Md.Tanbin Emon

In [11]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount
("/content/drive", force_remount=True).
```

In [12]:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler, LabelEncoder, OneHotEncoder
from sklearn.impute import SimpleImputer
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.metrics import classification_report, accuracy_score
```

In [13]:

```
data = pd.read_csv("/content/drive/MyDrive/eadg /Final/Sample_Data_AI_Lab_Final.xlsx - Sh
eet1.csv")
```

Handle Missing Values

In [15]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5986 entries, 0 to 5985
Data columns (total 11 columns):
 #   Column            Non-Null Count  Dtype  
---  ------            --------------  -----  
 0   MultipleLines     5986 non-null   int64  
 1   InternetService   5986 non-null   int64  
 2   OnlineSecurity    5986 non-null   int64  
 3   OnlineBackup      5986 non-null   int64  
 4   DeviceProtection  5986 non-null   int64  
 5   TechSupport       5986 non-null   int64  
 6   StreamingTV       5986 non-null   int64  
 7   StreamingMovies   5986 non-null   int64  
 8   MonthlyCharges    5986 non-null   float64
 9   TotalCharges      5986 non-null   object 
 10  Contract          5986 non-null   object 
dtypes: float64(1), int64(8), object(2)
memory usage: 514.5+ KB
```

In [16]:

```
data.columns
```

Out[16]:

```
Index(['MultipleLines', 'InternetService', 'OnlineSecurity', 'OnlineBackup',
       'DeviceProtection', 'TechSupport', 'StreamingTV', 'StreamingMovies',
       'MonthlyCharges', 'TotalCharges', 'Contract'],
      dtype='object')
```

In [17]:

```
data.isnull().sum()
```

Out[17]:

	0
MultipleLines	0
InternetService	0
OnlineSecurity	0
OnlineBackup	0
DeviceProtection	0
TechSupport	0
StreamingTV	0
StreamingMovies	0
MonthlyCharges	0
TotalCharges	0
Contract	0

dtype: int64

In [18]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
```

Encoding Categorical Variables

In [31]:

```
# Apply One-Hot Encoding
data_one_hot = pd.get_dummies(data, columns=['Contract'], drop_first=True)

# Check the transformed data
print(data_one_hot.head())
```

```
   MultipleLines  InternetService  OnlineSecurity  OnlineBackup  \
0              1                0               3             3   
1              0                2               0             1   
2              1                2               0             0   
3              0                1               0             0   
4              0                1               1             0   

   DeviceProtection  TechSupport  StreamingTV  StreamingMovies  \
0                 3            3            3                3   
1                 1            0            1                0   
2                 0            0            0                0   
3                 0            0            0                1   
4                 1            0            0                0   

   MonthlyCharges TotalCharges  Contract_0.5  Contract_1.0  
0           24.10      1734.65         False          True  
1           88.15       3973.2         False         False  
2           74.95      2869.85         False         False  
3           55.90        238.5         False         False  
4           53.45        119.5         False         False  
```

In [51]:

```
data
```

Out[51]:

	MultipleLines	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMo

0	MultipleLines	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMo
	1	0	3	3	3	3	3	
1	0	2	0	1	1	0	1	
2	1	2	0	0	0	0	0	
3	0	1	0	0	0	0	0	
4	0	1	1	0	1	0	0	
...	...	...	...	...	...	...	...	
5981	0	2	1	0	0	0	1	
5982	1	1	1	1	1	1	1	
5983	0	0	3	3	3	3	3	
5984	1	2	0	0	1	0	1	
5985	0	0	3	3	3	3	3	

5986 rows × 11 columns

In [20]:

```
data
```

Out[20]:

	MultipleLines	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMo
0	1	0	3	3	3	3	3	
1	0	2	0	1	1	0	1	
2	1	2	0	0	0	0	0	
3	0	1	0	0	0	0	0	
4	0	1	1	0	1	0	0	
...	...	...	...	...	...	...	...	
5981	0	2	1	0	0	0	1	
5982	1	1	1	1	1	1	1	
5983	0	0	3	3	3	3	3	
5984	1	2	0	0	1	0	1	
5985	0	0	3	3	3	3	3	

5986 rows × 11 columns

Feature Scaling

In [32]:

```python
from sklearn.preprocessing import LabelEncoder

label_encoder = LabelEncoder()

data['Contract'] = label_encoder.fit_transform(data['Contract'])

from sklearn.preprocessing import MinMaxScaler

min_max_scaler = MinMaxScaler()
contract_values = data['Contract'].values.reshape(-1, 1)
data['Contract'] = min_max_scaler.fit_transform(contract_values)

print(data['Contract'].head())
```

```
0    1.0
1    0.0
2    0.0
3    0.0
4    0.0
Name: Contract, dtype: float64
```

