assignment-11-02-02-2024-clamaint

February 5, 2024

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1.1 22MSRDS007

[1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import statsmodels.api as sm
from statsmodels.stats.outliers_influence import variance_inflation_factor
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, classification_report,␣
↪confusion_matrix
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import classification_report, confusion_matrix
from sklearn.model_selection import GridSearchCV

import warnings
warnings.simplefilter("ignore")
warnings.simplefilter(action='ignore', category=FutureWarning)
warnings.filterwarnings("ignore", category=UserWarning)
```

[2]:
```
# Load the dataset
df = pd.read_csv('D:/Chools/Day_06/claimants.csv')
```

1.1.1 1. Exploratory Data Analysis (EDA):

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

[3]:

	CASENUM	ATTORNEY	CLMSEX	CLMINSUR	SEATBELT	CLMAGE	LOSS
0	5	0	0.0	1.0	0.0	50.0	34.940
1	3	1	1.0	0.0	0.0	18.0	0.891
2	66	1	0.0	1.0	0.0	5.0	0.330
3	70	0	0.0	1.0	1.0	31.0	0.037
4	96	1	0.0	1.0	0.0	30.0	0.038

[4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1340 entries, 0 to 1339
Data columns (total 7 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   CASENUM   1340 non-null   int64  
 1   ATTORNEY  1340 non-null   int64  
 2   CLMSEX    1328 non-null   float64
 3   CLMINSUR  1299 non-null   float64
 4   SEATBELT  1292 non-null   float64
 5   CLMAGE    1151 non-null   float64
 6   LOSS      1340 non-null   float64
dtypes: float64(5), int64(2)
memory usage: 73.4 KB
```

[5]:
```
df.isnull().sum()
```

[5]:
```
CASENUM       0
ATTORNEY      0
CLMSEX       12
CLMINSUR     41
SEATBELT     48
CLMAGE      189
LOSS          0
dtype: int64
```

[6]:
```
# 1. Input mean for 'CLMAGE'
df['CLMAGE'].fillna(df['CLMAGE'].mean(), inplace=True)

# 2. Input median for 'CLMSEX', 'CLMINSUR', 'SEATBELT'
df['CLMSEX'].fillna(df['CLMSEX'].median(), inplace=True)
df['CLMINSUR'].fillna(df['CLMINSUR'].median(), inplace=True)
df['SEATBELT'].fillna(df['SEATBELT'].median(), inplace=True)

# Verify the changes
print(df.isnull().sum())
```

```
CASENUM     0
ATTORNEY    0
CLMSEX      0
CLMINSUR    0
SEATBELT    0
CLMAGE      0
LOSS        0
dtype: int64
```

[7]:
```
# Assuming your dataframe is named 'df'
unique_values_count = df.nunique()

# Print the number of unique values for each column
print("Number of Unique Values in Each Column:")
print(unique_values_count)
```

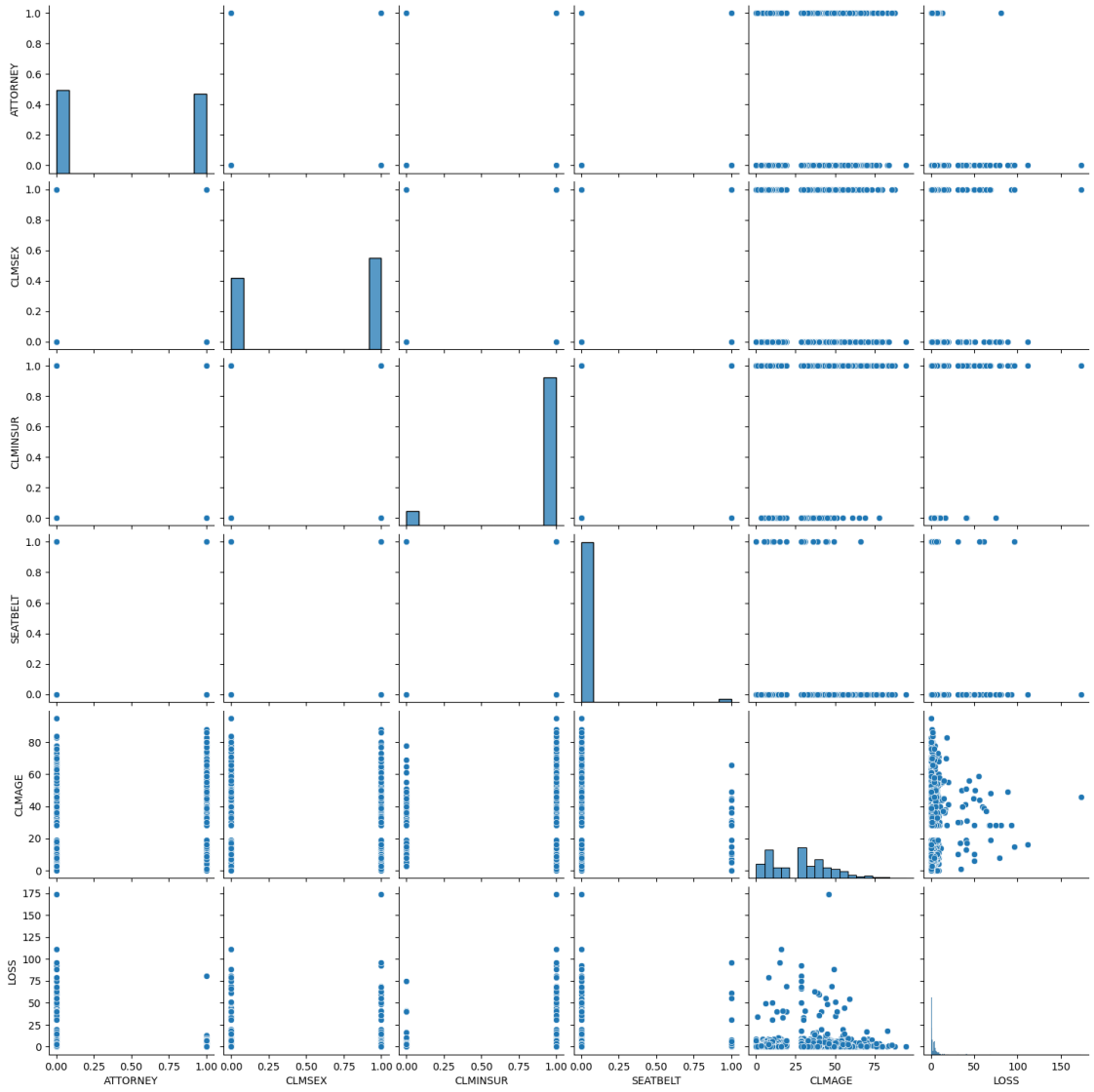
```
Number of Unique Values in Each Column:
CASENUM     1283
ATTORNEY       2
CLMSEX         2
CLMINSUR       2
SEATBELT       2
CLMAGE        69
LOSS         916
dtype: int64
```

