

```
# Create histograms to look for any other outliers
df.hist(bins=60, figsize=(20,10))
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[86]:

```
array([[<Axes: title={'center': 'Num_of_Vehicles'}>,
        <Axes: title={'center': 'Num_of_Pedestrians'}>,
        <Axes: title={'center': 'Num_of_Bicycles'}>],
       [<Axes: title={'center': 'Num_of_Motorcycles'}>,
        <Axes: title={'center': 'Num_of_Injuries'}>,
        <Axes: title={'center': 'Num_of_Fatal_Injuries'}>],
       [<Axes: title={'center': 'Lat'}>,
        <Axes: title={'center': 'Long'}>,
        <Axes: title={'center': 'Accident_Timestamp'}>]], dtype=object)
```



In [87]:

```
# Step 5: One Hot Encode the categorical variables
columns_to_encode = ['Initial_Impact_Type', 'Road_Surface_Condition', 'Environment_Condit
ion', 'Light','Traffic_Control', 'Injury_Type']

# Ensure the columns to be encoded are treated as strings
for col in columns_to_encode:
    df[col] = df[col].astype(str)

# Perform one-hot encoding
encoded_data = pd.get_dummies(df, columns=columns_to_encode, drop_first=True)

# Display the resulting dataset's shape to confirm encoding
print("Original dataset shape:", df.shape)
print("Encoded dataset shape:", encoded_data.shape)
df = encoded_data.copy()
df.head(1)
```

```
Original dataset shape: (74464, 15)
Encoded dataset shape: (74464, 54)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[87]:

	Num_of_Vehicles	Num_of_Pedestrians	Num_of_Bicycles	Num_of_Motorcycles	Num_of_Injuries	Num_of_Fatal_Injuries	
0	**1**	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**45.2**

In [ ]:

```
df.to_csv('clean_df.csv', index=False)
```

Summary of Data preprocessing

- **Numeric Columns that have greater greater than 80% null values have been replaced by zero because they have been likely been omitted during the data entry phase.**
- **Category Columns that have less than 5 null were removed**
- **Column titles have been renamed**
- **Several irrelevant Columns have been dropped**
- **Duplicates have been removed**
- **Outliers were found and latitude and removed.**
- **Categorical columns have been one hot encoded**

Section 3. Exploratory Data Analysis and Visualization

In [88]:

```
df.head()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[88]:

	Num_of_Vehicles	Num_of_Pedestrians	Num_of_Bicycles	Num_of_Motorcycles	Num_of_Injuries	Num_of_Fatal_Injuries	
0	1	0	0.0	0.0	0.0	0.0	45.2
1	2	0	0.0	0.0	0.0	0.0	45.4
2	1	0	0.0	0.0	0.0	0.0	45.3
3	2	0	0.0	0.0	0.0	0.0	45.3
4	2	0	0.0	0.0	0.0	0.0	45.3

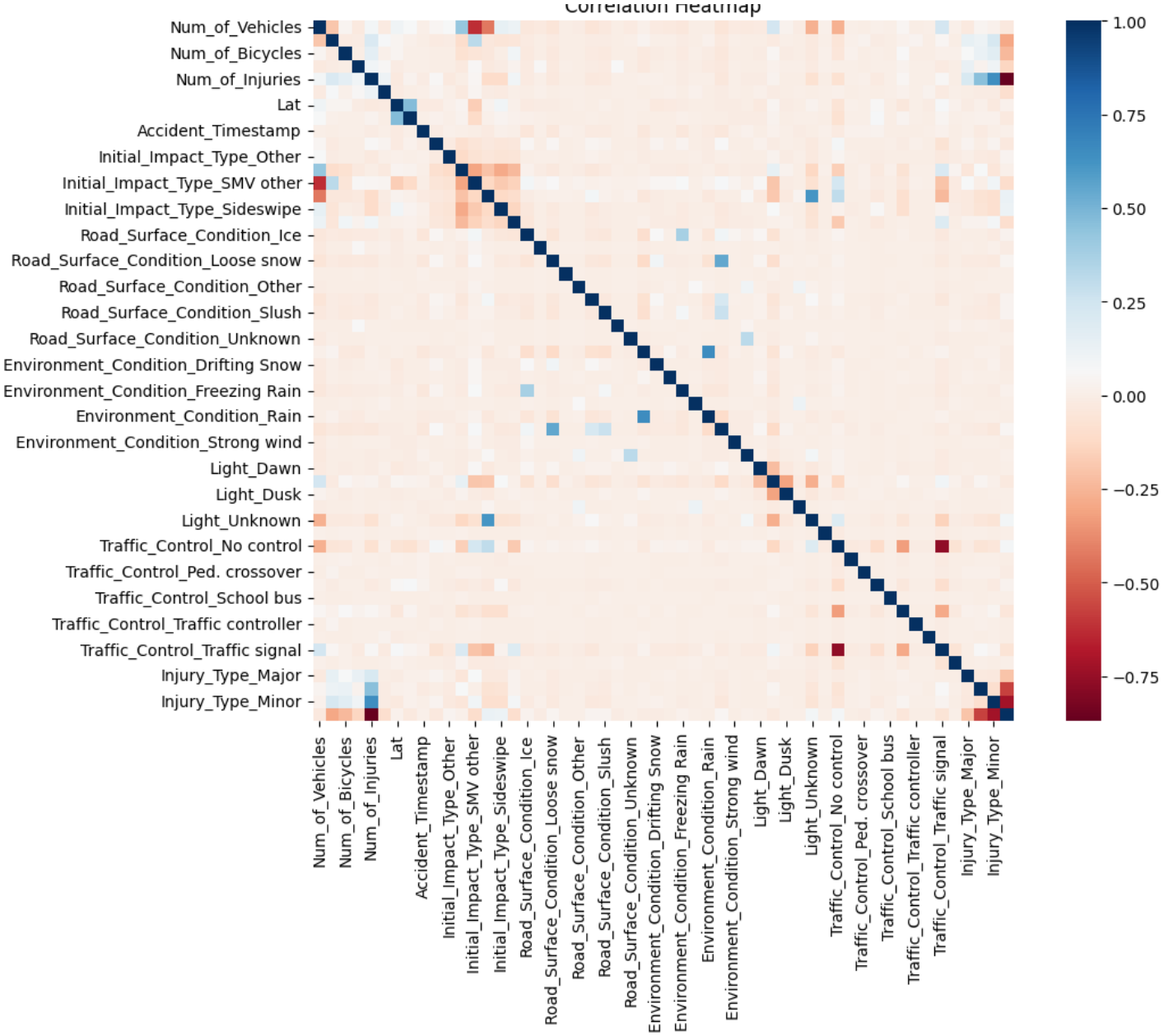
In [89]:

