

Import Necessary Libraries

```
In [49]: ## Import Necessary Libraries
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split, GridSearchCV, KFold
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

```
In [12]: df = pd.read_csv("preprocessed_car_accident_dataset.csv")
df.head()
```

```
Out[12]:
```

	Number_of_People_Involved	Severity_Code	Person_Sex	Seatbelt_Used	Age	Vehicle_Type
0	1	0	0	0	0.232877	0
1	2	1	1	1	0.328767	1
2	3	1	0	1	0.191781	1
3	1	0	1	1	0.739726	2
4	2	1	0	1	0.506849	2

Split the data into features (X) and target (y)

```
In [13]: X = df.drop('Severity_Code', axis=1)
y = df['Severity_Code']
```

Split the data into training and testing sets

```
In [14]: X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

Setting K-Fold Cross Validation's

It is a technique used to assess the performance and reliability of a machine learning model. It is useful when having a limited amount of data and want to make the most out of it as well as avoiding issues like overfitting or underfitting at the same time.

```
In [15]: # K-fold cross validation
kf = KFold(n_splits=5, shuffle=True, random_state=42)
```

Random Forest Model

```
In [16]: from sklearn.ensemble import RandomForestClassifier
```

```
In [17]: # Hyperparameter grid
rf_param_grid = {
    'n_estimators': [100, 200, 300],
    'max_depth': [None, 10, 20],
    'max_features': ['sqrt', 'log2', None],
}

rf = RandomForestClassifier(random_state=42)
rf_grid_search = GridSearchCV(rf, rf_param_grid, cv=kf, verbose=10)
rf_grid_search.fit(X_train, y_train)

# Access best model and params
best_rf_model = rf_grid_search.best_estimator_
best_rf_params = rf_grid_search.best_params_
```