In [33]:

```python
data
```

Out[33]:

	MultipleLines	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMo
0	1	0	3	3	3	3	3	
1	0	2	0	1	1	0	1	
2	1	2	0	0	0	0	0	
3	0	1	0	0	0	0	0	
4	0	1	1	0	1	0	0	
...	...	...	...	...	...	...	...	
5981	0	2	1	0	0	0	1	
5982	1	1	1	1	1	1	1	
5983	0	0	3	3	3	3	3	
5984	1	2	0	0	1	0	1	
5985	0	0	3	3	3	3	3	

5986 rows × 11 columns

Dataset Splitting

In [34]:

```python
from sklearn.model_selection import train_test_split

X = data[[ 'MultipleLines', 'InternetService', 'OnlineSecurity', 'OnlineBackup',
       'DeviceProtection', 'TechSupport', 'StreamingTV', 'StreamingMovies',
       'MonthlyCharges', 'TotalCharges'
       ]]
y = data['Contract']

X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42, stratify=y
)

# Display the shapes of the resulting datasets
print("Training Features Shape:", X_train.shape)
print("Testing Features Shape:", X_test.shape)
print("Training Target Shape:", y_train.shape)
print("Testing Target Shape:", y_test.shape)
```

```
Training Features Shape: (4788, 10)
Testing Features Shape: (1198, 10)
Training Target Shape: (4788,)
Testing Target Shape: (1198,)
```

In [27]:

```
data
```

Out[27]:

	MultipleLines	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMo
0	1	0	3	3	3	3	3	
1	0	2	0	1	1	0	1	
2	1	2	0	0	0	0	0	
3	0	1	0	0	0	0	0	
4	0	1	1	0	1	0	0	
...	...	...	...	...	...	...	...	
5981	0	2	1	0	0	0	1	
5982	1	1	1	1	1	1	1	
5983	0	0	3	3	3	3	3	
5984	1	2	0	0	1	0	1	
5985	0	0	3	3	3	3	3	

5986 rows × 11 columns

In [35]:

```
print("Training Features Shape:", X_train)
print("Testing Features Shape:", X_test)
print("Training Target Shape:", y_train)
print("Testing Target Shape:", y_test)
```

```
Training Features Shape:       MultipleLines   InternetService   OnlineSecurity   OnlineBack
up  \
4779              1                2               0             1
685               1                2               0             1
2993              1                1               1             0
3146              1                1               1             1
35                3                1               0             1
...             ...              ...             ...           ...
5876              1                2               0             0
4093              3                1               0             1
2496              1                2               0             1
4163              1                2               1             0
2572              0                2               1             0

      DeviceProtection  TechSupport  StreamingTV  StreamingMovies  \
4779                 0            0            1                1
685                  1            0            1                1
2993                 1            0            1                1
3146                 1            1            0                1
35                   0            1            0                0
...                ...          ...          ...              ...
5876                 1            1            0                0
4093                 1            0            1                1
2496                 0            0            0                0
4163                 0            0            1                1
2572                 0            0            0                0

      MonthlyCharges TotalCharges
4779           99.00      4744.35
```

```
4779           99.00      4744.35
685           104.75      5510.65
2993           79.70       5293.4
3146           79.90       3326.2
35             35.65        425.1
...              ...          ...
5876           86.75      1410.25
4093           55.45      2966.95
2496           79.15        79.15
4163           99.60       347.65
2572           73.60         73.6

[4788 rows x 10 columns]
Testing Features Shape:       MultipleLines  InternetService  OnlineSecurity  OnlineBacku
p  \
3997              0                1                1              0
1147              0                1                1              0
3659              0                0                3              3
2951              0                2                0              0
150               1                1                0              1
...             ...              ...              ...            ...
4880              1                2                0              1
1903              0                2                0              0
5507              0                1                1              1
5069              3                1                0              1
3574              1                2                0              1

      DeviceProtection  TechSupport  StreamingTV  StreamingMovies  \
3997                 1            0            1                0
1147                 1            0            1                0
3659                 3            3            3                3
2951                 0            0            1                0
150                  1            0            1                0
...                ...          ...          ...              ...
4880                 0            0            0                0
1903                 0            1            1                1
5507                 1            1            1                1
5069                 1            0            1                0
3574                 1            0            1                1

      MonthlyCharges TotalCharges
3997           64.25         1024
1147           66.40        94.55
3659           20.15       1337.5
2951           78.90       299.75
150            68.95       2038.7
...              ...          ...
4880           80.65       1451.9
1903           94.45       1511.2
5507           85.00      5607.75
5069           46.40        812.4
3574          104.80       7470.1

[1198 rows x 10 columns]
Training Target Shape: 4779    0.5
685     0.5
2993    1.0
3146    0.0
35      0.0
       ...
5876    0.5
4093    0.5
2496    0.0
4163    0.0
2572    0.0
Name: Contract, Length: 4788, dtype: float64
Testing Target Shape: 3997    1.0
1147    0.0
3659    1.0
2951    0.0
150     0.5
       ...
4880    0.0
```

```
4880     0.0
1903     0.0
5507     1.0
5069     0.5
3574     1.0
Name: Contract, Length: 1198, dtype: float64
```