```
# Correlation Heatmap

correlation_matrix = df.corr()
plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=False, fmt='.2f', cmap='RdBu', square=True)
plt.title('Correlation Heatmap')
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Correlation Heatmap



In [90]:

```
# Show highest correlations
correlation_pairs = correlation_matrix.unstack()
sorted_correlations = correlation_pairs.sort_values(ascending=False)
sorted_correlations = sorted_correlations[sorted_correlations < 1]
top_correlations = sorted_correlations.head(10)
print("Top 10 Correlations:")
print(top_correlations)
```

```
Top 10 Correlations:
Road_Surface_Condition_Wet                 Environment_Condition_Rain
0.655350
Environment_Condition_Rain                 Road_Surface_Condition_Wet
0.655350
Injury_Type_Minor                          Num_of_Injuries
0.644279
Num_of_Injuries                            Injury_Type_Minor
0.644279
Initial_Impact_Type_SMV unattended vehicle  Light_Unknown
0.613587
Light_Unknown                              Initial_Impact_Type_SMV unattended vehicle
0.613587
Environment_Condition_Snow                 Road_Surface_Condition_Loose snow
0.554039
Road_Surface_Condition_Loose snow          Environment_Condition_Snow
0.554039
Long                                       Lat
0.469353
Lat                                        Long
```

```
0.469353
dtype: float64
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [91]:

```
# Show lowest correlations
sorted_correlations = correlation_pairs.sort_values(ascending=True)
sorted_correlations = sorted_correlations[sorted_correlations < 1]
bottom_correlations = sorted_correlations.head(10)
print("Top 10 Lowest Correlations:")
print(bottom_correlations)
```