Fitting 5 folds for each of 27 candidates, totalling 135 fits

```
[CV 1/5; 1/27] START max_depth=None, max_features=sqrt, n_estimators=100.....
[CV 1/5; 1/27] END max_depth=None, max_features=sqrt, n_estimators=100;; score=0.8
46 total time= 0.7s
[CV 2/5; 1/27] START max_depth=None, max_features=sqrt, n_estimators=100.....
[CV 2/5; 1/27] END max_depth=None, max_features=sqrt, n_estimators=100;; score=0.8
55 total time= 0.6s
[CV 3/5; 1/27] START max_depth=None, max_features=sqrt, n_estimators=100.....
[CV 3/5; 1/27] END max_depth=None, max_features=sqrt, n_estimators=100;; score=0.8
54 total time= 0.6s
[CV 4/5; 1/27] START max_depth=None, max_features=sqrt, n_estimators=100.....
[CV 4/5; 1/27] END max_depth=None, max_features=sqrt, n_estimators=100;; score=0.8
49 total time= 0.6s
[CV 5/5; 1/27] START max_depth=None, max_features=sqrt, n_estimators=100.....
[CV 5/5; 1/27] END max_depth=None, max_features=sqrt, n_estimators=100;; score=0.8
49 total time= 0.6s
[CV 1/5; 2/27] START max_depth=None, max_features=sqrt, n_estimators=200.....
[CV 1/5; 2/27] END max_depth=None, max_features=sqrt, n_estimators=200;; score=0.8
46 total time= 1.3s
[CV 2/5; 2/27] START max_depth=None, max_features=sqrt, n_estimators=200.....
[CV 2/5; 2/27] END max_depth=None, max_features=sqrt, n_estimators=200;; score=0.8
56 total time= 1.3s
[CV 3/5; 2/27] START max_depth=None, max_features=sqrt, n_estimators=200.....
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[CV 5/5; 2/27] END max_depth=None, max_features=sqrt, n_estimators=200;; score=0.8
50 total time= 1.3s
[CV 1/5; 3/27] START max_depth=None, max_features=sqrt, n_estimators=300.....
[CV 1/5; 3/27] END max_depth=None, max_features=sqrt, n_estimators=300;; score=0.8
46 total time= 2.0s
[CV 2/5; 3/27] START max_depth=None, max_features=sqrt, n_estimators=300.....
[CV 2/5; 3/27] END max_depth=None, max_features=sqrt, n_estimators=300;; score=0.8
57 total time= 2.0s
[CV 3/5; 3/27] START max_depth=None, max_features=sqrt, n_estimators=300.....
[CV 3/5; 3/27] END max_depth=None, max_features=sqrt, n_estimators=300;; score=0.8
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51 total time= 2.0s
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47 total time= 2.0s
[CV 1/5; 4/27] START max_depth=None, max_features=log2, n_estimators=100.....
[CV 1/5; 4/27] END max_depth=None, max_features=log2, n_estimators=100;; score=0.8
46 total time= 0.6s
[CV 2/5; 4/27] START max_depth=None, max_features=log2, n_estimators=100.....
[CV 2/5; 4/27] END max_depth=None, max_features=log2, n_estimators=100;; score=0.8
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[CV 4/5; 4/27] START max_depth=None, max_features=log2, n_estimators=100.....
[CV 4/5; 4/27] END max_depth=None, max_features=log2, n_estimators=100;; score=0.8
49 total time= 0.6s
[CV 5/5; 4/27] START max_depth=None, max_features=log2, n_estimators=100.....
[CV 5/5; 4/27] END max_depth=None, max_features=log2, n_estimators=100;; score=0.8
49 total time= 0.6s
[CV 1/5; 5/27] START max_depth=None, max_features=log2, n_estimators=200.....
[CV 1/5; 5/27] END max_depth=None, max_features=log2, n_estimators=200;; score=0.8
46 total time= 1.3s
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[CV 2/5; 5/27] START max_depth=None, max_features=log2, n_estimators=200.....
[CV 2/5; 5/27] END max_depth=None, max_features=log2, n_estimators=200;; score=0.8
56 total time= 1.3s
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[CV 4/5; 5/27] END max_depth=None, max_features=log2, n_estimators=200;; score=0.8
49 total time= 1.3s
[CV 5/5; 5/27] START max_depth=None, max_features=log2, n_estimators=200.....
[CV 5/5; 5/27] END max_depth=None, max_features=log2, n_estimators=200;; score=0.8
50 total time= 1.3s
[CV 1/5; 6/27] START max_depth=None, max_features=log2, n_estimators=300.....
[CV 1/5; 6/27] END max_depth=None, max_features=log2, n_estimators=300;; score=0.8
46 total time= 2.0s
[CV 2/5; 6/27] START max_depth=None, max_features=log2, n_estimators=300.....
[CV 2/5; 6/27] END max_depth=None, max_features=log2, n_estimators=300;; score=0.8
57 total time= 2.0s
[CV 3/5; 6/27] START max_depth=None, max_features=log2, n_estimators=300.....
[CV 3/5; 6/27] END max_depth=None, max_features=log2, n_estimators=300;; score=0.8
56 total time= 2.0s
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[CV 4/5; 6/27] END max_depth=None, max_features=log2, n_estimators=300;; score=0.8
51 total time= 2.0s
[CV 5/5; 6/27] START max_depth=None, max_features=log2, n_estimators=300.....
[CV 5/5; 6/27] END max_depth=None, max_features=log2, n_estimators=300;; score=0.8
47 total time= 2.0s
[CV 1/5; 7/27] START max_depth=None, max_features=None, n_estimators=100.....
[CV 1/5; 7/27] END max_depth=None, max_features=None, n_estimators=100;; score=0.8
43 total time= 1.1s
[CV 2/5; 7/27] START max_depth=None, max_features=None, n_estimators=100.....
[CV 2/5; 7/27] END max_depth=None, max_features=None, n_estimators=100;; score=0.8
52 total time= 1.1s
[CV 3/5; 7/27] START max_depth=None, max_features=None, n_estimators=100.....
[CV 3/5; 7/27] END max_depth=None, max_features=None, n_estimators=100;; score=0.8
48 total time= 1.1s
[CV 4/5; 7/27] START max_depth=None, max_features=None, n_estimators=100.....
[CV 4/5; 7/27] END max_depth=None, max_features=None, n_estimators=100;; score=0.8
49 total time= 1.1s
[CV 5/5; 7/27] START max_depth=None, max_features=None, n_estimators=100.....
[CV 5/5; 7/27] END max_depth=None, max_features=None, n_estimators=100;; score=0.8
46 total time= 1.1s
[CV 1/5; 8/27] START max_depth=None, max_features=None, n_estimators=200.....
[CV 1/5; 8/27] END max_depth=None, max_features=None, n_estimators=200;; score=0.8
45 total time= 2.7s
[CV 2/5; 8/27] START max_depth=None, max_features=None, n_estimators=200.....
[CV 2/5; 8/27] END max_depth=None, max_features=None, n_estimators=200;; score=0.8
54 total time= 2.7s
[CV 3/5; 8/27] START max_depth=None, max_features=None, n_estimators=200.....
[CV 3/5; 8/27] END max_depth=None, max_features=None, n_estimators=200;; score=0.8
48 total time= 2.7s
[CV 4/5; 8/27] START max_depth=None, max_features=None, n_estimators=200.....
[CV 4/5; 8/27] END max_depth=None, max_features=None, n_estimators=200;; score=0.8
46 total time= 2.4s
[CV 5/5; 8/27] START max_depth=None, max_features=None, n_estimators=200.....
[CV 5/5; 8/27] END max_depth=None, max_features=None, n_estimators=200;; score=0.8
46 total time= 2.4s
[CV 1/5; 9/27] START max_depth=None, max_features=None, n_estimators=300.....
[CV 1/5; 9/27] END max_depth=None, max_features=None, n_estimators=300;; score=0.8
46 total time= 3.7s
[CV 2/5; 9/27] START max_depth=None, max_features=None, n_estimators=300.....
[CV 2/5; 9/27] END max_depth=None, max_features=None, n_estimators=300;; score=0.8
56 total time= 4.0s
[CV 3/5; 9/27] START max_depth=None, max_features=None, n_estimators=300.....
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[CV 3/5; 9/27] END max_depth=None, max_features=None, n_estimators=300;; score=0.8
50 total time= 3.9s
[CV 4/5; 9/27] START max_depth=None, max_features=None, n_estimators=300.....
[CV 4/5; 9/27] END max_depth=None, max_features=None, n_estimators=300;; score=0.8
49 total time= 3.7s
[CV 5/5; 9/27] START max_depth=None, max_features=None, n_estimators=300.....
[CV 5/5; 9/27] END max_depth=None, max_features=None, n_estimators=300;; score=0.8
45 total time= 3.6s
[CV 1/5; 10/27] START max_depth=10, max_features=sqrt, n_estimators=100.....
[CV 1/5; 10/27] END max_depth=10, max_features=sqrt, n_estimators=100;; score=0.87
3 total time= 0.4s
[CV 2/5; 10/27] START max_depth=10, max_features=sqrt, n_estimators=100.....
[CV 2/5; 10/27] END max_depth=10, max_features=sqrt, n_estimators=100;; score=0.89
1 total time= 0.3s
[CV 3/5; 10/27] START max_depth=10, max_features=sqrt, n_estimators=100.....
[CV 3/5; 10/27] END max_depth=10, max_features=sqrt, n_estimators=100;; score=0.88
2 total time= 0.3s
[CV 4/5; 10/27] START max_depth=10, max_features=sqrt, n_estimators=100.....
[CV 4/5; 10/27] END max_depth=10, max_features=sqrt, n_estimators=100;; score=0.87
8 total time= 0.4s
[CV 5/5; 10/27] START max_depth=10, max_features=sqrt, n_estimators=100.....
[CV 5/5; 10/27] END max_depth=10, max_features=sqrt, n_estimators=100;; score=0.87
3 total time= 0.4s
[CV 1/5; 11/27] START max_depth=10, max_features=sqrt, n_estimators=200.....
[CV 1/5; 11/27] END max_depth=10, max_features=sqrt, n_estimators=200;; score=0.87
3 total time= 0.8s
[CV 2/5; 11/27] START max_depth=10, max_features=sqrt, n_estimators=200.....
[CV 2/5; 11/27] END max_depth=10, max_features=sqrt, n_estimators=200;; score=0.89
2 total time= 0.8s
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2 total time= 0.8s
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[CV 5/5; 11/27] END max_depth=10, max_features=sqrt, n_estimators=200;; score=0.87
3 total time= 0.8s
[CV 1/5; 12/27] START max_depth=10, max_features=sqrt, n_estimators=300.....
[CV 1/5; 12/27] END max_depth=10, max_features=sqrt, n_estimators=300;; score=0.87
3 total time= 1.2s
[CV 2/5; 12/27] START max_depth=10, max_features=sqrt, n_estimators=300.....
[CV 2/5; 12/27] END max_depth=10, max_features=sqrt, n_estimators=300;; score=0.89
2 total time= 1.4s
[CV 3/5; 12/27] START max_depth=10, max_features=sqrt, n_estimators=300.....
[CV 3/5; 12/27] END max_depth=10, max_features=sqrt, n_estimators=300;; score=0.88
1 total time= 1.2s
[CV 4/5; 12/27] START max_depth=10, max_features=sqrt, n_estimators=300.....
[CV 4/5; 12/27] END max_depth=10, max_features=sqrt, n_estimators=300;; score=0.87
9 total time= 1.3s
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3 total time= 1.3s
[CV 1/5; 13/27] START max_depth=10, max_features=log2, n_estimators=100.....
[CV 1/5; 13/27] END max_depth=10, max_features=log2, n_estimators=100;; score=0.87
3 total time= 0.4s
[CV 2/5; 13/27] START max_depth=10, max_features=log2, n_estimators=100.....
[CV 2/5; 13/27] END max_depth=10, max_features=log2, n_estimators=100;; score=0.89
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[CV 3/5; 13/27] START max_depth=10, max_features=log2, n_estimators=100.....
[CV 3/5; 13/27] END max_depth=10, max_features=log2, n_estimators=100;; score=0.88
2 total time= 0.4s
[CV 4/5; 13/27] START max_depth=10, max_features=log2, n_estimators=100.....
[CV 4/5; 13/27] END max_depth=10, max_features=log2, n_estimators=100;; score=0.87

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8 total time= 0.5s
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[CV 5/5; 13/27] END max_depth=10, max_features=log2, n_estimators=100;; score=0.87
3 total time= 0.3s
[CV 1/5; 14/27] START max_depth=10, max_features=log2, n_estimators=200.....
[CV 1/5; 14/27] END max_depth=10, max_features=log2, n_estimators=200;; score=0.87
3 total time= 0.8s
[CV 2/5; 14/27] START max_depth=10, max_features=log2, n_estimators=200.....
[CV 2/5; 14/27] END max_depth=10, max_features=log2, n_estimators=200;; score=0.89
2 total time= 0.8s
[CV 3/5; 14/27] START max_depth=10, max_features=log2, n_estimators=200.....