Classification Task Implement the following classification algorithms to predict the target variable

- **K-Nearest Neighbors (KNN)**
- **Random Forest Classifier**
- **Naïve Bayes Classifier**

In [28]:

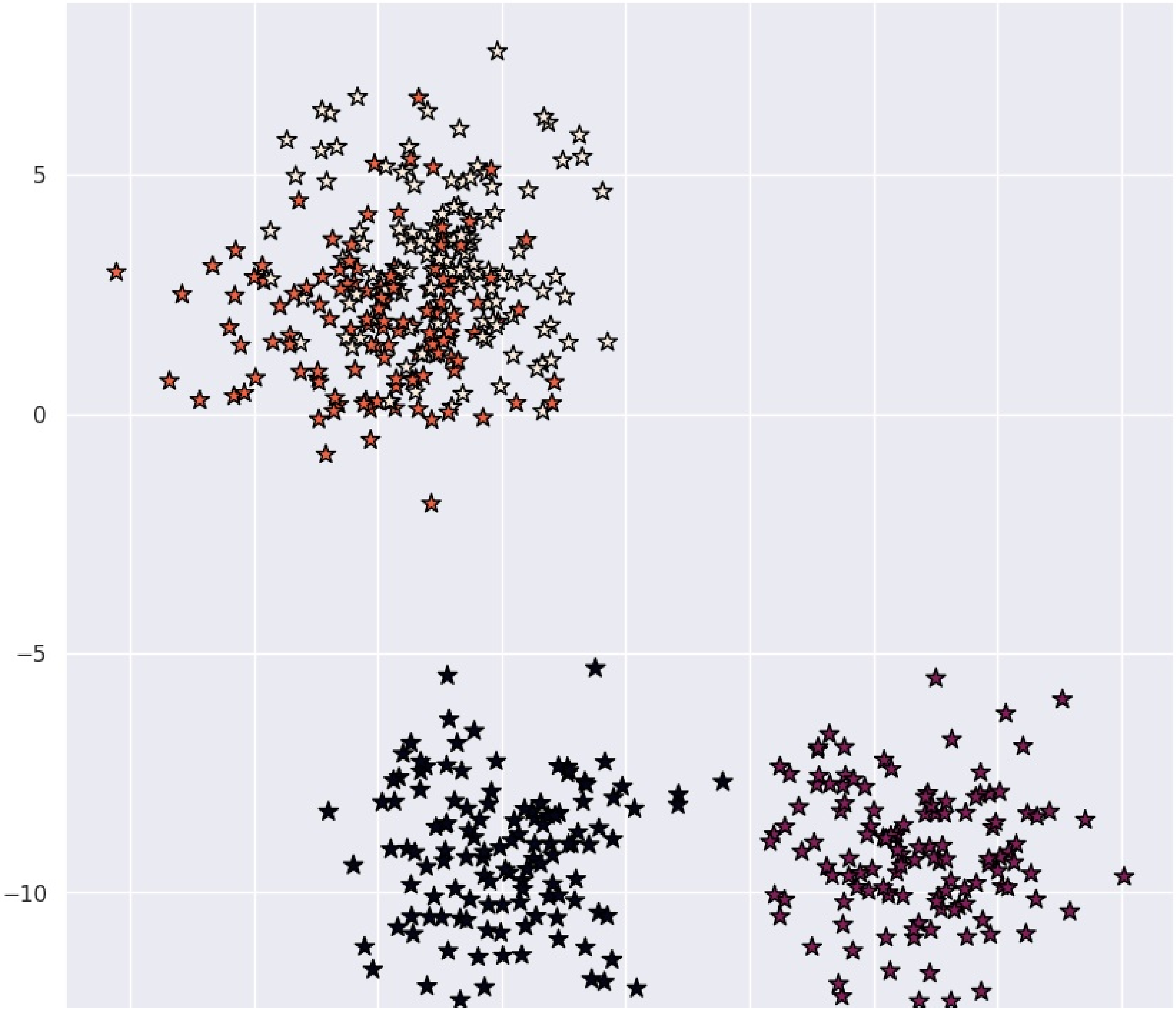
```
from sklearn.datasets import make_blobs
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import train_test_split
```