[8]:
```
df.isnull().sum()
```

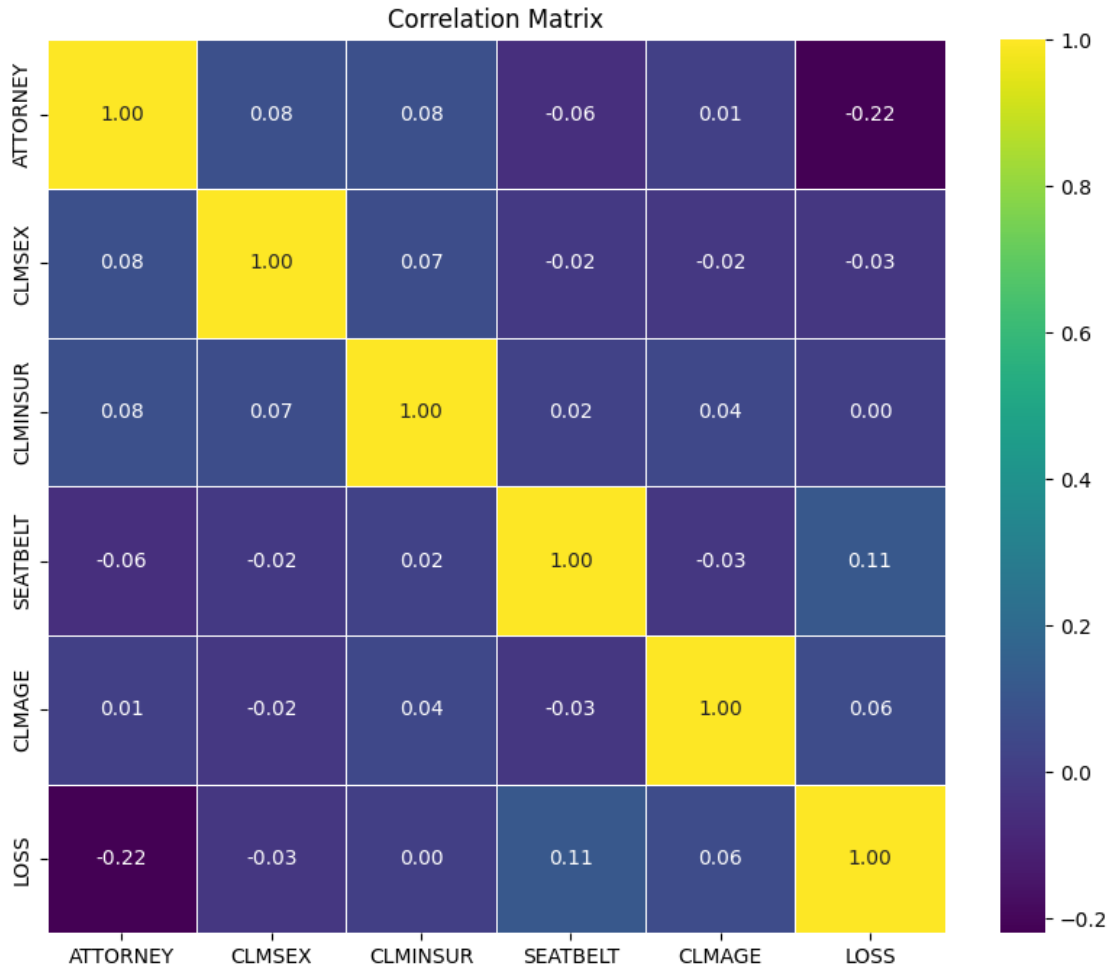
[8]:
```
CASENUM     0
ATTORNEY    0
CLMSEX      0
CLMINSUR    0
SEATBELT    0
CLMAGE      0
LOSS        0
dtype: int64
```

[9]:
```
df=df.drop('CASENUM',axis=1)
```

[10]:
```
# Pairplot with Viridis color palette
sns.pairplot(df)
plt.show()
```

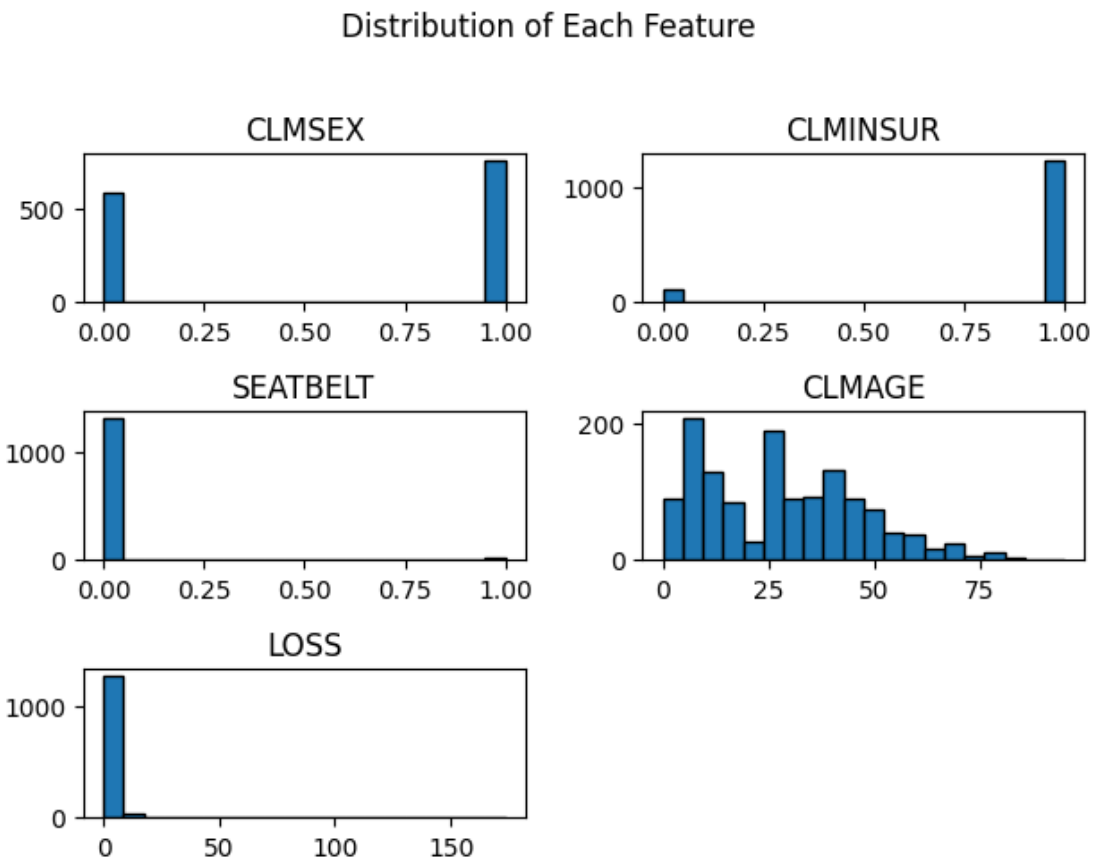


[11]:
```
# Correlation matrix heatmap
correlation_matrix = df.corr()
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='viridis', fmt=".2f",␣
 ↪linewidths=0.5)
plt.title('Correlation Matrix')
plt.show()
```