[CV 3/5; 14/27] END max_depth=10, max_features=log2, n_estimators=200;; score=0.88
2 total time= 0.8s
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8 total time= 0.8s
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3 total time= 0.8s
[CV 1/5; 15/27] START max_depth=10, max_features=log2, n_estimators=300.....
[CV 1/5; 15/27] END max_depth=10, max_features=log2, n_estimators=300;; score=0.87
3 total time= 1.3s
[CV 2/5; 15/27] START max_depth=10, max_features=log2, n_estimators=300.....
[CV 2/5; 15/27] END max_depth=10, max_features=log2, n_estimators=300;; score=0.89
2 total time= 1.2s
[CV 3/5; 15/27] START max_depth=10, max_features=log2, n_estimators=300.....
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1 total time= 1.5s
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[CV 4/5; 15/27] END max_depth=10, max_features=log2, n_estimators=300;; score=0.87
9 total time= 1.5s
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[CV 5/5; 15/27] END max_depth=10, max_features=log2, n_estimators=300;; score=0.87
3 total time= 1.6s
[CV 1/5; 16/27] START max_depth=10, max_features=None, n_estimators=100.....
[CV 1/5; 16/27] END max_depth=10, max_features=None, n_estimators=100;; score=0.87
3 total time= 0.9s
[CV 2/5; 16/27] START max_depth=10, max_features=None, n_estimators=100.....
[CV 2/5; 16/27] END max_depth=10, max_features=None, n_estimators=100;; score=0.89
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7 total time= 0.8s
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[CV 5/5; 16/27] END max_depth=10, max_features=None, n_estimators=100;; score=0.87
4 total time= 0.8s
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[CV 4/5; 17/27] END max_depth=10, max_features=None, n_estimators=200;; score=0.87
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[CV 5/5; 17/27] END max_depth=10, max_features=None, n_estimators=200;; score=0.87
3 total time= 1.9s

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[CV 1/5; 18/27] START max_depth=10, max_features=None, n_estimators=300.....
[CV 1/5; 18/27] END max_depth=10, max_features=None, n_estimators=300;; score=0.87
2 total time= 2.9s
[CV 2/5; 18/27] START max_depth=10, max_features=None, n_estimators=300.....
[CV 2/5; 18/27] END max_depth=10, max_features=None, n_estimators=300;; score=0.89
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[CV 3/5; 18/27] END max_depth=10, max_features=None, n_estimators=300;; score=0.88
0 total time= 2.8s
[CV 4/5; 18/27] START max_depth=10, max_features=None, n_estimators=300.....
[CV 4/5; 18/27] END max_depth=10, max_features=None, n_estimators=300;; score=0.87
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[CV 5/5; 18/27] START max_depth=10, max_features=None, n_estimators=300.....
[CV 5/5; 18/27] END max_depth=10, max_features=None, n_estimators=300;; score=0.87
4 total time= 2.9s
[CV 1/5; 19/27] START max_depth=20, max_features=sqrt, n_estimators=100.....
[CV 1/5; 19/27] END max_depth=20, max_features=sqrt, n_estimators=100;; score=0.85
4 total time= 0.7s
[CV 2/5; 19/27] START max_depth=20, max_features=sqrt, n_estimators=100.....
[CV 2/5; 19/27] END max_depth=20, max_features=sqrt, n_estimators=100;; score=0.86
5 total time= 0.7s
[CV 3/5; 19/27] START max_depth=20, max_features=sqrt, n_estimators=100.....
[CV 3/5; 19/27] END max_depth=20, max_features=sqrt, n_estimators=100;; score=0.86
0 total time= 0.7s
[CV 4/5; 19/27] START max_depth=20, max_features=sqrt, n_estimators=100.....
[CV 4/5; 19/27] END max_depth=20, max_features=sqrt, n_estimators=100;; score=0.85
5 total time= 0.7s
[CV 5/5; 19/27] START max_depth=20, max_features=sqrt, n_estimators=100.....
[CV 5/5; 19/27] END max_depth=20, max_features=sqrt, n_estimators=100;; score=0.85
5 total time= 0.7s
[CV 1/5; 20/27] START max_depth=20, max_features=sqrt, n_estimators=200.....
[CV 1/5; 20/27] END max_depth=20, max_features=sqrt, n_estimators=200;; score=0.85
2 total time= 1.6s
[CV 2/5; 20/27] START max_depth=20, max_features=sqrt, n_estimators=200.....
[CV 2/5; 20/27] END max_depth=20, max_features=sqrt, n_estimators=200;; score=0.86
3 total time= 1.5s
[CV 3/5; 20/27] START max_depth=20, max_features=sqrt, n_estimators=200.....
[CV 3/5; 20/27] END max_depth=20, max_features=sqrt, n_estimators=200;; score=0.86
0 total time= 1.6s
[CV 4/5; 20/27] START max_depth=20, max_features=sqrt, n_estimators=200.....
[CV 4/5; 20/27] END max_depth=20, max_features=sqrt, n_estimators=200;; score=0.85
8 total time= 1.5s
[CV 5/5; 20/27] START max_depth=20, max_features=sqrt, n_estimators=200.....
[CV 5/5; 20/27] END max_depth=20, max_features=sqrt, n_estimators=200;; score=0.85
6 total time= 1.6s
[CV 1/5; 21/27] START max_depth=20, max_features=sqrt, n_estimators=300.....
[CV 1/5; 21/27] END max_depth=20, max_features=sqrt, n_estimators=300;; score=0.85
3 total time= 2.4s
[CV 2/5; 21/27] START max_depth=20, max_features=sqrt, n_estimators=300.....
[CV 2/5; 21/27] END max_depth=20, max_features=sqrt, n_estimators=300;; score=0.86
4 total time= 2.4s
[CV 3/5; 21/27] START max_depth=20, max_features=sqrt, n_estimators=300.....
[CV 3/5; 21/27] END max_depth=20, max_features=sqrt, n_estimators=300;; score=0.86
2 total time= 2.3s
[CV 4/5; 21/27] START max_depth=20, max_features=sqrt, n_estimators=300.....
[CV 4/5; 21/27] END max_depth=20, max_features=sqrt, n_estimators=300;; score=0.85
7 total time= 2.4s
[CV 5/5; 21/27] START max_depth=20, max_features=sqrt, n_estimators=300.....
[CV 5/5; 21/27] END max_depth=20, max_features=sqrt, n_estimators=300;; score=0.85
5 total time= 2.4s
[CV 1/5; 22/27] START max_depth=20, max_features=log2, n_estimators=100.....
[CV 1/5; 22/27] END max_depth=20, max_features=log2, n_estimators=100;; score=0.85
4 total time= 0.7s
[CV 2/5; 22/27] START max_depth=20, max_features=log2, n_estimators=100.....

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[CV 2/5; 22/27] END max_depth=20, max_features=log2, n_estimators=100;; score=0.86
5 total time= 0.7s
[CV 3/5; 22/27] START max_depth=20, max_features=log2, n_estimators=100.....
[CV 3/5; 22/27] END max_depth=20, max_features=log2, n_estimators=100;; score=0.86
0 total time= 0.7s
[CV 4/5; 22/27] START max_depth=20, max_features=log2, n_estimators=100.....
[CV 4/5; 22/27] END max_depth=20, max_features=log2, n_estimators=100;; score=0.85
5 total time= 0.7s
[CV 5/5; 22/27] START max_depth=20, max_features=log2, n_estimators=100.....
[CV 5/5; 22/27] END max_depth=20, max_features=log2, n_estimators=100;; score=0.85
5 total time= 0.6s
[CV 1/5; 23/27] START max_depth=20, max_features=log2, n_estimators=200.....
[CV 1/5; 23/27] END max_depth=20, max_features=log2, n_estimators=200;; score=0.85
2 total time= 1.3s
[CV 2/5; 23/27] START max_depth=20, max_features=log2, n_estimators=200.....
[CV 2/5; 23/27] END max_depth=20, max_features=log2, n_estimators=200;; score=0.86
3 total time= 1.6s
[CV 3/5; 23/27] START max_depth=20, max_features=log2, n_estimators=200.....
[CV 3/5; 23/27] END max_depth=20, max_features=log2, n_estimators=200;; score=0.86
0 total time= 1.3s
[CV 4/5; 23/27] START max_depth=20, max_features=log2, n_estimators=200.....
[CV 4/5; 23/27] END max_depth=20, max_features=log2, n_estimators=200;; score=0.85
8 total time= 1.4s
[CV 5/5; 23/27] START max_depth=20, max_features=log2, n_estimators=200.....
[CV 5/5; 23/27] END max_depth=20, max_features=log2, n_estimators=200;; score=0.85
6 total time= 1.5s
[CV 1/5; 24/27] START max_depth=20, max_features=log2, n_estimators=300.....
[CV 1/5; 24/27] END max_depth=20, max_features=log2, n_estimators=300;; score=0.85
3 total time= 2.3s
[CV 2/5; 24/27] START max_depth=20, max_features=log2, n_estimators=300.....
[CV 2/5; 24/27] END max_depth=20, max_features=log2, n_estimators=300;; score=0.86
4 total time= 2.3s
[CV 3/5; 24/27] START max_depth=20, max_features=log2, n_estimators=300.....
[CV 3/5; 24/27] END max_depth=20, max_features=log2, n_estimators=300;; score=0.86
2 total time= 2.3s
[CV 4/5; 24/27] START max_depth=20, max_features=log2, n_estimators=300.....
[CV 4/5; 24/27] END max_depth=20, max_features=log2, n_estimators=300;; score=0.85
7 total time= 2.2s
[CV 5/5; 24/27] START max_depth=20, max_features=log2, n_estimators=300.....
[CV 5/5; 24/27] END max_depth=20, max_features=log2, n_estimators=300;; score=0.85
5 total time= 2.3s
[CV 1/5; 25/27] START max_depth=20, max_features=None, n_estimators=100.....
[CV 1/5; 25/27] END max_depth=20, max_features=None, n_estimators=100;; score=0.85
0 total time= 1.2s
[CV 2/5; 25/27] START max_depth=20, max_features=None, n_estimators=100.....
[CV 2/5; 25/27] END max_depth=20, max_features=None, n_estimators=100;; score=0.86
2 total time= 1.2s
[CV 3/5; 25/27] START max_depth=20, max_features=None, n_estimators=100.....
[CV 3/5; 25/27] END max_depth=20, max_features=None, n_estimators=100;; score=0.85
7 total time= 1.2s
[CV 4/5; 25/27] START max_depth=20, max_features=None, n_estimators=100.....
[CV 4/5; 25/27] END max_depth=20, max_features=None, n_estimators=100;; score=0.85
5 total time= 1.2s
[CV 5/5; 25/27] START max_depth=20, max_features=None, n_estimators=100.....
[CV 5/5; 25/27] END max_depth=20, max_features=None, n_estimators=100;; score=0.85
2 total time= 1.3s
[CV 1/5; 26/27] START max_depth=20, max_features=None, n_estimators=200.....
[CV 1/5; 26/27] END max_depth=20, max_features=None, n_estimators=200;; score=0.85
1 total time= 2.6s
[CV 2/5; 26/27] START max_depth=20, max_features=None, n_estimators=200.....
[CV 2/5; 26/27] END max_depth=20, max_features=None, n_estimators=200;; score=0.86
1 total time= 2.4s
[CV 3/5; 26/27] START max_depth=20, max_features=None, n_estimators=200.....
[CV 3/5; 26/27] END max_depth=20, max_features=None, n_estimators=200;; score=0.85
```



```

5 total time= 2.4s
[CV 4/5; 26/27] START max_depth=20, max_features=None, n_estimators=200.....
[CV 4/5; 26/27] END max_depth=20, max_features=None, n_estimators=200;; score=0.85
5 total time= 2.4s
[CV 5/5; 26/27] START max_depth=20, max_features=None, n_estimators=200.....
[CV 5/5; 26/27] END max_depth=20, max_features=None, n_estimators=200;; score=0.85
3 total time= 2.3s
[CV 1/5; 27/27] START max_depth=20, max_features=None, n_estimators=300.....
[CV 1/5; 27/27] END max_depth=20, max_features=None, n_estimators=300;; score=0.85
3 total time= 3.6s
[CV 2/5; 27/27] START max_depth=20, max_features=None, n_estimators=300.....
[CV 2/5; 27/27] END max_depth=20, max_features=None, n_estimators=300;; score=0.86
1 total time= 3.6s
[CV 3/5; 27/27] START max_depth=20, max_features=None, n_estimators=300.....
[CV 3/5; 27/27] END max_depth=20, max_features=None, n_estimators=300;; score=0.85
6 total time= 3.8s
[CV 4/5; 27/27] START max_depth=20, max_features=None, n_estimators=300.....
[CV 4/5; 27/27] END max_depth=20, max_features=None, n_estimators=300;; score=0.85
6 total time= 4.6s
[CV 5/5; 27/27] START max_depth=20, max_features=None, n_estimators=300.....
[CV 5/5; 27/27] END max_depth=20, max_features=None, n_estimators=300;; score=0.85
1 total time= 3.7s