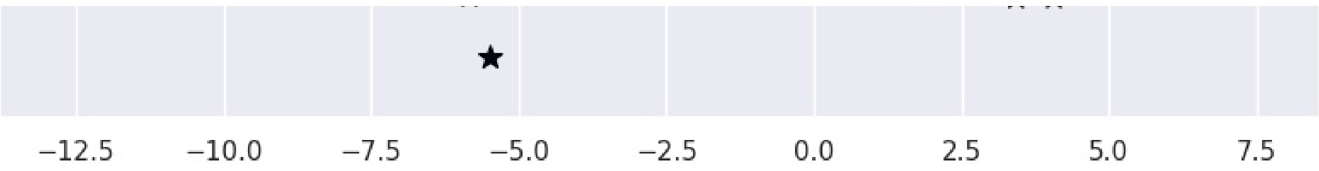
In [40]:

```
X, y = make_blobs(n_samples = 500, n_features = 2, centers = 4,cluster_std = 1.5, random
_state = 41)
```

In [41]:

```
sns.set_theme()
plt.figure(figsize=(10, 10))
plt.scatter(X[:, 0], X[:, 1], c=y, marker='*', s=100, edgecolors='black')
plt.show()
```





In [42]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 0)
```

In [43]:

```
knn5 = KNeighborsClassifier(n_neighbors = 5)
knn1 = KNeighborsClassifier(n_neighbors=1)
```

In [44]:

```
knn5.fit(X_train, y_train)
knn1.fit(X_train, y_train)

y_pred_5 = knn5.predict(X_test)
y_pred_1 = knn1.predict(X_test)
```

In [45]:

```
from sklearn.metrics import accuracy_score
print("Accuracy with k=5", accuracy_score(y_test, y_pred_5)*100)
print("Accuracy with k=1", accuracy_score(y_test, y_pred_1)*100)
```

```
Accuracy with k=5 83.2
Accuracy with k=1 83.2
```

KNN

In [46]:

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report

# Initialize and train the KNN model
knn = KNeighborsClassifier(n_neighbors=5)
knn.fit(X_train, y_train)

# Predict using the KNN model
y_pred_knn = knn.predict(X_test)

# Generate and print the classification report
print("K-Nearest Neighbors (KNN) Classification Report:")
print(classification_report(y_test, y_pred_knn))
```

```
K-Nearest Neighbors (KNN) Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        33
           1       1.00      1.00      1.00        34
           2       0.66      0.68      0.67        31
           3       0.62      0.59      0.60        27

    accuracy                           0.83       125
   macro avg       0.82      0.82      0.82       125
weighted avg       0.83      0.83      0.83       125
```

Random Forest Classifier

In [47]:

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

```
# Initialize and train the Random Forest model
rf = RandomForestClassifier(n_estimators=100, random_state=42)
rf.fit(X_train, y_train)

# Predict using the Random Forest model
y_pred_rf = rf.predict(X_test)

# Generate and print the classification report
print("Random Forest Classifier Classification Report:")
print(classification_report(y_test, y_pred_rf))
```

```
Random Forest Classifier Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        33
           1       1.00      1.00      1.00        34
           2       0.69      0.65      0.67        31
           3       0.62      0.67      0.64        27

    accuracy                           0.84       125
   macro avg       0.83      0.83      0.83       125
weighted avg       0.84      0.84      0.84       125
```

Naïve Bayes Classifier

In [48]:

```
from sklearn.naive_bayes import GaussianNB

# Initialize and train the Naive Bayes model
nb = GaussianNB()
nb.fit(X_train, y_train)

# Predict using the Naive Bayes model
y_pred_nb = nb.predict(X_test)

# Generate and print the classification report
print("Naïve Bayes Classifier Classification Report:")
print(classification_report(y_test, y_pred_nb))
```

```
Naïve Bayes Classifier Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        33
           1       1.00      1.00      1.00        34
           2       0.74      0.74      0.74        31
           3       0.70      0.70      0.70        27

    accuracy                           0.87       125
   macro avg       0.86      0.86      0.86       125
weighted avg       0.87      0.87      0.87       125
```

