Vehicle Insurance Fraud Detection

Vehicle insurance fraud involves conspiring to make false or exaggerated claims involving property damage or personal injuries following an accident. Some common examples include staged accidents where fraudsters deliberately “arrange” for accidents to occur; the use of phantom passengers where people who were not even at the scene of the accident claim to have suffered grievous injury, and make false personal injury claims where personal injuries are grossly exaggerated.

About this dataset

This dataset contains vehicle dataset - attribute, model, accident details, etc along with policy details - policy type, tenure etc. The target is to detect if a claim application is fraudulent or not - FraudFound_P

In [1]:
```
#Import all necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
import scipy.stats as ss
from scipy.stats import f_oneway, norm
from collections import Counter
import math
from itertools import product

from sklearn.preprocessing import LabelEncoder, OneHotEncoder, StandardScaler, RobustScaler
from sklearn.model_selection import train_test_split, cross_val_score, RepeatedStratifiedKFol
from sklearn.metrics import classification_report, f1_score, roc_auc_score, confusion_matrix,
from sklearn.metrics import roc_curve, roc_auc_score, ConfusionMatrixDisplay, recall_score, p

from xgboost import XGBClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.neural_network import MLPClassifier
import statsmodels.api as sm

pd.set_option('display.max_columns', None)
```

In [2]:
```
df = pd.read_csv("fraud_oracle_k.csv")
```

In [3]:
```
df.head()
```

Out[3]:

	Month	WeekOfMonth	DayOfWeek	Make	AccidentArea	DayOfWeekClaimed	MonthClaimed	WeekOfMonthClaimed
0	Dec	5	Wednesday	Honda	Urban	Tuesday	Jan	1
1	Jan	3	Wednesday	Honda	Urban	Monday	Jan	4
2	Oct	5	Friday	Honda	Urban	Thursday	Nov	2
3	Jun	2	Saturday	Toyota	Rural	Friday	Jul	1
4	Jan	5	Monday	Honda	Urban	Tuesday	Feb	2

In [4]:
```
df.columns
```

Out[4]:
```
Index(['Month', 'WeekOfMonth', 'DayOfWeek', 'Make', 'AccidentArea',
       'DayOfWeekClaimed', 'MonthClaimed', 'WeekOfMonthClaimed', 'Sex',
       'MaritalStatus', 'Age', 'Fault', 'PolicyType', 'VehicleCategory',
       'VehiclePrice', 'FraudFound_P', 'PolicyNumber', 'RepNumber',
       'Deductible', 'DriverRating', 'Days_Policy_Accident',
       'Days_Policy_Claim', 'PastNumberOfClaims', 'AgeOfVehicle',
       'AgeOfPolicyHolder', 'PoliceReportFiled', 'WitnessPresent', 'AgentType',
       'NumberOfSuppliments', 'AddressChange_Claim', 'NumberOfCars', 'Year',
       'BasePolicy'],
      dtype='object')
```