```
Top 10 Lowest Correlations:
Num_of_Injuries                 Injury_Type_None                -0.870617
Injury_Type_None                Num_of_Injuries                 -0.870617
Traffic_Control_Traffic signal  Traffic_Control_No control      -0.766861
Traffic_Control_No control      Traffic_Control_Traffic signal  -0.766861
Injury_Type_Minor               Injury_Type_None                -0.720206
Injury_Type_None                Injury_Type_Minor               -0.720206
Initial_Impact_Type_SMV other   Num_of_Vehicles                 -0.624984
Num_of_Vehicles                 Initial_Impact_Type_SMV other   -0.624984
Injury_Type_None                Injury_Type_Minimal             -0.572750
Injury_Type_Minimal             Injury_Type_None                -0.572750
dtype: float64
```

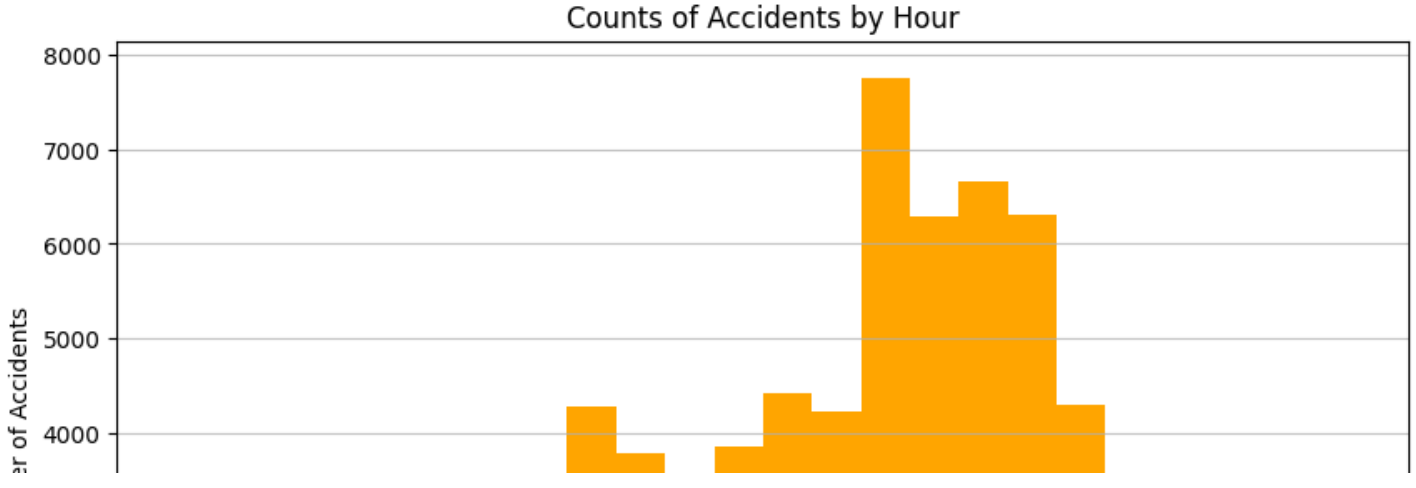
```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