```

```

In [18]: print(best_rf_params)

rf_y_pred = best_rf_model.predict(X_test)
print("\nClassification Report for Random Forest Model:")
print(classification_report(y_test, rf_y_pred))

{'max_depth': 10, 'max_features': 'sqrt', 'n_estimators': 200}

Classification Report for Random Forest Model:

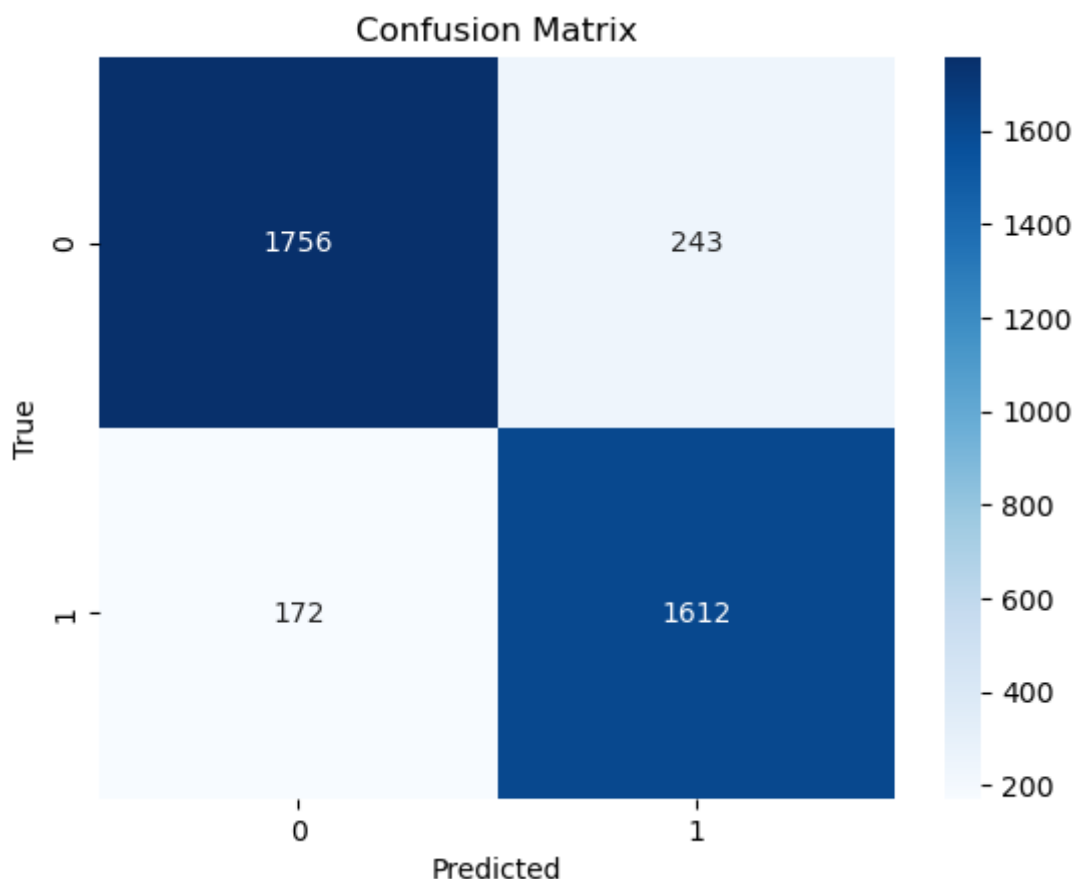
```