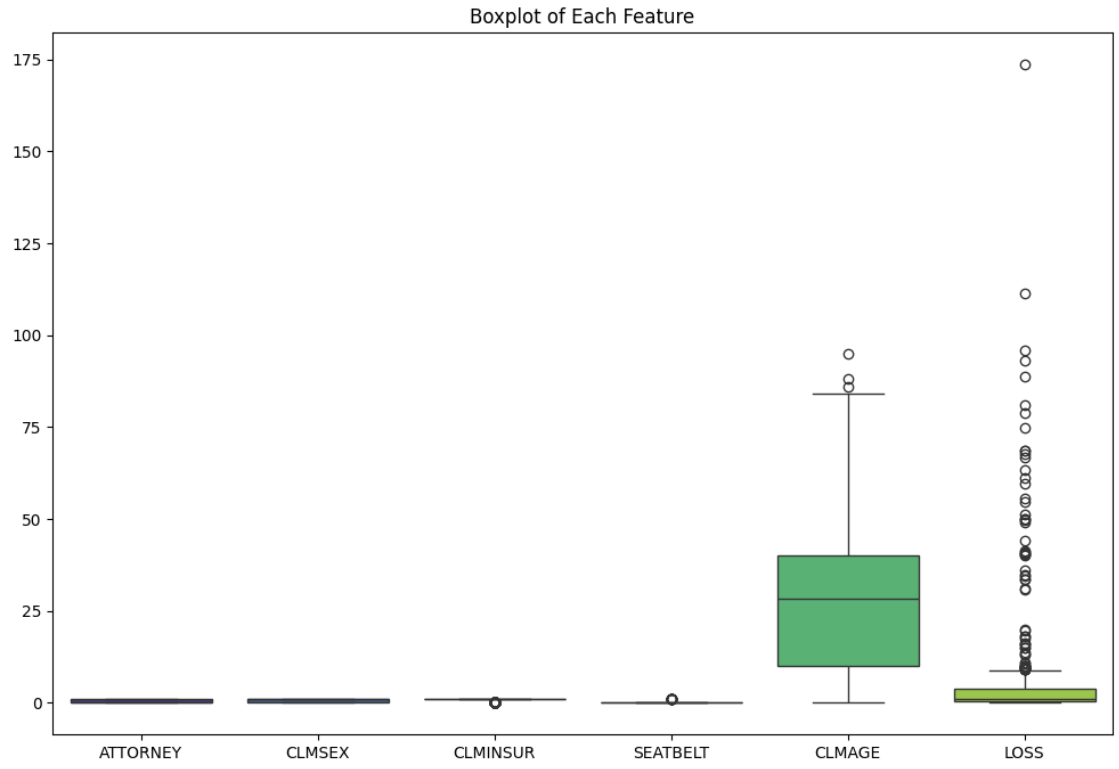


[12]:
```
# Distribution of each feature
plt.figure(figsize=(12, 8))
df.drop('ATTORNEY', axis=1).hist(bins=20, edgecolor='black', grid=False)
plt.suptitle('Distribution of Each Feature', y=1.02)
plt.tight_layout()
plt.show()
```

```
<Figure size 1200x800 with 0 Axes>
```

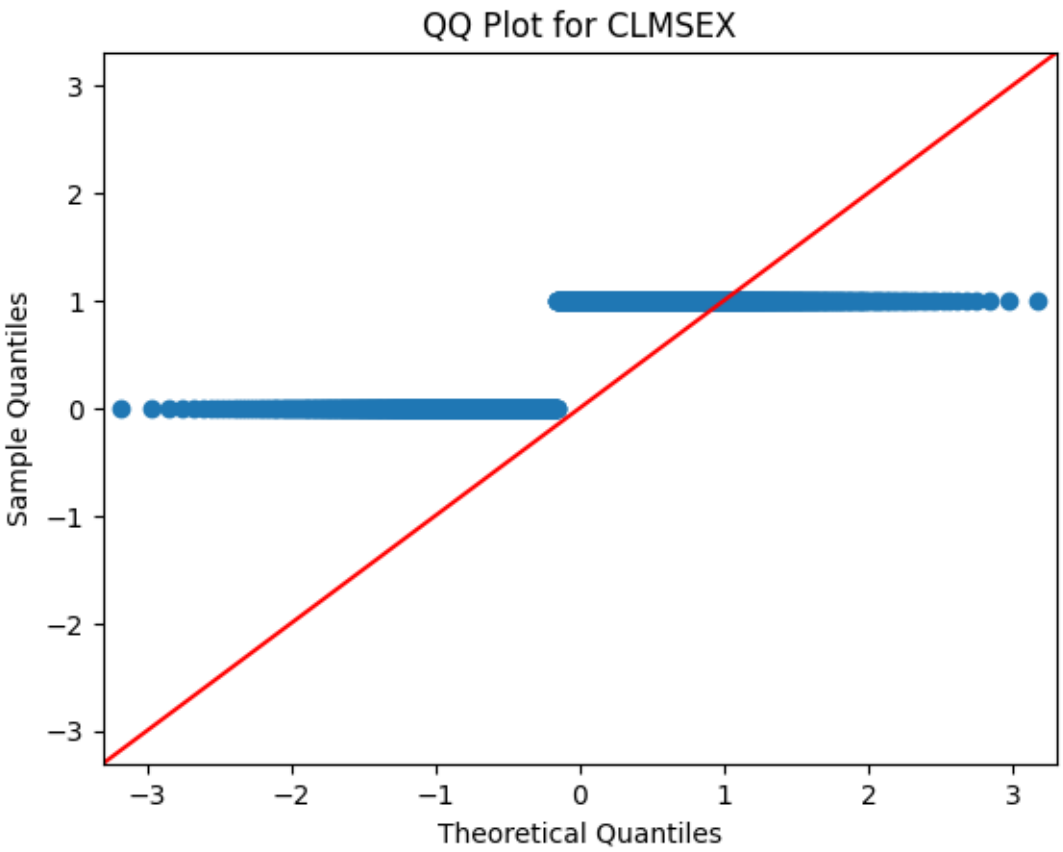


[13]:
```
# Boxplot for each feature
plt.figure(figsize=(12, 8))
sns.boxplot(data=df, palette='viridis')
plt.title('Boxplot of Each Feature')
plt.show()
```