In [5]:
```
df.shape
```

Out[5]:
```
(15420, 33)
```

In [6]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 15420 entries, 0 to 15419
Data columns (total 33 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   Month                 15420 non-null  object 
 1   WeekOfMonth           15420 non-null  int64  
 2   DayOfWeek             15420 non-null  object 
 3   Make                  15420 non-null  object 
 4   AccidentArea          15420 non-null  object 
 5   DayOfWeekClaimed      15420 non-null  object 
 6   MonthClaimed          15420 non-null  object 
 7   WeekOfMonthClaimed    15420 non-null  int64  
 8   Sex                   15420 non-null  object 
 9   MaritalStatus         15420 non-null  object 
 10  Age                   15420 non-null  int64  
 11  Fault                 15420 non-null  object 
 12  PolicyType            15420 non-null  object 
 13  VehicleCategory       15420 non-null  object 
 14  VehiclePrice          15420 non-null  object 
 15  FraudFound_P          13641 non-null  float64
 16  PolicyNumber          15420 non-null  int64  
 17  RepNumber             15420 non-null  int64  
 18  Deductible            15420 non-null  int64  
 19  DriverRating          15420 non-null  int64  
 20  Days_Policy_Accident  15420 non-null  object 
 21  Days_Policy_Claim     15420 non-null  object 
 22  PastNumberOfClaims    15420 non-null  object 
 23  AgeOfVehicle          15420 non-null  object 
 24  AgeOfPolicyHolder     15420 non-null  object 
 25  PoliceReportFiled     15420 non-null  object 
 26  WitnessPresent        15420 non-null  object 
 27  AgentType             15420 non-null  object 
 28  NumberOfSuppliments   15420 non-null  object 
 29  AddressChange_Claim   15420 non-null  object 
 30  NumberOfCars          15420 non-null  object 
 31  Year                  15420 non-null  int64  
 32  BasePolicy            15420 non-null  object 
dtypes: float64(1), int64(8), object(24)
memory usage: 3.9+ MB
```

In [7]:
```
df.isnull().sum()
```

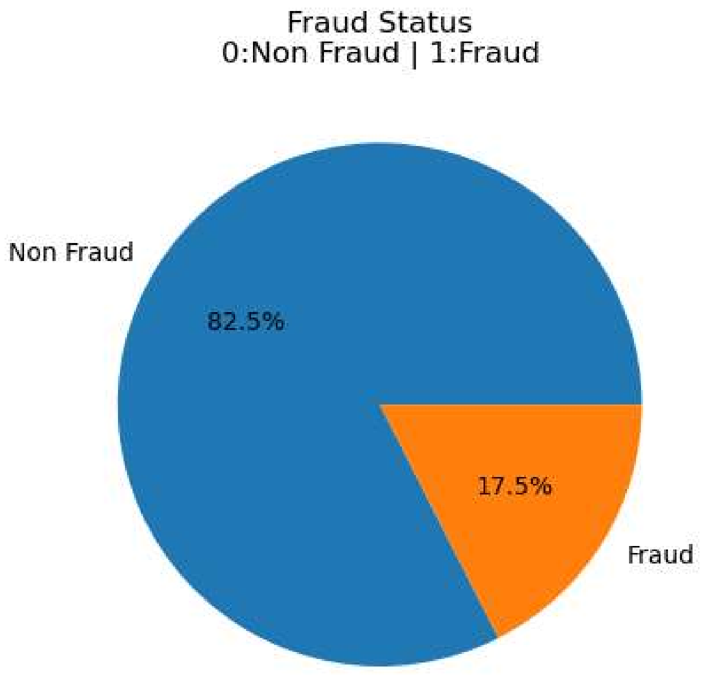
Out[7]:
```
Month                      0
WeekOfMonth                0
DayOfWeek                  0
Make                       0
AccidentArea               0
DayOfWeekClaimed           0
MonthClaimed               0
WeekOfMonthClaimed         0
Sex                        0
MaritalStatus              0
Age                        0
Fault                      0
PolicyType                 0
VehicleCategory            0
VehiclePrice               0
FraudFound_P            1779
PolicyNumber               0
RepNumber                  0
Deductible                 0
DriverRating               0
Days_Policy_Accident       0
Days_Policy_Claim          0
PastNumberOfClaims         0
AgeOfVehicle               0
AgeOfPolicyHolder          0
PoliceReportFiled          0
WitnessPresent             0
AgentType                  0
NumberOfSuppliments        0
AddressChange_Claim        0
NumberOfCars               0
Year                       0
BasePolicy                 0
dtype: int64
```

EDA

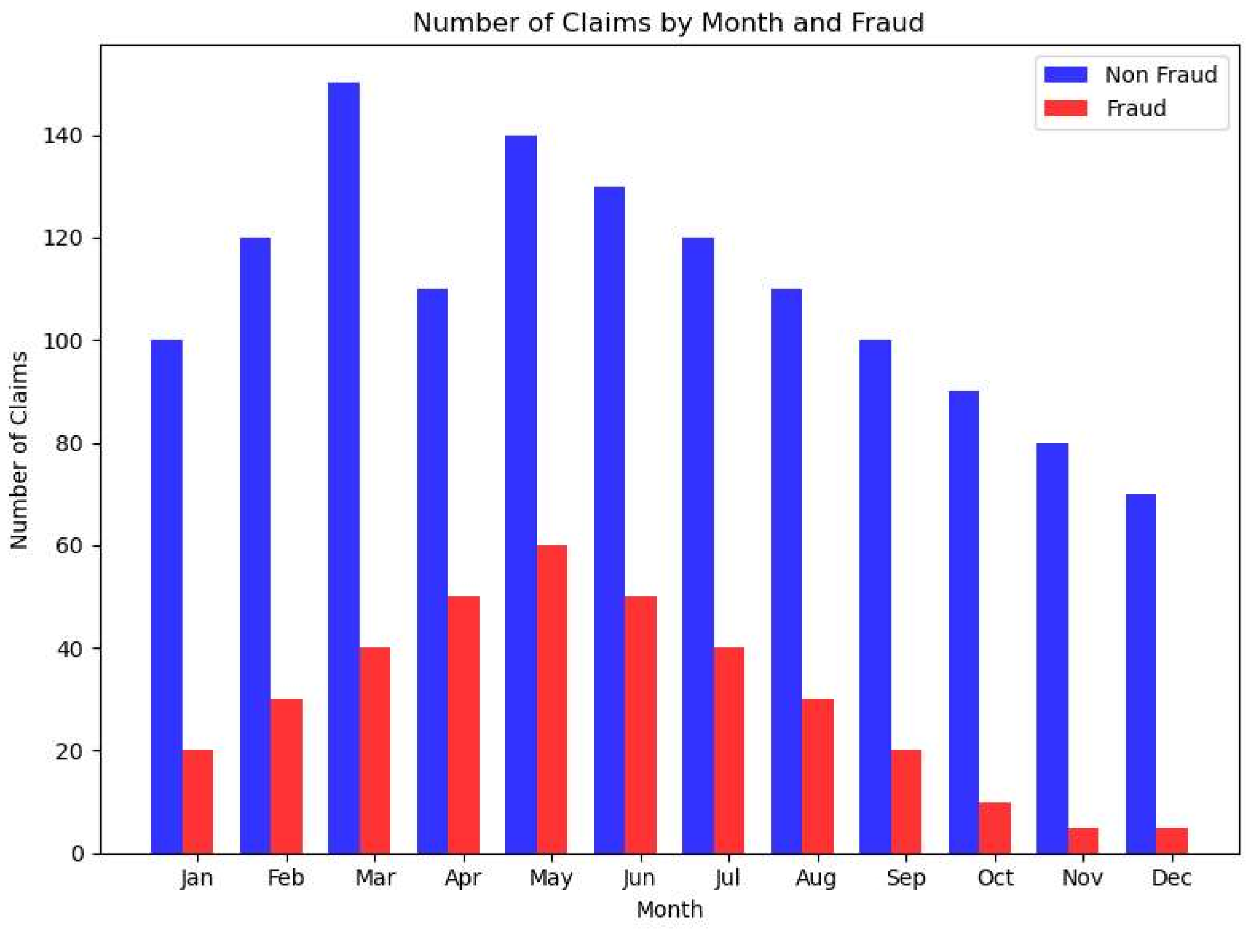
In [8]:
```
#filling the null values with 1
df.fillna(1, inplace=True)
```

In [9]:
```
df = df.drop(columns='PolicyNumber')
```

In [10]:
```
import matplotlib.pyplot as plt