Evaluation Metrics For each classifier, generate a detailed classification report that includes the following metrics:

1. **Precision**
2. **Recall**
3. **F1-Score**
4. **Accuracy**

In [49]:

```
from sklearn.metrics import classification_report, accuracy_score

# Function to print evaluation metrics
def evaluate_model(y_true, y_pred, model_name):
    print(f"--- {model_name} Classification Report ---")
    print(classification_report(y_true, y_pred))
    accuracy = accuracy_score(y_true, y_pred)
    print(f"Accuracy: {accuracy:.4f}\n")

# K-Nearest Neighbors (KNN)
evaluate_model(y_test, y_pred_knn, "K-Nearest Neighbors (KNN)")

# Random Forest Classifier
evaluate_model(y_test, y_pred_rf, "Random Forest Classifier")

# Naive Bayes Classifier
evaluate_model(y_test, y_pred_nb, "Naive Bayes Classifier")
```

```
--- K-Nearest Neighbors (KNN) Classification Report ---
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        33
           1       1.00      1.00      1.00        34
           2       0.66      0.68      0.67        31
           3       0.62      0.59      0.60        27

    accuracy                           0.83       125
   macro avg       0.82      0.82      0.82       125
weighted avg       0.83      0.83      0.83       125

Accuracy: 0.8320

--- Random Forest Classifier Classification Report ---
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        33
           1       1.00      1.00      1.00        34
           2       0.69      0.65      0.67        31
           3       0.62      0.67      0.64        27

    accuracy                           0.84       125
   macro avg       0.83      0.83      0.83       125
weighted avg       0.84      0.84      0.84       125

Accuracy: 0.8400

--- Naive Bayes Classifier Classification Report ---
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        33
           1       1.00      1.00      1.00        34
           2       0.74      0.74      0.74        31
           3       0.70      0.70      0.70        27

    accuracy                           0.87       125
   macro avg       0.86      0.86      0.86       125
weighted avg       0.87      0.87      0.87       125

Accuracy: 0.8720
```

Comparative Analysis Compare the performance of the three algorithms using the metrics generated in the classification reports. Include a brief discussion addressing:

- **Which algorithm performs the best based on the metrics.**
- **The possible reasons for the observed performance differences.**
- **Recommendations for improving classification performance if necessary.**

In [50]:

```
import pandas as pd

metrics = {
    "Model": ["KNN", "Random Forest", "Naive Bayes"],
    "Accuracy": [
        accuracy_score(y_test, y_pred_knn),
        accuracy_score(y_test, y_pred_rf),
        accuracy_score(y_test, y_pred_nb)
    ],
    "Precision": [
        classification_report(y_test, y_pred_knn, output_dict=True)['weighted avg']['pre
cision'],
        classification_report(y_test, y_pred_rf, output_dict=True)['weighted avg']['prec
ision'],
        classification_report(y_test, y_pred_nb, output_dict=True)['weighted avg']['prec
ision']
    ],
    "Recall": [
        classification_report(y_test, y_pred_knn, output_dict=True)['weighted avg']['rec
all'],
        classification_report(y_test, y_pred_rf, output_dict=True)['weighted avg']['reca
ll'],
        classification_report(y_test, y_pred_nb, output_dict=True)['weighted avg']['reca
ll']
    ],
    "F1-Score": [
        classification_report(y_test, y_pred_knn, output_dict=True)['weighted avg']['f1-
score'],
        classification_report(y_test, y_pred_rf, output_dict=True)['weighted avg']['f1-s
core'],
        classification_report(y_test, y_pred_nb, output_dict=True)['weighted avg']['f1-s
core']
    ]
}

metrics_df = pd.DataFrame(metrics)

print("Comparative Analysis of Classification Models:")
print(metrics_df)

print("\nBest Performing Model per Metric:")
print(metrics_df.loc[metrics_df[['Accuracy', 'Precision', 'Recall', 'F1-Score']].idxmax(
)])
```

```
Comparative Analysis of Classification Models:
           Model  Accuracy  Precision  Recall  F1-Score
0            KNN     0.832   0.831673   0.832  0.831748
1  Random Forest     0.840   0.841103   0.840  0.840190
2    Naive Bayes     0.872   0.872000   0.872  0.872000

Best Performing Model per Metric:
         Model  Accuracy  Precision  Recall  F1-Score
2  Naive Bayes     0.872      0.872   0.872     0.872
2  Naive Bayes     0.872      0.872   0.872     0.872
2  Naive Bayes     0.872      0.872   0.872     0.872
2  Naive Bayes     0.872      0.872   0.872     0.872
```