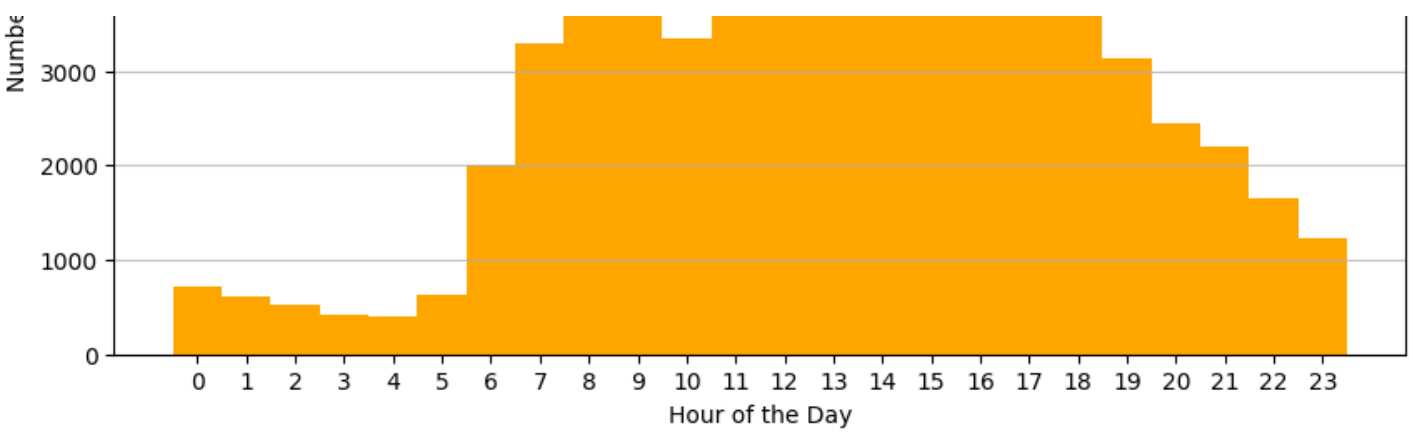
In [92]:

```
# Create accident count by the hour

df['Hour'] = df['Accident_Timestamp'].dt.hour
plt.figure(figsize=(10, 6))
plt.hist(df['Hour'], bins=range(0, 25), align='left', color='orange')
plt.xticks(range(0, 24))
plt.xlabel('Hour of the Day')
plt.ylabel('Number of Accidents')
plt.title('Counts of Accidents by Hour')
plt.grid(axis='y', alpha=0.75)
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```





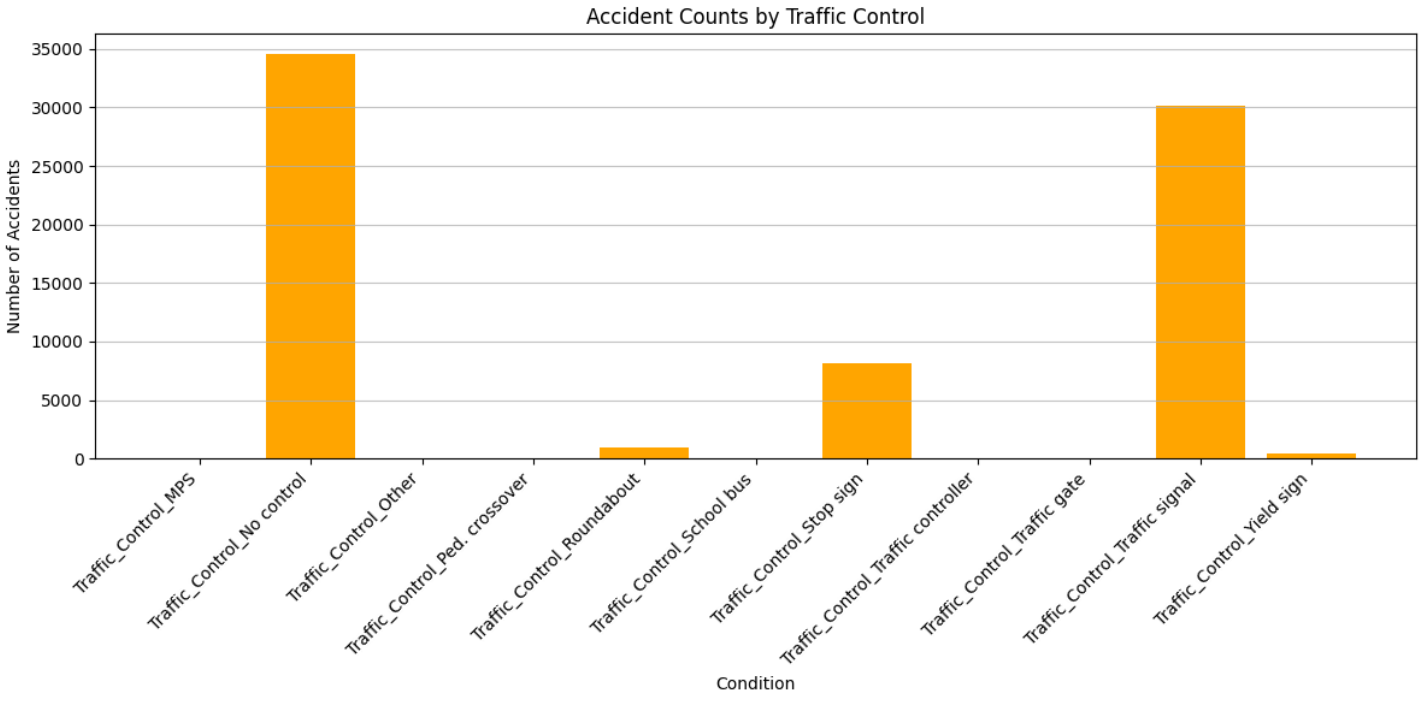
- **The highest accidents occur in the afternoon at around 2pm - 6pm**
- **Lowest happen at night from 11pm to 6am**

In [94]:

```
# Function to create histograms
def plot_accident_counts_by_condition(df, column_prefix, title):
    condition_columns = [col for col in df.columns if col.startswith(column_prefix)]
    condition_counts = df[condition_columns].sum().reset_index()
    condition_counts.columns = ['Condition', 'Accident Count']
    condition_counts = condition_counts[condition_counts['Accident Count'] > 0]
    plt.figure(figsize=(12, 6))
    plt.bar(condition_counts['Condition'], condition_counts['Accident Count'], color='or
ange')
    plt.xticks(rotation=45, ha='right')
    plt.xlabel('Condition')
    plt.ylabel('Number of Accidents')
    plt.title(title)
    plt.grid(axis='y', alpha=0.75)
    plt.tight_layout()
    plt.show()

# Show histogram of accident counts per traffic control type
plot_accident_counts_by_condition(df, 'Traffic_Control_', 'Accident Counts by Traffic Con
trol')
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```