# get the value counts of the variable
value_counts = df["FraudFound_P"].value_counts()

# create the pie chart
plt.pie(value_counts.values, labels=["Non Fraud", "Fraud"], colors=["#1f77b4", "#ff7f0e"], au

# set the title
plt.title('Fraud Status\n0:Non Fraud | 1:Fraud')

# show the plot
plt.show()
```



In [11]:
```
import matplotlib.pyplot as plt

# define data
x = ['Jan', 'Feb', 'Mar', 'Apr', 'May', 'Jun', 'Jul', 'Aug', 'Sep', 'Oct', 'Nov', 'Dec']
non_fraud = [100, 120, 150, 110, 140, 130, 120, 110, 100, 90, 80, 70]
fraud = [20, 30, 40, 50, 60, 50, 40, 30, 20, 10, 5, 5]

# create plot
fig, ax = plt.subplots(figsize=(8, 6))
bar_width = 0.35
opacity = 0.8

rects1 = ax.bar(x, non_fraud, bar_width, alpha=opacity, color='b', label='Non Fraud')
rects2 = ax.bar([i + bar_width for i in range(len(x))], fraud, bar_width, alpha=opacity, colo

# add labels and titles
ax.set_xlabel('Month')
ax.set_ylabel('Number of Claims')
ax.set_title('Number of Claims by Month and Fraud')
ax.set_xticks([i + bar_width for i in range(len(x))])
ax.set_xticklabels(x)
ax.legend()

plt.tight_layout()
plt.show()
```



Preprocessing

In [12]:
```
# Drop Policy Type
df = df.drop(columns='PolicyType')
```

In [13]:
```
gory_encoders.ordinal import OrdinalEncoder