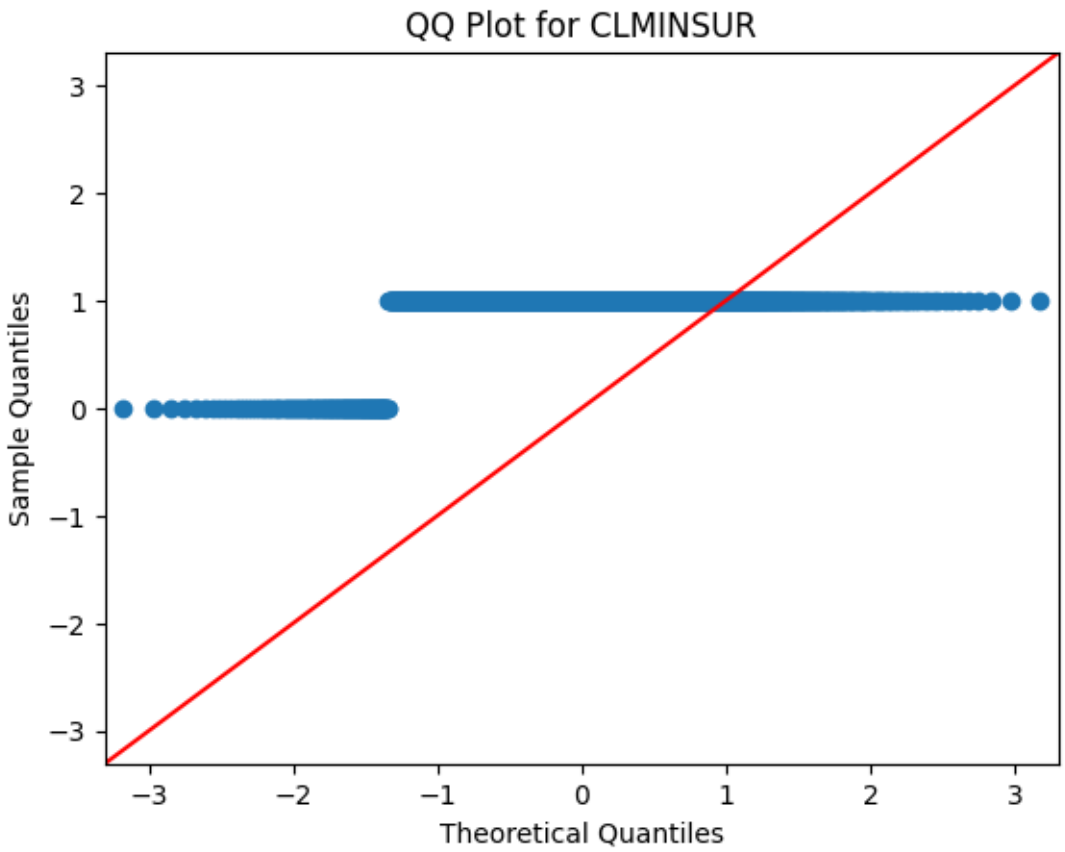


[14]:
```
# QQ plot for each feature
for feature in df.columns:
    if feature not in ['CASENUM', 'ATTORNEY']:
        plt.figure(figsize=(6, 4))
        sm.qqplot(df[feature], line='45')
        plt.title(f'QQ Plot for {feature}')
        plt.show()
```

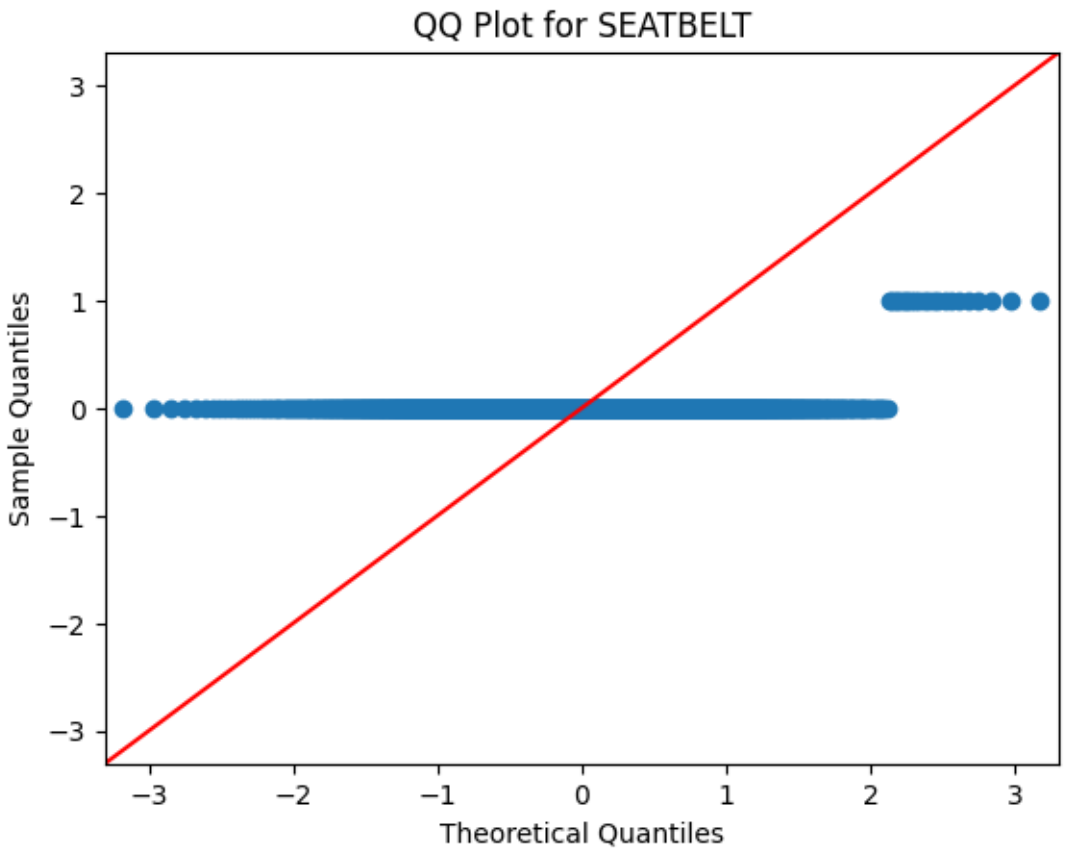
```
<Figure size 600x400 with 0 Axes>
```