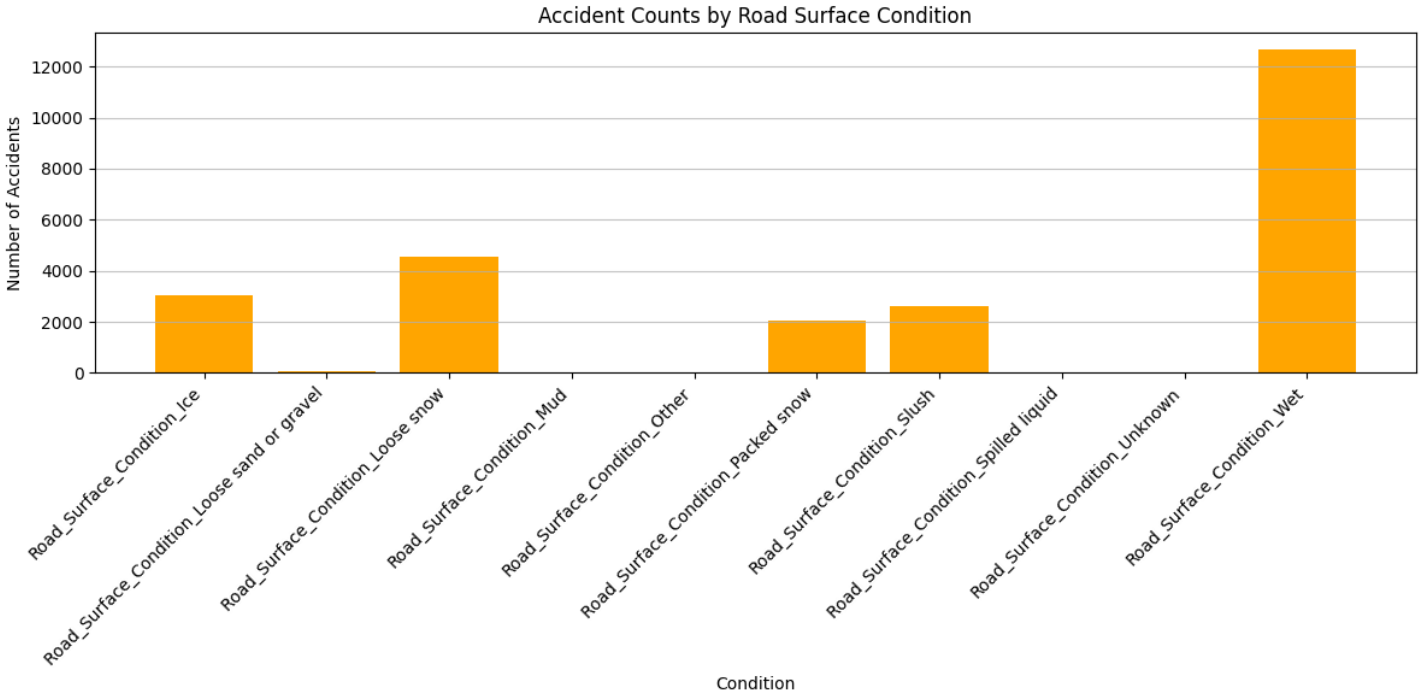
Highest accident counts happen when there is