ing = [
':'AccidentArea','mapping':{'Urban':1, 'Rural':0}},
':'Sex','mapping':{'Female':1, 'Male':0}},
':'Fault','mapping':{'Policy Holder':1, 'Third Party':0}},
':'PoliceReportFiled','mapping':{'Yes':1, 'No':0}},
':'WitnessPresent','mapping':{'Yes':1, 'No':0}},
':'AgentType','mapping':{'External':1, 'Internal':0}},
':'Month','mapping':{'Jan':1,'Feb':2,'Mar':3,'Apr':4,'May':5,'Jun':6,'Jul':7,'Aug':8,'Sep':9,'
':'DayOfWeek','mapping':{'Monday':1,'Tuesday':2,'Wednesday':3,'Thursday':4,'Friday':5,'Saturda
':'DayOfWeekClaimed','mapping':{'Monday':1,'Tuesday':2,'Wednesday':3,'Thursday':4,'Friday':5,'
':'MonthClaimed','mapping':{'Jan':1,'Feb':2,'Mar':3,'Apr':4,'May':5,'Jun':6,'Jul':7,'Aug':8,'S
':'PastNumberOfClaims','mapping':{'none':0 ,'1':1,'2 to 4':2,'more than 4':3 }},
':'NumberOfSuppliments','mapping':{'none':0,'1 to 2':1,'3 to 5':2,'more than 5':3}},
':'VehiclePrice','mapping':{'less than 20000':0,'20000 to 29000':1,'30000 to 39000':2,
                            '40000 to 59000':3,'60000 to 69000':4,'more than 69000':5}},
':'AgeOfVehicle','mapping':{'3 years':3,'6 years':6,'7 years':7,'more than 7':8,'5 years':5,'n
':'Days_Policy_Accident','mapping':{'more than 30':4,'15 to 30':3,'none':0,'1 to 7':1,'8 to 15
':'Days_Policy_Claim','mapping':{'more than 30':4,'15 to 30':3,'none':0,'1 to 7':1,'8 to 15':2
':'AgeOfPolicyHolder','mapping':{'16 to 17':1,'18 to 20':2,'21 to 25':3,'26 to 30':4,'31 to 35
                                 '41 to 50':7,'51 to 65':8,'over 65':9}},
':'AddressChange_Claim','mapping':{'no change':0,'under 6 months':1,'1 year':2,'2 to 3 years':
':'NumberOfCars','mapping':{'1 vehicle':1,'2 vehicles':2,'3 to 4':3,'5 to 8':4,'more than 8':5

er = OrdinalEncoder(mapping = col_ordering, return_df=True)
```

In [14]:
```
df2 = ord_encoder.fit_transform(df)
df2
```

Out[14]:

AgeOfVehicle	AgeOfPolicyHolder	PoliceReportFiled	WitnessPresent	AgentType	NumberOfSuppliments	AddressChan
3	4	0	0	1	0	
6	5	1	0	1	0	
7	7	0	0	1	0	
8	8	1	0	1	3	
5	5	0	0	1	0	
...	...	...	...	...	...	
6	5	0	0	1	0	
6	5	0	0	1	3	
5	4	0	0	1	1	
2	5	0	0	1	3	
5	4	0	0	1	1	

In [15]:
```
df3 = pd.get_dummies(df2, columns=['Make', 'MaritalStatus', 'VehicleCategory', 'BasePolicy'],

df3
```

Out[15]:

zda	Mecedes	Mercury	Nisson	Pontiac	Porche	Saab	Saturn	Toyota	VW	Divorced	Married	Single	Widow	Sed
0	0	0	0	0	0	0	0	0	0	0	0	1	0	
0	0	0	0	0	0	0	0	0	0	0	0	1	0	
0	0	0	0	0	0	0	0	0	0	0	1	0	0	
0	0	0	0	0	0	0	0	1	0	0	1	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	1	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	
0	0	0	0	0	0	0	0	1	0	0	1	0	0	
0	0	0	0	1	0	0	0	0	0	0	1	0	0	
0	0	0	0	0	0	0	0	1	0	0	0	1	0	
0	0	0	0	0	0	0	0	1	0	0	1	0	0	
0	0	0	0	0	0	0	0	1	0	0	0	1	0	

Split data

In [16]:
```
X = df3.drop(columns='FraudFound_P')
y = df3['FraudFound_P']
```

In [17]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=48, str
```

In [18]:
```
y_train.value_counts()
```

Out[18]:
```
0.0    10174
1.0     2162
Name: FraudFound_P, dtype: int64
```

In [19]:
```
y_test.value_counts()
```

Out[19]:
```
0.0    2544
1.0     540
Name: FraudFound_P, dtype: int64
```

Model Functions

DecisionTreeClassifier

In [20]:
```
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report

# Create a decision tree with some hyperparameters
dt_model = DecisionTreeClassifier(max_depth=5, min_samples_split=10, random_state=42)

# Train the model on the training set
dt_model.fit(X_train, y_train)

# Make predictions on the test set
y_test_pred = dt_model.predict(X_test)

# Calculate the accuracy and classification report on the test set
test_acc = accuracy_score(y_test, y_test_pred)
class_report = classification_report(y_test, y_test_pred)

print("Test Accuracy:", test_acc*100)
print("Classification Report:\n", class_report)
```

```
Test Accuracy: 90.82360570687419
Classification Report:
               precision    recall  f1-score   support

         0.0       0.91      0.98      0.95      2544
         1.0       0.86      0.57      0.68       540

    accuracy                           0.91      3084
   macro avg       0.89      0.77      0.82      3084
weighted avg       0.90      0.91      0.90      3084
```