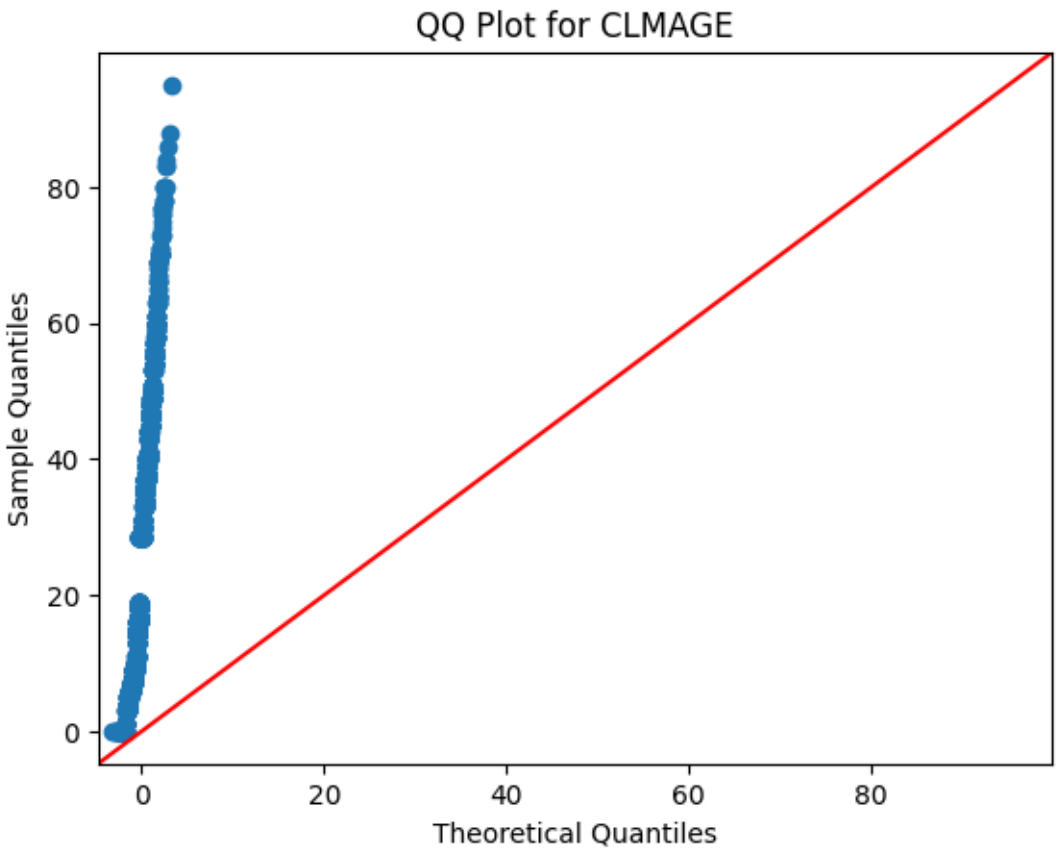
<Figure size 600x400 with 0 Axes>



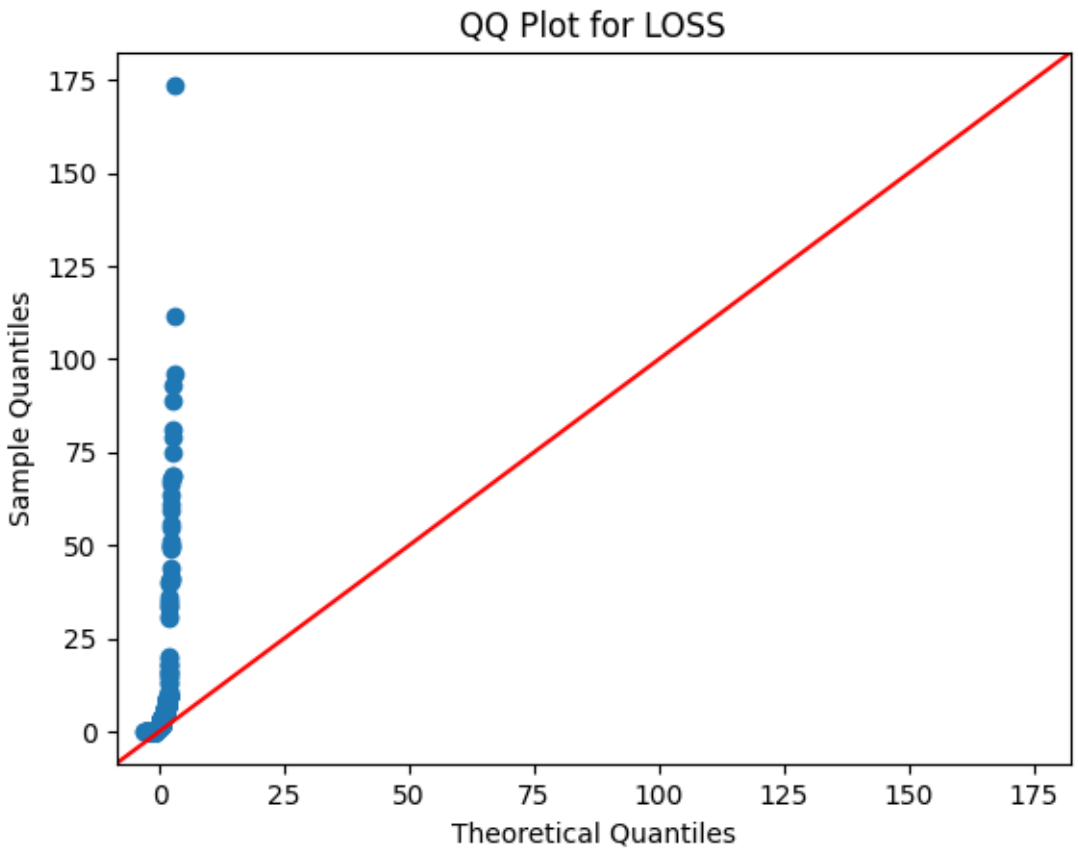
<Figure size 600x400 with 0 Axes>



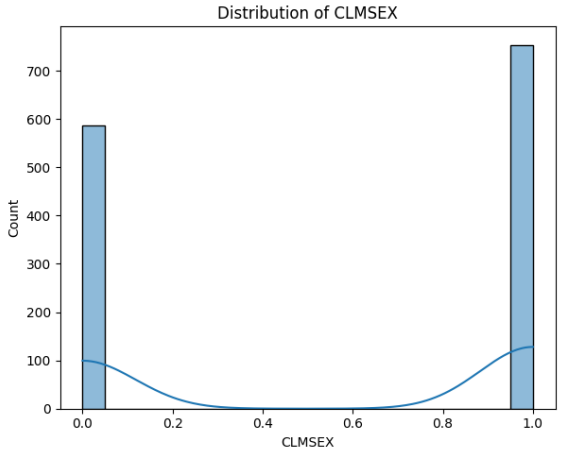
<Figure size 600x400 with 0 Axes>

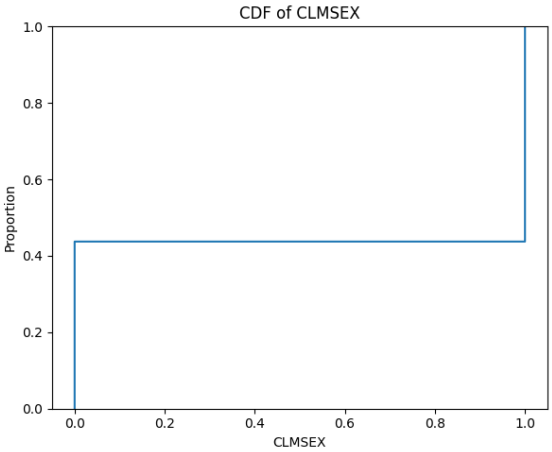


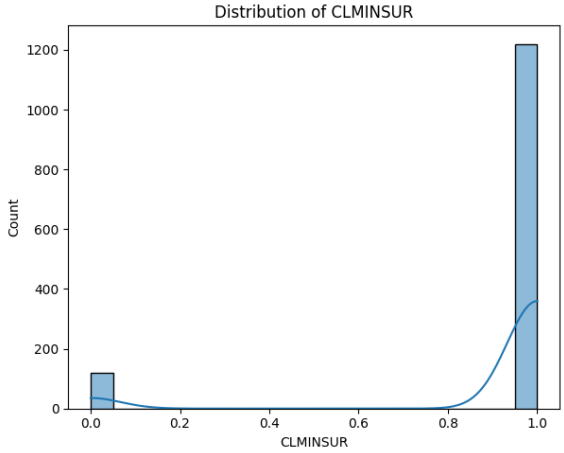

```
<Figure size 600x400 with 0 Axes>
```

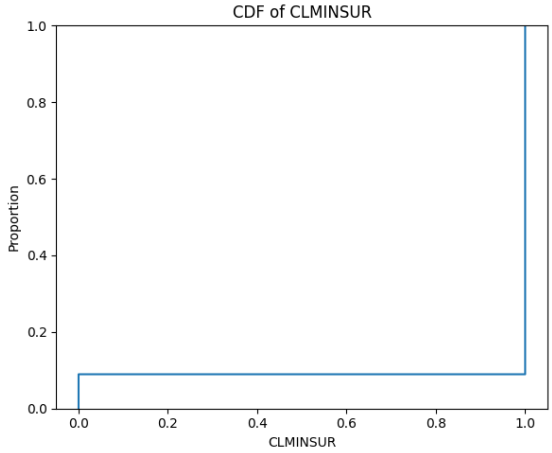


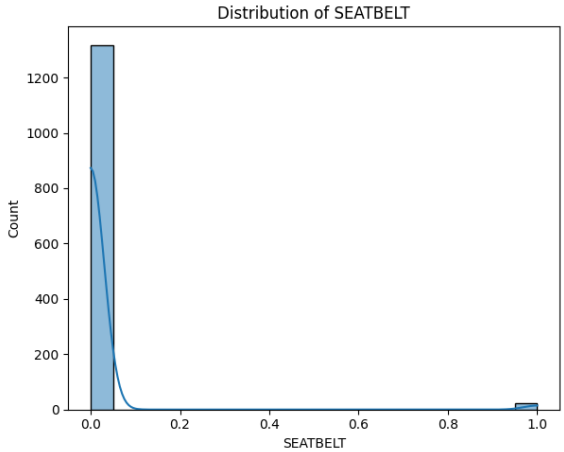
[15]:
```python
# Individual feature distributions and CDFs
for feature in df.columns:
    if feature not in ['CASENUM', 'ATTORNEY']:
        plt.figure(figsize=(12, 5))

        # Distribution plot
        plt.subplot(1, 2, 1)
        sns.histplot(df[feature], kde=True, bins=20)