	precision	recall	f1-score	support
0	0.91	0.88	0.89	1999
1	0.87	0.90	0.89	1784
accuracy			0.89	3783
macro avg	0.89	0.89	0.89	3783
weighted avg	0.89	0.89	0.89	3783

```

In [19]: # Confusion Matrix
sns.heatmap(confusion_matrix(y_test, rf_y_pred), annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()

```



KNN Model

```
In [20]: from sklearn.neighbors import KNeighborsClassifier
```

```
In [21]: # Define a grid of hyperparameters to search
# Grid search is used to find the best combination of hyperparameters for a machine
# Hyperparameters are settings or configurations for the model that are not learned
knn_param_grid = {
    'n_neighbors': [3, 5, 7, 9], # Example values for k
    'weights': ['uniform', 'distance'],
    'metric': ['euclidean', 'manhattan'] # Additional hyperparameters specific to
}

# Create KNN classifier
knn = KNeighborsClassifier()

# Perform grid search
knn_grid_search = GridSearchCV(knn, knn_param_grid, cv=kf, verbose=10)
knn_grid_search.fit(X_train, y_train)

# Access best model and params
best_knn_model = knn_grid_search.best_estimator_
best_knn_params = knn_grid_search.best_params_
```

```
Fitting 5 folds for each of 16 candidates, totalling 80 fits
[CV 1/5; 1/16] START metric=euclidean, n_neighbors=3, weights=uniform.....
[CV 1/5; 1/16] END metric=euclidean, n_neighbors=3, weights=uniform;; score=0.839
total time= 0.0s
[CV 2/5; 1/16] START metric=euclidean, n_neighbors=3, weights=uniform.....
[CV 2/5; 1/16] END metric=euclidean, n_neighbors=3, weights=uniform;; score=0.856
total time= 0.0s
[CV 3/5; 1/16] START metric=euclidean, n_neighbors=3, weights=uniform.....
[CV 3/5; 1/16] END metric=euclidean, n_neighbors=3, weights=uniform;; score=0.846
total time= 0.0s
[CV 4/5; 1/16] START metric=euclidean, n_neighbors=3, weights=uniform.....
[CV 4/5; 1/16] END metric=euclidean, n_neighbors=3, weights=uniform;; score=0.848
total time= 0.0s
[CV 5/5; 1/16] START metric=euclidean, n_neighbors=3, weights=uniform.....
[CV 5/5; 1/16] END metric=euclidean, n_neighbors=3, weights=uniform;; score=0.839
total time= 0.0s
[CV 1/5; 2/16] START metric=euclidean, n_neighbors=3, weights=distance.....
[CV 1/5; 2/16] END metric=euclidean, n_neighbors=3, weights=distance;; score=0.811
total time= 0.0s
[CV 2/5; 2/16] START metric=euclidean, n_neighbors=3, weights=distance.....
[CV 2/5; 2/16] END metric=euclidean, n_neighbors=3, weights=distance;; score=0.825
total time= 0.0s
[CV 3/5; 2/16] START metric=euclidean, n_neighbors=3, weights=distance.....
[CV 3/5; 2/16] END metric=euclidean, n_neighbors=3, weights=distance;; score=0.825
total time= 0.0s
[CV 4/5; 2/16] START metric=euclidean, n_neighbors=3, weights=distance.....
[CV 4/5; 2/16] END metric=euclidean, n_neighbors=3, weights=distance;; score=0.824
total time= 0.0s
[CV 5/5; 2/16] START metric=euclidean, n_neighbors=3, weights=distance.....
[CV 5/5; 2/16] END metric=euclidean, n_neighbors=3, weights=distance;; score=0.816
total time= 0.0s
[CV 1/5; 3/16] START metric=euclidean, n_neighbors=5, weights=uniform.....
[CV 1/5; 3/16] END metric=euclidean, n_neighbors=5, weights=uniform;; score=0.856
total time= 0.0s
[CV 2/5; 3/16] START metric=euclidean, n_neighbors=5, weights=uniform.....
[CV 2/5; 3/16] END metric=euclidean, n_neighbors=5, weights=uniform;; score=0.865
total time= 0.0s
[CV 3/5; 3/16] START metric=euclidean, n_neighbors=5, weights=uniform.....
[CV 3/5; 3/16] END metric=euclidean, n_neighbors=5, weights=uniform;; score=0.858
total time= 0.0s
[CV 4/5; 3/16] START metric=euclidean, n_neighbors=5, weights=uniform.....
[CV 4/5; 3/16] END metric=euclidean, n_neighbors=5, weights=uniform;; score=0.858
total time= 0.0s
[CV 5/5; 3/16] START metric=euclidean, n_neighbors=5, weights=uniform.....
[CV 5/5; 3/16] END metric=euclidean, n_neighbors=5, weights=uniform;; score=0.855
total time= 0.0s
[CV 1/5; 4/16] START metric=euclidean, n_neighbors=5, weights=distance.....
[CV 1/5; 4/16] END metric=euclidean, n_neighbors=5, weights=distance;; score=0.818
total time= 0.0s
[CV 2/5; 4/16] START metric=euclidean, n_neighbors=5, weights=distance.....
[CV 2/5; 4/16] END metric=euclidean, n_neighbors=5, weights=distance;; score=0.827
total time= 0.0s
[CV 3/5; 4/16] START metric=euclidean, n_neighbors=5, weights=distance.....
[CV 3/5; 4/16] END metric=euclidean, n_neighbors=5, weights=distance;; score=0.828
total time= 0.0s
[CV 4/5; 4/16] START metric=euclidean, n_neighbors=5, weights=distance.....
[CV 4/5; 4/16] END metric=euclidean, n_neighbors=5, weights=distance;; score=0.828
total time= 0.0s
[CV 5/5; 4/16] START metric=euclidean, n_neighbors=5, weights=distance.....
[CV 5/5; 4/16] END metric=euclidean, n_neighbors=5, weights=distance;; score=0.822
total time= 0.0s
[CV 1/5; 5/16] START metric=euclidean, n_neighbors=7, weights=uniform.....
[CV 1/5; 5/16] END metric=euclidean, n_neighbors=7, weights=uniform;; score=0.855
total time= 0.0s
```

```
[CV 2/5; 5/16] START metric=euclidean, n_neighbors=7, weights=uniform.....
[CV 2/5; 5/16] END metric=euclidean, n_neighbors=7, weights=uniform;; score=0.871
total time= 0.0s
[CV 3/5; 5/16] START metric=euclidean, n_neighbors=7, weights=uniform.....
[CV 3/5; 5/16] END metric=euclidean, n_neighbors=7, weights=uniform;; score=0.863
total time= 0.0s
[CV 4/5; 5/16] START metric=euclidean, n_neighbors=7, weights=uniform.....
[CV 4/5; 5/16] END metric=euclidean, n_neighbors=7, weights=uniform;; score=0.859
total time= 0.0s
[CV 5/5; 5/16] START metric=euclidean, n_neighbors=7, weights=uniform.....
[CV 5/5; 5/16] END metric=euclidean, n_neighbors=7, weights=uniform;; score=0.862
total time= 0.0s
[CV 1/5; 6/16] START metric=euclidean, n_neighbors=7, weights=distance.....
[CV 1/5; 6/16] END metric=euclidean, n_neighbors=7, weights=distance;; score=0.821
total time= 0.0s
[CV 2/5; 6/16] START metric=euclidean, n_neighbors=7, weights=distance.....
[CV 2/5; 6/16] END metric=euclidean, n_neighbors=7, weights=distance;; score=0.828
total time= 0.0s
[CV 3/5; 6/16] START metric=euclidean, n_neighbors=7, weights=distance.....
[CV 3/5; 6/16] END metric=euclidean, n_neighbors=7, weights=distance;; score=0.828
total time= 0.0s
[CV 4/5; 6/16] START metric=euclidean, n_neighbors=7, weights=distance.....
[CV 4/5; 6/16] END metric=euclidean, n_neighbors=7, weights=distance;; score=0.828
total time= 0.0s
[CV 5/5; 6/16] START metric=euclidean, n_neighbors=7, weights=distance.....
[CV 5/5; 6/16] END metric=euclidean, n_neighbors=7, weights=distance;; score=0.824
total time= 0.0s
[CV 1/5; 7/16] START metric=euclidean, n_neighbors=9, weights=uniform.....
[CV 1/5; 7/16] END metric=euclidean, n_neighbors=9, weights=uniform;; score=0.857
total time= 0.0s
[CV 2/5; 7/16] START metric=euclidean, n_neighbors=9, weights=uniform.....
[CV 2/5; 7/16] END metric=euclidean, n_neighbors=9, weights=uniform;; score=0.873
total time= 0.0s
[CV 3/5; 7/16] START metric=euclidean, n_neighbors=9, weights=uniform.....
[CV 3/5; 7/16] END metric=euclidean, n_neighbors=9, weights=uniform;; score=0.864
total time= 0.0s
[CV 4/5; 7/16] START metric=euclidean, n_neighbors=9, weights=uniform.....
[CV 4/5; 7/16] END metric=euclidean, n_neighbors=9, weights=uniform;; score=0.859
total time= 0.0s
[CV 5/5; 7/16] START metric=euclidean, n_neighbors=9, weights=uniform.....
[CV 5/5; 7/16] END metric=euclidean, n_neighbors=9, weights=uniform;; score=0.862
total time= 0.0s
[CV 1/5; 8/16] START metric=euclidean, n_neighbors=9, weights=distance.....
[CV 1/5; 8/16] END metric=euclidean, n_neighbors=9, weights=distance;; score=0.822
total time= 0.0s
[CV 2/5; 8/16] START metric=euclidean, n_neighbors=9, weights=distance.....
[CV 2/5; 8/16] END metric=euclidean, n_neighbors=9, weights=distance;; score=0.830
total time= 0.0s
[CV 3/5; 8/16] START metric=euclidean, n_neighbors=9, weights=distance.....
[CV 3/5; 8/16] END metric=euclidean, n_neighbors=9, weights=distance;; score=0.828
total time= 0.0s
[CV 4/5; 8/16] START metric=euclidean, n_neighbors=9, weights=distance.....
[CV 4/5; 8/16] END metric=euclidean, n_neighbors=9, weights=distance;; score=0.828
total time= 0.0s
[CV 5/5; 8/16] START metric=euclidean, n_neighbors=9, weights=distance.....
[CV 5/5; 8/16] END metric=euclidean, n_neighbors=9, weights=distance;; score=0.824
total time= 0.0s
[CV 1/5; 9/16] START metric=manhattan, n_neighbors=3, weights=uniform.....
[CV 1/5; 9/16] END metric=manhattan, n_neighbors=3, weights=uniform;; score=0.840
total time= 0.0s
[CV 2/5; 9/16] START metric=manhattan, n_neighbors=3, weights=uniform.....
[CV 2/5; 9/16] END metric=manhattan, n_neighbors=3, weights=uniform;; score=0.857
total time= 0.0s
[CV 3/5; 9/16] START metric=manhattan, n_neighbors=3, weights=uniform.....
```

```
[CV 3/5; 9/16] END metric=manhattan, n_neighbors=3, weights=uniform;; score=0.846
total time= 0.0s
[CV 4/5; 9/16] START metric=manhattan, n_neighbors=3, weights=uniform.....
[CV 4/5; 9/16] END metric=manhattan, n_neighbors=3, weights=uniform;; score=0.849
total time= 0.0s
[CV 5/5; 9/16] START metric=manhattan, n_neighbors=3, weights=uniform.....
[CV 5/5; 9/16] END metric=manhattan, n_neighbors=3, weights=uniform;; score=0.841
total time= 0.0s
[CV 1/5; 10/16] START metric=manhattan, n_neighbors=3, weights=distance.....
[CV 1/5; 10/16] END metric=manhattan, n_neighbors=3, weights=distance;; score=0.81
2 total time= 0.0s
[CV 2/5; 10/16] START metric=manhattan, n_neighbors=3, weights=distance.....
[CV 2/5; 10/16] END metric=manhattan, n_neighbors=3, weights=distance;; score=0.82
6 total time= 0.0s
[CV 3/5; 10/16] START metric=manhattan, n_neighbors=3, weights=distance.....
[CV 3/5; 10/16] END metric=manhattan, n_neighbors=3, weights=distance;; score=0.82
5 total time= 0.0s
[CV 4/5; 10/16] START metric=manhattan, n_neighbors=3, weights=distance.....
[CV 4/5; 10/16] END metric=manhattan, n_neighbors=3, weights=distance;; score=0.82
5 total time= 0.0s
[CV 5/5; 10/16] START metric=manhattan, n_neighbors=3, weights=distance.....
[CV 5/5; 10/16] END metric=manhattan, n_neighbors=3, weights=distance;; score=0.81
8 total time= 0.0s
[CV 1/5; 11/16] START metric=manhattan, n_neighbors=5, weights=uniform.....
[CV 1/5; 11/16] END metric=manhattan, n_neighbors=5, weights=uniform;; score=0.856
total time= 0.0s
[CV 2/5; 11/16] START metric=manhattan, n_neighbors=5, weights=uniform.....
[CV 2/5; 11/16] END metric=manhattan, n_neighbors=5, weights=uniform;; score=0.868
total time= 0.0s
[CV 3/5; 11/16] START metric=manhattan, n_neighbors=5, weights=uniform.....
[CV 3/5; 11/16] END metric=manhattan, n_neighbors=5, weights=uniform;; score=0.859
total time= 0.0s
[CV 4/5; 11/16] START metric=manhattan, n_neighbors=5, weights=uniform.....
[CV 4/5; 11/16] END metric=manhattan, n_neighbors=5, weights=uniform;; score=0.859
total time= 0.0s
[CV 5/5; 11/16] START metric=manhattan, n_neighbors=5, weights=uniform.....
[CV 5/5; 11/16] END metric=manhattan, n_neighbors=5, weights=uniform;; score=0.857
total time= 0.0s
[CV 1/5; 12/16] START metric=manhattan, n_neighbors=5, weights=distance.....
[CV 1/5; 12/16] END metric=manhattan, n_neighbors=5, weights=distance;; score=0.81
9 total time= 0.0s
[CV 2/5; 12/16] START metric=manhattan, n_neighbors=5, weights=distance.....
[CV 2/5; 12/16] END metric=manhattan, n_neighbors=5, weights=distance;; score=0.82
9 total time= 0.0s
[CV 3/5; 12/16] START metric=manhattan, n_neighbors=5, weights=distance.....
[CV 3/5; 12/16] END metric=manhattan, n_neighbors=5, weights=distance;; score=0.82
9 total time= 0.0s
[CV 4/5; 12/16] START metric=manhattan, n_neighbors=5, weights=distance.....
[CV 4/5; 12/16] END metric=manhattan, n_neighbors=5, weights=distance;; score=0.82
9 total time= 0.0s
[CV 5/5; 12/16] START metric=manhattan, n_neighbors=5, weights=distance.....
[CV 5/5; 12/16] END metric=manhattan, n_neighbors=5, weights=distance;; score=0.82
3 total time= 0.0s
[CV 1/5; 13/16] START metric=manhattan, n_neighbors=7, weights=uniform.....
[CV 1/5; 13/16] END metric=manhattan, n_neighbors=7, weights=uniform;; score=0.857
total time= 0.0s
[CV 2/5; 13/16] START metric=manhattan, n_neighbors=7, weights=uniform.....
[CV 2/5; 13/16] END metric=manhattan, n_neighbors=7, weights=uniform;; score=0.873
total time= 0.0s
[CV 3/5; 13/16] START metric=manhattan, n_neighbors=7, weights=uniform.....
[CV 3/5; 13/16] END metric=manhattan, n_neighbors=7, weights=uniform;; score=0.864
total time= 0.0s
[CV 4/5; 13/16] START metric=manhattan, n_neighbors=7, weights=uniform.....
[CV 4/5; 13/16] END metric=manhattan, n_neighbors=7, weights=uniform;; score=0.861
```

```

total time= 0.0s
[CV 5/5; 13/16] START metric=manhattan, n_neighbors=7, weights=uniform.....
[CV 5/5; 13/16] END metric=manhattan, n_neighbors=7, weights=uniform;; score=0.863
total time= 0.0s
[CV 1/5; 14/16] START metric=manhattan, n_neighbors=7, weights=distance.....
[CV 1/5; 14/16] END metric=manhattan, n_neighbors=7, weights=distance;; score=0.82
2 total time= 0.0s
[CV 2/5; 14/16] START metric=manhattan, n_neighbors=7, weights=distance.....
[CV 2/5; 14/16] END metric=manhattan, n_neighbors=7, weights=distance;; score=0.82
8 total time= 0.0s
[CV 3/5; 14/16] START metric=manhattan, n_neighbors=7, weights=distance.....
[CV 3/5; 14/16] END metric=manhattan, n_neighbors=7, weights=distance;; score=0.82
9 total time= 0.0s
[CV 4/5; 14/16] START metric=manhattan, n_neighbors=7, weights=distance.....
[CV 4/5; 14/16] END metric=manhattan, n_neighbors=7, weights=distance;; score=0.82
9 total time= 0.0s
[CV 5/5; 14/16] START metric=manhattan, n_neighbors=7, weights=distance.....
[CV 5/5; 14/16] END metric=manhattan, n_neighbors=7, weights=distance;; score=0.82
4 total time= 0.0s
[CV 1/5; 15/16] START metric=manhattan, n_neighbors=9, weights=uniform.....
[CV 1/5; 15/16] END metric=manhattan, n_neighbors=9, weights=uniform;; score=0.859
total time= 0.0s
[CV 2/5; 15/16] START metric=manhattan, n_neighbors=9, weights=uniform.....
[CV 2/5; 15/16] END metric=manhattan, n_neighbors=9, weights=uniform;; score=0.873
total time= 0.0s
[CV 3/5; 15/16] START metric=manhattan, n_neighbors=9, weights=uniform.....
[CV 3/5; 15/16] END metric=manhattan, n_neighbors=9, weights=uniform;; score=0.866
total time= 0.0s
[CV 4/5; 15/16] START metric=manhattan, n_neighbors=9, weights=uniform.....
[CV 4/5; 15/16] END metric=manhattan, n_neighbors=9, weights=uniform;; score=0.862
total time= 0.0s
[CV 5/5; 15/16] START metric=manhattan, n_neighbors=9, weights=uniform.....
[CV 5/5; 15/16] END metric=manhattan, n_neighbors=9, weights=uniform;; score=0.864
total time= 0.0s
[CV 1/5; 16/16] START metric=manhattan, n_neighbors=9, weights=distance.....
[CV 1/5; 16/16] END metric=manhattan, n_neighbors=9, weights=distance;; score=0.82
4 total time= 0.0s
[CV 2/5; 16/16] START metric=manhattan, n_neighbors=9, weights=distance.....
[CV 2/5; 16/16] END metric=manhattan, n_neighbors=9, weights=distance;; score=0.83
0 total time= 0.0s
[CV 3/5; 16/16] START metric=manhattan, n_neighbors=9, weights=distance.....
[CV 3/5; 16/16] END metric=manhattan, n_neighbors=9, weights=distance;; score=0.82
9 total time= 0.0s
[CV 4/5; 16/16] START metric=manhattan, n_neighbors=9, weights=distance.....
[CV 4/5; 16/16] END metric=manhattan, n_neighbors=9, weights=distance;; score=0.82
9 total time= 0.0s
[CV 5/5; 16/16] START metric=manhattan, n_neighbors=9, weights=distance.....
[CV 5/5; 16/16] END metric=manhattan, n_neighbors=9, weights=distance;; score=0.82
7 total time= 0.0s