- **No traffic Control**
- **Traffic Signal**

In [95]:

```
# Call the function for road surface conditions
plot_accident_counts_by_condition(df, 'Road_Surface_Condition_', 'Accident Counts by Road Surface Condition')
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `should_run_async` will not call `transform_cell` automatically in the future. Please pass the result to `transformed_cell` argument and any exception that happen during thetransform in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

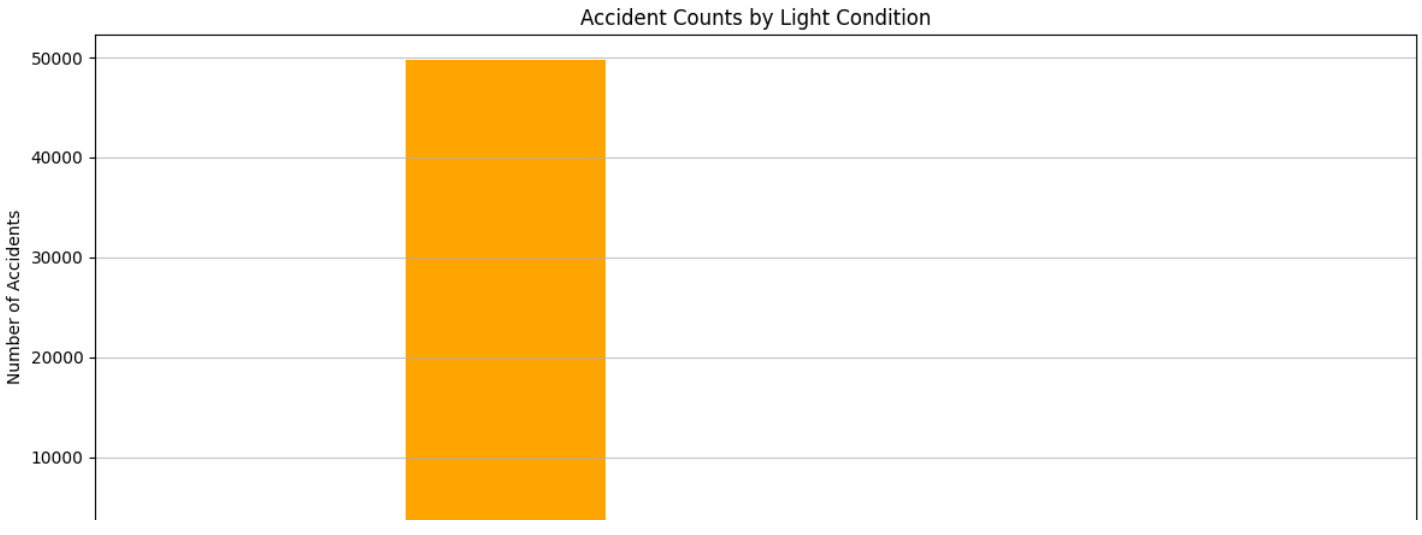


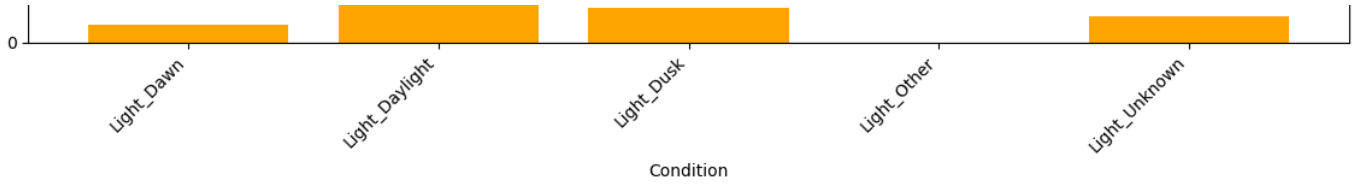
- **Most accidents occur during wet weather**

In [96]:

```
plot_accident_counts_by_condition(df, 'Light_', 'Accident Counts by Light Condition')
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `should_run_async` will not call `transform_cell` automatically in the future. Please pass the result to `transformed_cell` argument and any exception that happen during thetransform in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```





In [97]:

```
# Visualize the locations of fatal injuries

import folium
def create_map(df, lat_column, lon_column, value_column=None):

    m = folium.Map(location=[df[lat_column].mean(), df[lon_column].mean()], zoom_start=1
2, zoomControl=False)
    for _, row in df.iterrows():
        if row[value_column] > 0:
            Num_of_Fatal_Injuries = int(row.get("Num_of_Fatal_Injuries", 0)) if pd.notna
(row.get("Num_of_Fatal_Injuries")) else 0
            Num_of_Injuries = int(row.get("Num_of_Injuries", 0)) if pd.notna(row.get("Nu
m_of_Injuries")) else 0
            Num_of_Bicycles = int(row.get("Num_of_Bicycles", 0)) if pd.notna(row.get("Nu
m_of_Bicycles")) else 0
            Num_of_Motorcycles = int(row.get("Num_of_Motorcycles", 0)) if pd.notna(row.g
et("Num_of_Motorcycles")) else 0
            popup_text = (
                f'<div style="width: 200px;">'
                f'<strong>Deaths:</strong> {Num_of_Fatal_Injuries}<br>'
                f'<strong>Injuries:</strong> {Num_of_Injuries}<br>'
                f'<strong>Vehicles:</strong> {row.get("Num_of_Vehicles", "N/A")}<br>'
                f'<strong>Pedestrians:</strong> {row.get("Num_of_Pedestrians", "N/A")}<b
r>'
                f'<strong>Bicycles:</strong> {Num_of_Bicycles}<br>'
                f'<strong>Motorcyles:</strong> {Num_of_Motorcycles}<br>'
                f'<strong>Time:</strong> {row.get("Accident_Timestamp", "N/A")}'
                f'</div>'
            )

            folium.CircleMarker(
                location=(row[lat_column], row[lon_column]),
                radius=3,
                color='red',
                fill=True,
                fill_color='red',
                fill_opacity=1,
                popup=popup_text
            ).add_to(m)

    return m

lat_column = 'Lat'
lon_column = 'Long'
value_column = 'Num_of_Fatal_Injuries'

map_with_dots = create_map(df, lat_column, lon_column, value_column)
map_with_dots
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[97]:

Make this Notebook Trusted to load map: File -> Trust Notebook

In [98]:

```
# Using Y Data Profiling
from ydata_profiling import ProfileReport
profile = ProfileReport(df, title="Traffic Collision Report")
profile.to_file("collision_report.html")
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

```
/usr/local/lib/python3.10/dist-packages/ydata_profiling/model/pandas/discretize_pandas.py
:52: FutureWarning: Setting an item of incompatible dtype is deprecated and will raise in
a future error of pandas. Value '[0 1 3 ... 6 6 7]' has dtype incompatible with int32, pl
ease explicitly cast to a compatible dtype first.
  discretized_df.loc[:, column] = self._discretize_column(
```

Section 4. Data Analysis using Apriori (incomplete)

Find the association rule between the following that contribute the the frequency of collisions

- **Light**
- **Environmental_Condition**
- **Traffic_Control**
- **Road Surface Condition**

This Section will be completed for the final project as I realized I need to redo some additional data cleaning and ran out of time.

In [ ]:

```
# Incomplete Code (code returning error - will fix for final project)
# I will get it to work for my final project
# Source
# https://www.geeksforgeeks.org/implementing-apriori-algorithm-in-python/
# https://intellipaat.com/blog/data-science-apriori-algorithm/

from mlxtend.frequent_patterns import apriori, association_rules

# Convert the dataframe into true/false (incomplete)
```

```
# Apply the apropri algorithm
association_rules = apriori(df, min_support=0.0045, use_colnames=True)
association_results = list(association_rules)
print(len(association_results))
print(association_results)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
/usr/local/lib/python3.10/dist-packages/mlxtend/frequent_patterns/fpcommon.py:161: Deprec
ationWarning: DataFrames with non-bool types result in worse computationalperformance and
their support might be discontinued in the future.Please use a DataFrame with bool type
  warnings.warn(
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-42-0ef170339307> in <cell line: 13>()
     11
     12 # Apply the apropri algorithm
---> 13 association_rules = apriori(df, min_support=0.0045, use_colnames=True)
     14 association_results = list(association_rules)
     15 print(len(association_results))

/usr/local/lib/python3.10/dist-packages/mlxtend/frequent_patterns/apriori.py in apriori(d
f, min_support, use_colnames, max_len, verbose, low_memory)
    239         )
    240
--> 241     fpc.valid_input_check(df)
    242
    243     if hasattr(df, "sparse"):

/usr/local/lib/python3.10/dist-packages/mlxtend/frequent_patterns/fpcommon.py in valid_in
put_check(df, null_values)
    207                     " are True, False, 0, 1, NaN. Found value %s" % (val)
    208                 )
--> 209             raise ValueError(s)
    210
    211

ValueError: The allowed values for a DataFrame are True, False, 0, 1. Found value 45.2544
8109
```

Section 5. Collision Prediction using decision tree

Target Variables

- **Num_of_Injuries**
- **Num_of_Fatal_Injuries**

In [99]:

```
df.head()
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[99]:

	Num_of_Vehicles	Num_of_Pedestrians	Num_of_Bicycles	Num_of_Motorcycles	Num_of_Injuries	Num_of_Fatal_Injuries	
0	1	0	0.0	0.0	0.0	0.0	45.2

	Num_of_Vehicles	Num_of_Pedestrians	Num_of_Bicycles	Num_of_Motorcycles	Num_of_Injuries	Num_of_Fatal_Injuries	
1	2	0	0.0	0.0	0.0	0.0	45.4
2	1	0	0.0	0.0	0.0	0.0	45.3
3	2	0	0.0	0.0	0.0	0.0	45.3
4	2	0	0.0	0.0	0.0	0.0	45.3

In [101]:

```
# Source Code from CIND 123

# First split the data into train and test set
from sklearn.model_selection import train_test_split

# Split dataset into training set and test set
class_col_name='Num_of_Injuries'

feature_names=df.columns[df.columns != class_col_name ]
feature_names = feature_names.drop(['Accident_Timestamp'])