        plt.title(f'Distribution of {feature}')

        # CDF plot
        plt.subplot(1, 2, 2)
        sns.ecdfplot(df[feature])
        plt.title(f'CDF of {feature}')

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

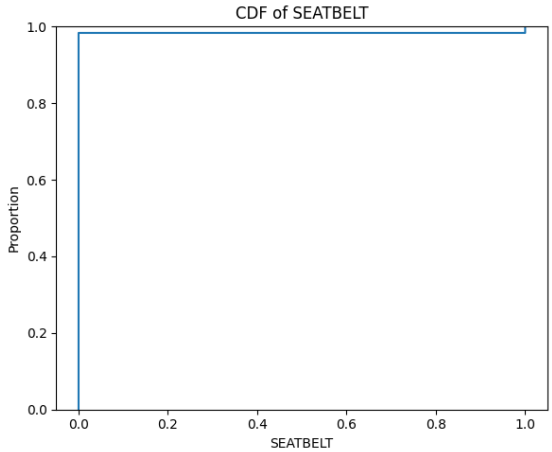

Distribution of CLMSEX
Count
CLMSEX

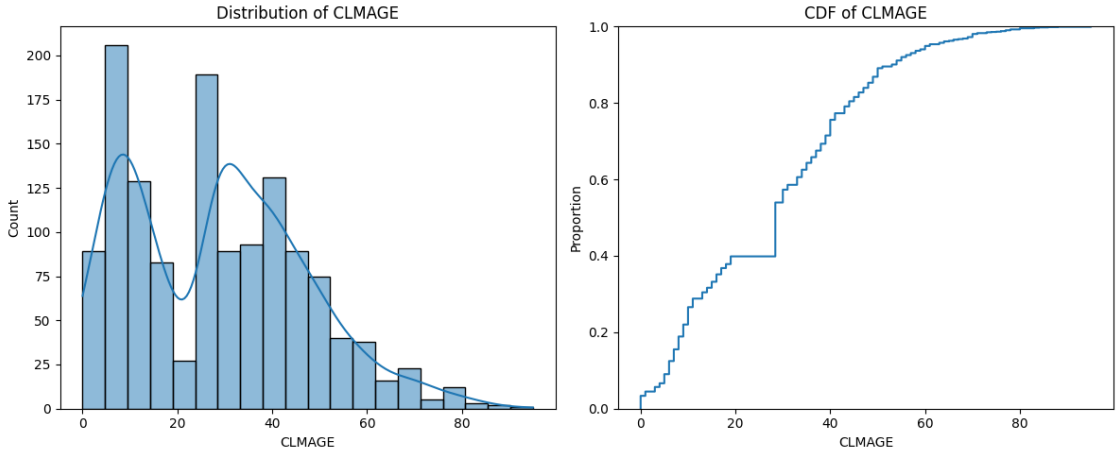

CDF of CLMSEX
Proportion
CLMSEX

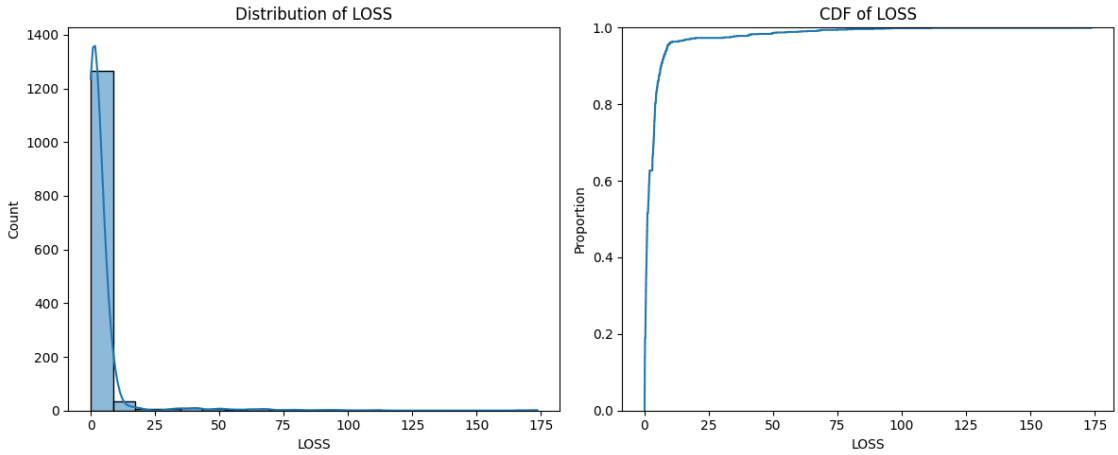

Distribution of CLMINSUR
Count
CLMINSUR


CDF of CLMINSUR
Proportion
CLMINSUR


Distribution of SEATBELT
Count
SEATBELT


CDF of SEATBELT
Proportion
SEATBELT





1.1.2 checking VIF

[16]:
```
# Assuming X contains the predictor variables
VIF = df.drop('ATTORNEY', axis=1)