```

```

In [22]: print(best_knn_params)

knn_y_pred = best_knn_model.predict(X_test)
print("\nClassification Report for KNN Model:")
print(classification_report(y_test, knn_y_pred))

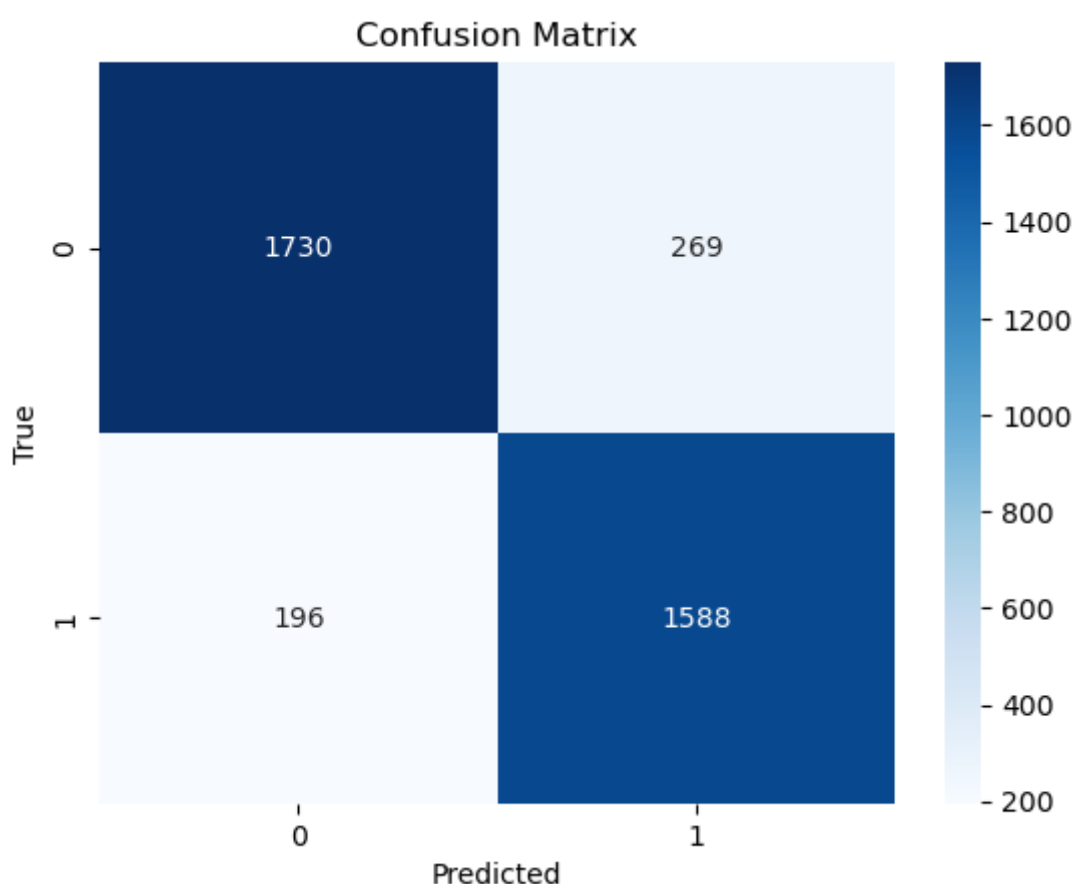
```

```
{'metric': 'manhattan', 'n_neighbors': 9, 'weights': 'uniform'}
```

Classification Report for KNN Model:

	precision	recall	f1-score	support
0	0.90	0.87	0.88	1999
1	0.86	0.89	0.87	1784
accuracy			0.88	3783
macro avg	0.88	0.88	0.88	3783
weighted avg	0.88	0.88	0.88	3783

```
In [23]: # Confusion Matrix
sns.heatmap(confusion_matrix(y_test, knn_y_pred), annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()
```



Logistic Regression Model

```
In [38]: from sklearn.linear_model import LogisticRegression
```

```
In [41]: # Define hyperparameters
lr_param_grid = {
    'C': [0.001, 0.01, 0.1, 1, 10, 100],
    'penalty': ['l1', 'l2'],
    'max_iter': [100, 1000],
}

# Creating a Gaussian Naive Bayes model
lr_model = LogisticRegression(random_state=42)
```

```
# Grid search
lr_grid_search = GridSearchCV(estimator=lr_model, param_grid=lr_param_grid, cv=kf,
lr_grid_search.fit(X_train, y_train)

# Access best model and params
best_lr_model = lr_grid_search.best_estimator_
best_lr_params = lr_grid_search.best_params_
```



```

Fitting 5 folds for each of 24 candidates, totalling 120 fits
[CV 1/5; 1/24] START C=0.001, max_iter=100, penalty=l1.....
[CV 1/5; 1/24] END C=0.001, max_iter=100, penalty=l1; , score=nan total time=  0.0
s
[CV 2/5; 1/24] START C=0.001, max_iter=100, penalty=l1.....
[CV 2/5; 1/24] END C=0.001, max_iter=100, penalty=l1; , score=nan total time=  0.0
s
[CV 3/5; 1/24] START C=0.001, max_iter=100, penalty=l1.....
[CV 3/5; 1/24] END C=0.001, max_iter=100, penalty=l1; , score=nan total time=  0.0
s
[CV 4/5; 1/24] START C=0.001, max_iter=100, penalty=l1.....
[CV 4/5; 1/24] END C=0.001, max_iter=100, penalty=l1; , score=nan total time=  0.0
s
[CV 5/5; 1/24] START C=0.001, max_iter=100, penalty=l1.....
[CV 5/5; 1/24] END C=0.001, max_iter=100, penalty=l1; , score=nan total time=  0.0
s
[CV 1/5; 2/24] START C=0.001, max_iter=100, penalty=l2.....
[CV 1/5; 2/24] END C=0.001, max_iter=100, penalty=l2; , score=0.784 total time=
0.0s
[CV 2/5; 2/24] START C=0.001, max_iter=100, penalty=l2.....
[CV 2/5; 2/24] END C=0.001, max_iter=100, penalty=l2; , score=0.785 total time=
0.0s
[CV 3/5; 2/24] START C=0.001, max_iter=100, penalty=l2.....
[CV 3/5; 2/24] END C=0.001, max_iter=100, penalty=l2; , score=0.799 total time=
0.0s
[CV 4/5; 2/24] START C=0.001, max_iter=100, penalty=l2.....
[CV 4/5; 2/24] END C=0.001, max_iter=100, penalty=l2; , score=0.788 total time=
0.0s
[CV 5/5; 2/24] START C=0.001, max_iter=100, penalty=l2.....
[CV 5/5; 2/24] END C=0.001, max_iter=100, penalty=l2; , score=0.789 total time=
0.0s
[CV 1/5; 3/24] START C=0.001, max_iter=1000, penalty=l1.....
[CV 1/5; 3/24] END C=0.001, max_iter=1000, penalty=l1; , score=nan total time=  0.
0s
[CV 2/5; 3/24] START C=0.001, max_iter=1000, penalty=l1.....
[CV 2/5; 3/24] END C=0.001, max_iter=1000, penalty=l1; , score=nan total time=  0.
0s
[CV 3/5; 3/24] START C=0.001, max_iter=1000, penalty=l1.....
[CV 3/5; 3/24] END C=0.001, max_iter=1000, penalty=l1; , score=nan total time=  0.
0s
[CV 4/5; 3/24] START C=0.001, max_iter=1000, penalty=l1.....
[CV 4/5; 3/24] END C=0.001, max_iter=1000, penalty=l1; , score=nan total time=  0.
0s
[CV 5/5; 3/24] START C=0.001, max_iter=1000, penalty=l1.....
[CV 5/5; 3/24] END C=0.001, max_iter=1000, penalty=l1; , score=nan total time=  0.
0s
[CV 1/5; 4/24] START C=0.001, max_iter=1000, penalty=l2.....
[CV 1/5; 4/24] END C=0.001, max_iter=1000, penalty=l2; , score=0.784 total time=
0.0s
[CV 2/5; 4/24] START C=0.001, max_iter=1000, penalty=l2.....
[CV 2/5; 4/24] END C=0.001, max_iter=1000, penalty=l2; , score=0.785 total time=
0.0s
[CV 3/5; 4/24] START C=0.001, max_iter=1000, penalty=l2.....
[CV 3/5; 4/24] END C=0.001, max_iter=1000, penalty=l2; , score=0.799 total time=
0.0s
[CV 4/5; 4/24] START C=0.001, max_iter=1000, penalty=l2.....
[CV 4/5; 4/24] END C=0.001, max_iter=1000, penalty=l2; , score=0.788 total time=
0.0s
[CV 5/5; 4/24] START C=0.001, max_iter=1000, penalty=l2.....
[CV 5/5; 4/24] END C=0.001, max_iter=1000, penalty=l2; , score=0.789 total time=
0.0s
[CV 1/5; 5/24] START C=0.01, max_iter=100, penalty=l1.....
[CV 1/5; 5/24] END C=0.01, max_iter=100, penalty=l1; , score=nan total time=  0.0s
[CV 2/5; 5/24] START C=0.01, max_iter=100, penalty=l1.....

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```

[CV 2/5; 5/24] END C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 3/5; 5/24] START C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 3/5; 5/24] END C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 4/5; 5/24] START C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 4/5; 5/24] END C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 5/5; 5/24] START C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 5/5; 5/24] END C=0.01, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 1/5; 6/24] START C=0.01, max_iter=100, penalty=l2; score=0.814 total time= 0.0s
[CV 1/5; 6/24] END C=0.01, max_iter=100, penalty=l2; score=0.814 total time= 0.0s
[CV 2/5; 6/24] START C=0.01, max_iter=100, penalty=l2; score=0.825 total time= 0.0s
[CV 2/5; 6/24] END C=0.01, max_iter=100, penalty=l2; score=0.825 total time= 0.0s
[CV 3/5; 6/24] START C=0.01, max_iter=100, penalty=l2; score=0.832 total time= 0.0s
[CV 3/5; 6/24] END C=0.01, max_iter=100, penalty=l2; score=0.832 total time= 0.0s
[CV 4/5; 6/24] START C=0.01, max_iter=100, penalty=l2; score=0.824 total time= 0.0s
[CV 4/5; 6/24] END C=0.01, max_iter=100, penalty=l2; score=0.824 total time= 0.0s
[CV 5/5; 6/24] START C=0.01, max_iter=100, penalty=l2; score=0.822 total time= 0.0s
[CV 5/5; 6/24] END C=0.01, max_iter=100, penalty=l2; score=0.822 total time= 0.0s
[CV 1/5; 7/24] START C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 1/5; 7/24] END C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 2/5; 7/24] START C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 2/5; 7/24] END C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 3/5; 7/24] START C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 3/5; 7/24] END C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 4/5; 7/24] START C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 4/5; 7/24] END C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 5/5; 7/24] START C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 5/5; 7/24] END C=0.01, max_iter=1000, penalty=l1; score=nan total time= 0.0s
[CV 1/5; 8/24] START C=0.01, max_iter=1000, penalty=l2; score=0.814 total time= 0.0s
[CV 1/5; 8/24] END C=0.01, max_iter=1000, penalty=l2; score=0.814 total time= 0.0s
[CV 2/5; 8/24] START C=0.01, max_iter=1000, penalty=l2; score=0.825 total time= 0.0s
[CV 2/5; 8/24] END C=0.01, max_iter=1000, penalty=l2; score=0.825 total time= 0.0s
[CV 3/5; 8/24] START C=0.01, max_iter=1000, penalty=l2; score=0.832 total time= 0.0s
[CV 3/5; 8/24] END C=0.01, max_iter=1000, penalty=l2; score=0.832 total time= 0.0s
[CV 4/5; 8/24] START C=0.01, max_iter=1000, penalty=l2; score=0.824 total time= 0.0s
[CV 4/5; 8/24] END C=0.01, max_iter=1000, penalty=l2; score=0.824 total time= 0.0s
[CV 5/5; 8/24] START C=0.01, max_iter=1000, penalty=l2; score=0.822 total time= 0.0s
[CV 5/5; 8/24] END C=0.01, max_iter=1000, penalty=l2; score=0.822 total time= 0.0s
[CV 1/5; 9/24] START C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 1/5; 9/24] END C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 2/5; 9/24] START C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 2/5; 9/24] END C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 3/5; 9/24] START C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 3/5; 9/24] END C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 4/5; 9/24] START C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 4/5; 9/24] END C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 5/5; 9/24] START C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 5/5; 9/24] END C=0.1, max_iter=100, penalty=l1; score=nan total time= 0.0s
[CV 1/5; 10/24] START C=0.1, max_iter=100, penalty=l2; score=0.817 total time= 0.0s
[CV 1/5; 10/24] END C=0.1, max_iter=100, penalty=l2; score=0.817 total time= 0.0s