# 70% training and 30% test
X_train, X_test, y_train, y_test = train_test_split(df.loc[:, feature_names], df[class_col_name], test_size=0.3,random_state=1)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `should_run_async` will not call `transform_cell` automatically in the future. Please pass the result to `transformed_cell` argument and any exception that happen during thetransform in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [102]:

```
from sklearn import tree
clf = tree.DecisionTreeClassifier(max_depth=5)
clf = clf.fit(X_train, y_train)
print("Successfuly trained the decision tree...")
```

```
Successfuly trained the decision tree...
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `should_run_async` will not call `transform_cell` automatically in the future. Please pass the result to `transformed_cell` argument and any exception that happen during thetransform in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

In [103]:

```
import graphviz
#Get unique class values to display on the tree
class_values=df[class_col_name].unique()
# Convert class_values to strings
class_values = [str(value) for value in class_values]
print ("class Names",class_values)


dot_data = tree.export_graphviz(clf, out_file=None,
                                feature_names=feature_names,
                                class_names=class_values,
                                filled=True)
# Plot tree
graph = graphviz.Source(dot_data, format="png")
graph
```

```
class Names ['0.0', '1.0', '2.0', '5.0', '6.0', '3.0', '4.0', '8.0', '7.0', '9.0']
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
```

Out[103]:

In [108]:

```
# Confusion Matrix

from sklearn.metrics import confusion_matrix, classification_report

y_pred = clf.predict(X_test)
cf = confusion_matrix(y_test, y_pred)
print("Confusion Matrix")
print(cf)

# Print classification report for precision, recall, F1-score
print(classification_report(y_test, y_pred))

# Instead of unpacking to tn, fp, fn, tp which works for binary classification,
# For multi-class, consider overall metrics like accuracy
from sklearn.metrics import accuracy_score
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531: Undefine
dMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
```

```
Confusion Matrix
[[18300     0     0     0     0     0     0     0     0     0]
 [    0  3118     5     0     0     0     0     0     0     0]
 [    0   700    13     0     2     0     0     0     0     0]
 [    0   140     0     1     0     0     0     0     0     0]
 [    0    32     0     1     0     0     0     0     0     0]
 [    0    17     0     0     0     0     0     0     0     0]
 [    0     6     0     0     0     0     0     0     0     0]
 [    0     2     0     0     0     0     0     0     0     0]
 [    0     2     0     0     0     0     0     0     0     0]
 [    0     1     0     0     0     0     0     0     0     0]]
              precision    recall  f1-score   support

         0.0       1.00      1.00      1.00     18300
         1.0       0.78      1.00      0.87      3123
         2.0       0.72      0.02      0.04       715
         3.0       0.50      0.01      0.01       141
         4.0       0.00      0.00      0.00        33
         5.0       0.00      0.00      0.00        17
         6.0       0.00      0.00      0.00         6
         7.0       0.00      0.00      0.00         2
         8.0       0.00      0.00      0.00         2
         9.0       0.00      0.00      0.00         1

    accuracy                           0.96     22340
   macro avg       0.30      0.20      0.19     22340
weighted avg       0.95      0.96      0.94     22340

Accuracy: 0.9593554162936437
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531: Undefine
dMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted
```

```
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531: Undefine
dMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
```

In [106]:

```
#print precision, recall, and accuracy from the perspective of each of the class (0 and 1
for German dataset)
from sklearn.metrics import classification_report
from sklearn import metrics

print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

         0.0       1.00      1.00      1.00     18300
         1.0       0.78      1.00      0.87      3123
         2.0       0.72      0.02      0.04       715
         3.0       0.50      0.01      0.01       141
         4.0       0.00      0.00      0.00        33
         5.0       0.00      0.00      0.00        17
         6.0       0.00      0.00      0.00         6
         7.0       0.00      0.00      0.00         2
         8.0       0.00      0.00      0.00         2
         9.0       0.00      0.00      0.00         1

    accuracy                           0.96     22340
   macro avg       0.30      0.20      0.19     22340
weighted avg       0.95      0.96      0.94     22340
```

```
/usr/local/lib/python3.10/dist-packages/ipykernel/ipkernel.py:283: DeprecationWarning: `s
hould_run_async` will not call `transform_cell` automatically in the future. Please pass
the result to `transformed_cell` argument and any exception that happen during thetransfo
rm in `preprocessing_exc_tuple` in IPython 7.17 and above.
  and should_run_async(code)
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531: Undefine
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samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531: Undefine
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samples. Use `zero_division` parameter to control this behavior.
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/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531: Undefine
dMetricWarning: Precision is ill-defined and being set to 0.0 in labels with no predicted
samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
```

Section 6. Collision Prediction using Random Forest (to be completed for the final project)

In [ ]:

```
from sklearn.ensemble import RandomForestClassifier
```

Section 7. Result