# Calculate VIF for each predictor variable
vif_data = pd.DataFrame()
vif_data["Variable"] = VIF.columns
vif_data["VIF"] = [variance_inflation_factor(VIF.values, i) for i in range(VIF.
  ↪shape[1])]

# Display the VIF values
print(vif_data)
```

```
   Variable       VIF
```

```
0    CLMSEX  2.146477
1  CLMINSUR  3.809952
2  SEATBELT  1.030784
3    CLMAGE  2.859328
4      LOSS  1.141058
```

[17]:
```python
import numpy as np

# Calculate Z-scores for each column
z_scores = np.abs((df - df.mean()) / df.std())

# Define a threshold for outliers (e.g., Z-score greater than 3)
outlier_threshold = 3

# Identify outliers for each column
outliers = (z_scores > outlier_threshold).sum()

# Display the count of outliers for each column
print("Number of outliers for each column:")
print(outliers)
```

```
Number of outliers for each column:
ATTORNEY      0
CLMSEX        0
CLMINSUR    120
SEATBELT     22
CLMAGE        3
LOSS         30
dtype: int64
```

[18]:
```python
from scipy.stats.mstats import winsorize

# Set the threshold for winsorization (e.g., 5% from both ends)
winsorization_threshold = 0.05

# Apply winsorization to columns with outliers
columns_with_outliers = ['CLMINSUR', 'SEATBELT', 'CLMAGE', 'LOSS']

for column in columns_with_outliers:
    winsorized_values = winsorize(df[column], limits=winsorization_threshold)
    df[column] = winsorized_values

# Verify the changes
print(df.describe())
```

```
          ATTORNEY       CLMSEX     CLMINSUR  SEATBELT       CLMAGE  \
count  1340.000000  1340.000000  1340.000000    1340.0  1340.000000
mean      0.488806     0.562687     0.910448       0.0    28.038303
```

```
std       0.500061     0.496240     0.285646       0.0    17.525390
min       0.000000     0.000000     0.000000       0.0     3.000000
25%       0.000000     0.000000     1.000000       0.0    10.000000
50%       0.000000     1.000000     1.000000       0.0    28.414422
75%       1.000000     1.000000     1.000000       0.0    40.000000
max       1.000000     1.000000     1.000000       0.0    61.000000
```

```
              LOSS
count  1340.000000
mean      2.368237
std       2.562772
min       0.040000
25%       0.400000
50%       1.069500
75%       3.781500
max       8.801000
```

1.1.3 3. Model Fitting:

[19]:
```
X = df.drop('ATTORNEY', axis=1)
y = df['ATTORNEY']
```

[20]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

2 decision Tree

[21]:
```
decision_tree = DecisionTreeClassifier(max_depth=3, min_samples_split=5,␣
 ↪min_samples_leaf=2, class_weight='balanced')
decision_tree.fit(X_train, y_train)

y_pred_decision_tree = decision_tree.predict(X_test)

accuracy = accuracy_score(y_test, y_pred_decision_tree)
print(f"Decision Tree Accuracy: {accuracy}")
```