```

```

0s
[CV 2/5; 10/24] START C=0.1, max_iter=100, penalty=l2.....
[CV 2/5; 10/24] END C=0.1, max_iter=100, penalty=l2;; score=0.828 total time=  0.
0s
[CV 3/5; 10/24] START C=0.1, max_iter=100, penalty=l2.....
[CV 3/5; 10/24] END C=0.1, max_iter=100, penalty=l2;; score=0.827 total time=  0.
0s
[CV 4/5; 10/24] START C=0.1, max_iter=100, penalty=l2.....
[CV 4/5; 10/24] END C=0.1, max_iter=100, penalty=l2;; score=0.821 total time=  0.
0s
[CV 5/5; 10/24] START C=0.1, max_iter=100, penalty=l2.....
[CV 5/5; 10/24] END C=0.1, max_iter=100, penalty=l2;; score=0.819 total time=  0.
0s
[CV 1/5; 11/24] START C=0.1, max_iter=1000, penalty=l1.....
[CV 1/5; 11/24] END C=0.1, max_iter=1000, penalty=l1;; score=nan total time=  0.0
s
[CV 2/5; 11/24] START C=0.1, max_iter=1000, penalty=l1.....
[CV 2/5; 11/24] END C=0.1, max_iter=1000, penalty=l1;; score=nan total time=  0.0
s
[CV 3/5; 11/24] START C=0.1, max_iter=1000, penalty=l1.....
[CV 3/5; 11/24] END C=0.1, max_iter=1000, penalty=l1;; score=nan total time=  0.0
s
[CV 4/5; 11/24] START C=0.1, max_iter=1000, penalty=l1.....
[CV 4/5; 11/24] END C=0.1, max_iter=1000, penalty=l1;; score=nan total time=  0.0
s
[CV 5/5; 11/24] START C=0.1, max_iter=1000, penalty=l1.....
[CV 5/5; 11/24] END C=0.1, max_iter=1000, penalty=l1;; score=nan total time=  0.0
s
[CV 1/5; 12/24] START C=0.1, max_iter=1000, penalty=l2.....
[CV 1/5; 12/24] END C=0.1, max_iter=1000, penalty=l2;; score=0.817 total time=
0.0s
[CV 2/5; 12/24] START C=0.1, max_iter=1000, penalty=l2.....
[CV 2/5; 12/24] END C=0.1, max_iter=1000, penalty=l2;; score=0.828 total time=
0.0s
[CV 3/5; 12/24] START C=0.1, max_iter=1000, penalty=l2.....
[CV 3/5; 12/24] END C=0.1, max_iter=1000, penalty=l2;; score=0.827 total time=
0.0s
[CV 4/5; 12/24] START C=0.1, max_iter=1000, penalty=l2.....
[CV 4/5; 12/24] END C=0.1, max_iter=1000, penalty=l2;; score=0.821 total time=
0.0s
[CV 5/5; 12/24] START C=0.1, max_iter=1000, penalty=l2.....
[CV 5/5; 12/24] END C=0.1, max_iter=1000, penalty=l2;; score=0.819 total time=
0.0s
[CV 1/5; 13/24] START C=1, max_iter=100, penalty=l1.....
[CV 1/5; 13/24] END C=1, max_iter=100, penalty=l1;; score=nan total time=  0.0s
[CV 2/5; 13/24] START C=1, max_iter=100, penalty=l1.....
[CV 2/5; 13/24] END C=1, max_iter=100, penalty=l1;; score=nan total time=  0.0s
[CV 3/5; 13/24] START C=1, max_iter=100, penalty=l1.....
[CV 3/5; 13/24] END C=1, max_iter=100, penalty=l1;; score=nan total time=  0.0s
[CV 4/5; 13/24] START C=1, max_iter=100, penalty=l1.....
[CV 4/5; 13/24] END C=1, max_iter=100, penalty=l1;; score=nan total time=  0.0s
[CV 5/5; 13/24] START C=1, max_iter=100, penalty=l1.....
[CV 5/5; 13/24] END C=1, max_iter=100, penalty=l1;; score=nan total time=  0.0s
[CV 1/5; 14/24] START C=1, max_iter=100, penalty=l2.....
[CV 1/5; 14/24] END C=1, max_iter=100, penalty=l2;; score=0.811 total time=  0.0s
[CV 2/5; 14/24] START C=1, max_iter=100, penalty=l2.....
[CV 2/5; 14/24] END C=1, max_iter=100, penalty=l2;; score=0.823 total time=  0.0s
[CV 3/5; 14/24] START C=1, max_iter=100, penalty=l2.....
[CV 3/5; 14/24] END C=1, max_iter=100, penalty=l2;; score=0.820 total time=  0.0s
[CV 4/5; 14/24] START C=1, max_iter=100, penalty=l2.....
[CV 4/5; 14/24] END C=1, max_iter=100, penalty=l2;; score=0.817 total time=  0.0s
[CV 5/5; 14/24] START C=1, max_iter=100, penalty=l2.....
[CV 5/5; 14/24] END C=1, max_iter=100, penalty=l2;; score=0.813 total time=  0.0s
[CV 1/5; 15/24] START C=1, max_iter=1000, penalty=l1.....