```
Decision Tree Accuracy: 0.7350746268656716
```

[22]:
```
bins = [0, 18, 35, 50, 100]
labels = ['0-18', '19-35', '36-50', '51-100']
df['CLMAGE_GROUP'] = pd.cut(df['CLMAGE'], bins=bins, labels=labels, right=False)
df = pd.get_dummies(df, columns=['CLMAGE_GROUP'], prefix='CLMAGE_GROUP',␣
 ↪drop_first=True)
```

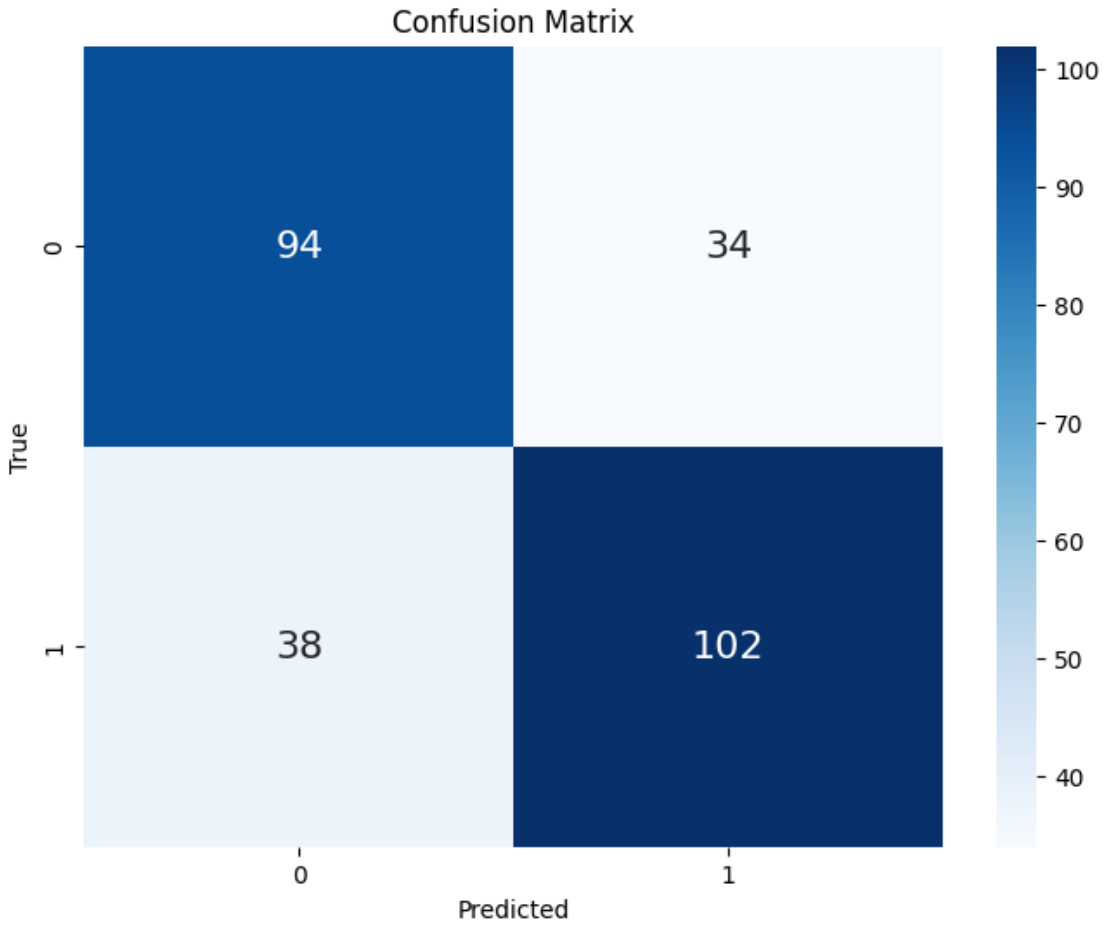
[23]:
```
param_grid = {
 'criterion': ['gini', 'entropy'],
```

```
 'max_depth': [3],
 'min_samples_split': [5],
 'min_samples_leaf': [2],
 'class_weight': ['balanced']
}


dt_model = DecisionTreeClassifier(random_state=42)

grid_search = GridSearchCV(dt_model, param_grid, cv=5, scoring='accuracy')
grid_search.fit(X_train, y_train)
best_params = grid_search.best_params_

dt_model_best = DecisionTreeClassifier(random_state=42, **best_params)
dt_model_best.fit(X_train, y_train)
y_pred_best = dt_model_best.predict(X_test)

accuracy_best = accuracy_score(y_test, y_pred_best)
conf_matrix_best = confusion_matrix(y_test, y_pred_best)
classification_rep_best = classification_report(y_test, y_pred_best)

print(f"Best Parameters: {best_params}")
print(f"Accuracy after tuning: {accuracy_best:.2f}")
print(f"Confusion Matrix:\n{conf_matrix_best}")
print(f"Classification Report:\n{classification_rep_best}")
```

```
Best Parameters: {'class_weight': 'balanced', 'criterion': 'entropy',
'max_depth': 3, 'min_samples_leaf': 2, 'min_samples_split': 5}
Accuracy after tuning: 0.73
Confusion Matrix:
[[ 94  34]
 [ 38 102]]
Classification Report:
              precision    recall  f1-score   support

           0       0.71      0.73      0.72       128
           1       0.75      0.73      0.74       140

    accuracy                           0.73       268
   macro avg       0.73      0.73      0.73       268
weighted avg       0.73      0.73      0.73       268
```

[24]:
```
plt.figure(figsize=(8, 6))
sns.heatmap(conf_matrix_best, annot=True, fmt='d', cmap='Blues',␣
 ↪annot_kws={"size": 16})
plt.title('Confusion Matrix')
```

```
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```



2.1 Random Forest

[25]:
```
from sklearn.ensemble import RandomForestClassifier

# Initialize the Random Forest model with pre-pruning parameters
rf_model = RandomForestClassifier(n_estimators=100,max_depth=3,␣
 ↪min_samples_split=5, min_samples_leaf=2, class_weight='balanced',␣
 ↪random_state=42)

# Fit the Random Forest model
rf_model.fit(X_train, y_train)

# Make predictions on the test set
```

```
y_pred_rf = rf_model.predict(X_test)

# Evaluate the Random Forest model
accuracy_rf = accuracy_score(y_test, y_pred_rf)
print(f"Accuracy (Random Forest): {accuracy_rf}")
```

```
Accuracy (Random Forest): 0.7425373134328358
```

2.2 isolation forest

[26]:
```
X = df.drop(columns=['ATTORNEY'])
y = df['ATTORNEY']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.25,␣
↪random_state=42)
```

[27]:
```
from sklearn.ensemble import IsolationForest

iso_forest = IsolationForest(contamination=0.01)
iso_forest.fit(X_train)
```

[27]:
```
IsolationForest(contamination=0.01)
```

[28]:
```
iso_forest = IsolationForest(contamination=0.01)
iso_forest.fit(X_train)
```

[28]:
```
IsolationForest(contamination=0.01)
```

[29]:
```
y_pred = iso_forest.predict(X_test)
```

[30]:
```
y_pred_binary = [1 if pred == 1 else 0 for pred in y_pred]
```

[31]:
```
print(y_pred_binary)
```

```
[1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
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1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
```

[32]:
```
import matplotlib.pyplot as plt
sns.scatterplot(x=range(len(y_pred_binary)), y=y_pred_binary)
plt.show()
```