```

20/65

```
0s
[CV 3/5; 20/24] START C=10, max_iter=1000, penalty=l2.....
[CV 3/5; 20/24] END C=10, max_iter=1000, penalty=l2;; score=0.818 total time= 0.
0s
[CV 4/5; 20/24] START C=10, max_iter=1000, penalty=l2.....
[CV 4/5; 20/24] END C=10, max_iter=1000, penalty=l2;; score=0.816 total time= 0.
0s
[CV 5/5; 20/24] START C=10, max_iter=1000, penalty=l2.....
[CV 5/5; 20/24] END C=10, max_iter=1000, penalty=l2;; score=0.812 total time= 0.
0s
[CV 1/5; 21/24] START C=100, max_iter=100, penalty=l1.....
[CV 1/5; 21/24] END C=100, max_iter=100, penalty=l1;; score=nan total time= 0.0s
[CV 2/5; 21/24] START C=100, max_iter=100, penalty=l1.....
[CV 2/5; 21/24] END C=100, max_iter=100, penalty=l1;; score=nan total time= 0.0s
[CV 3/5; 21/24] START C=100, max_iter=100, penalty=l1.....
[CV 3/5; 21/24] END C=100, max_iter=100, penalty=l1;; score=nan total time= 0.0s
[CV 4/5; 21/24] START C=100, max_iter=100, penalty=l1.....
[CV 4/5; 21/24] END C=100, max_iter=100, penalty=l1;; score=nan total time= 0.0s
[CV 5/5; 21/24] START C=100, max_iter=100, penalty=l1.....
[CV 5/5; 21/24] END C=100, max_iter=100, penalty=l1;; score=nan total time= 0.0s
[CV 1/5; 22/24] START C=100, max_iter=100, penalty=l2.....
[CV 1/5; 22/24] END C=100, max_iter=100, penalty=l2;; score=0.810 total time= 0.
0s
[CV 2/5; 22/24] START C=100, max_iter=100, penalty=l2.....
[CV 2/5; 22/24] END C=100, max_iter=100, penalty=l2;; score=0.822 total time= 0.
0s
[CV 3/5; 22/24] START C=100, max_iter=100, penalty=l2.....
[CV 3/5; 22/24] END C=100, max_iter=100, penalty=l2;; score=0.818 total time= 0.
0s
[CV 4/5; 22/24] START C=100, max_iter=100, penalty=l2.....
[CV 4/5; 22/24] END C=100, max_iter=100, penalty=l2;; score=0.816 total time= 0.
0s
[CV 5/5; 22/24] START C=100, max_iter=100, penalty=l2.....
[CV 5/5; 22/24] END C=100, max_iter=100, penalty=l2;; score=0.812 total time= 0.
0s
[CV 1/5; 23/24] START C=100, max_iter=1000, penalty=l1.....
[CV 1/5; 23/24] END C=100, max_iter=1000, penalty=l1;; score=nan total time= 0.0
s
[CV 2/5; 23/24] START C=100, max_iter=1000, penalty=l1.....
[CV 2/5; 23/24] END C=100, max_iter=1000, penalty=l1;; score=nan total time= 0.0
s
[CV 3/5; 23/24] START C=100, max_iter=1000, penalty=l1.....
[CV 3/5; 23/24] END C=100, max_iter=1000, penalty=l1;; score=nan total time= 0.0
s
[CV 4/5; 23/24] START C=100, max_iter=1000, penalty=l1.....
[CV 4/5; 23/24] END C=100, max_iter=1000, penalty=l1;; score=nan total time= 0.0
s
[CV 5/5; 23/24] START C=100, max_iter=1000, penalty=l1.....
[CV 5/5; 23/24] END C=100, max_iter=1000, penalty=l1;; score=nan total time= 0.0
s
[CV 1/5; 24/24] START C=100, max_iter=1000, penalty=l2.....
[CV 1/5; 24/24] END C=100, max_iter=1000, penalty=l2;; score=0.810 total time=
0.0s
[CV 2/5; 24/24] START C=100, max_iter=1000, penalty=l2.....
[CV 2/5; 24/24] END C=100, max_iter=1000, penalty=l2;; score=0.822 total time=
0.0s
[CV 3/5; 24/24] START C=100, max_iter=1000, penalty=l2.....
[CV 3/5; 24/24] END C=100, max_iter=1000, penalty=l2;; score=0.818 total time=
0.0s
[CV 4/5; 24/24] START C=100, max_iter=1000, penalty=l2.....
[CV 4/5; 24/24] END C=100, max_iter=1000, penalty=l2;; score=0.816 total time=
0.0s
[CV 5/5; 24/24] START C=100, max_iter=1000, penalty=l2.....
```

[CV 5/5; 24/24] END C=100, max_iter=1000, penalty=l2;, score=0.812 total time=0.0s

```
In [42]: print(best_lr_params)

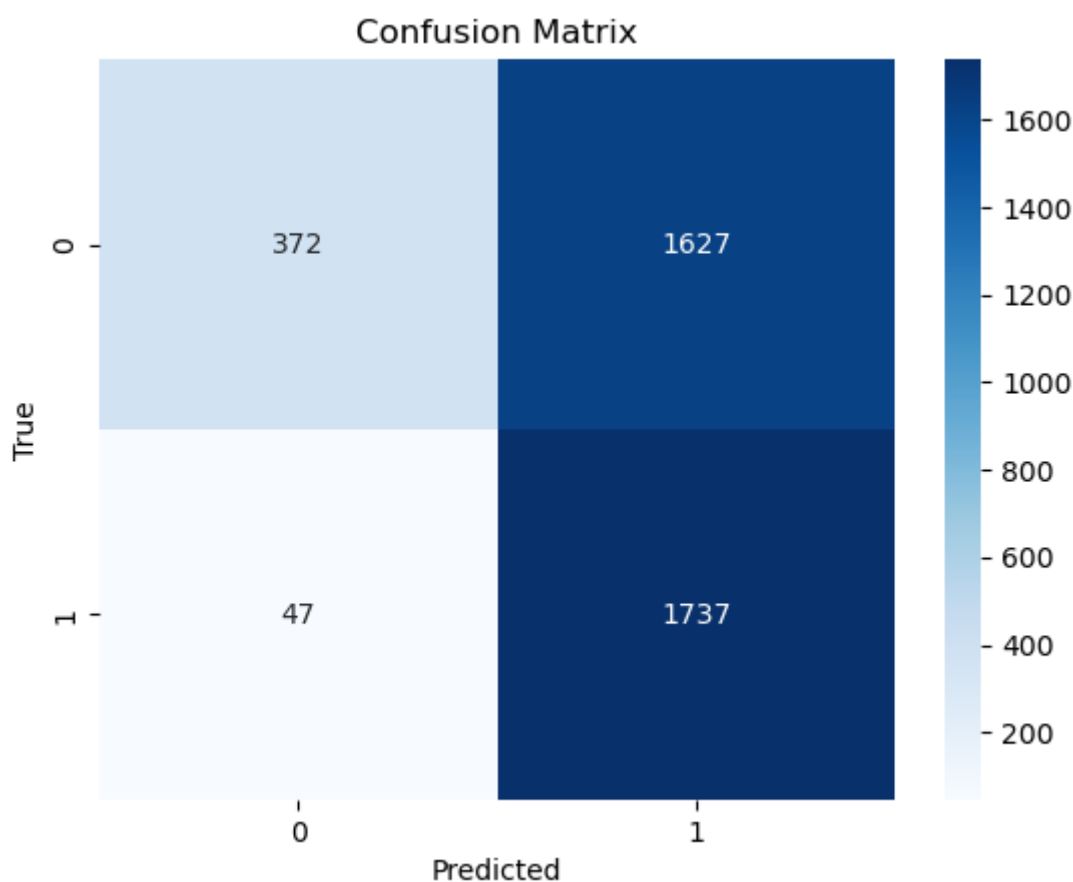
lr_y_pred = best_lr_model.predict(X_test)
print("\nClassification Report for Logistic Regression Model:")
print(classification_report(y_test, lr_y_pred))

{'C': 0.01, 'max_iter': 100, 'penalty': 'l2'}
```

Classification Report for Logistic Regression Model:

	precision	recall	f1-score	support
0	0.84	0.85	0.85	1999
1	0.83	0.82	0.82	1784
accuracy			0.84	3783
macro avg	0.84	0.83	0.84	3783
weighted avg	0.84	0.84	0.84	3783

```
In [27]: # Confusion Matrix
sns.heatmap(confusion_matrix(y_test, NB_y_pred), annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()
```



SVM Model

```
In [28]: from sklearn.svm import SVC
```

```
In [29]: # Hyperparameter grid
svm_param_grid = {
    'C': [0.1, 1, 10],
    'kernel': ['linear', 'rbf'],
    'gamma': [0.01, 0.1, 1],
}

# Create an SVM classifier
svm = SVC(probability=True, random_state=42)
svm_grid_search = GridSearchCV(svm, svm_param_grid, cv=kf, verbose=10)
svm_grid_search.fit(X_train, y_train)

# Access best model and params
best_svm_model = svm_grid_search.best_estimator_
best_svm_params = svm_grid_search.best_params_
```

```

Fitting 5 folds for each of 18 candidates, totalling 90 fits
[CV 1/5; 1/18] START C=0.1, gamma=0.01, kernel=linear.....
[CV 1/5; 1/18] END C=0.1, gamma=0.01, kernel=linear;; score=0.835 total time= 12.1s
[CV 2/5; 1/18] START C=0.1, gamma=0.01, kernel=linear.....
[CV 2/5; 1/18] END C=0.1, gamma=0.01, kernel=linear;; score=0.844 total time= 11.6s
[CV 3/5; 1/18] START C=0.1, gamma=0.01, kernel=linear.....
[CV 3/5; 1/18] END C=0.1, gamma=0.01, kernel=linear;; score=0.840 total time= 11.5s
[CV 4/5; 1/18] START C=0.1, gamma=0.01, kernel=linear.....
[CV 4/5; 1/18] END C=0.1, gamma=0.01, kernel=linear;; score=0.842 total time= 11.3s
[CV 5/5; 1/18] START C=0.1, gamma=0.01, kernel=linear.....
[CV 5/5; 1/18] END C=0.1, gamma=0.01, kernel=linear;; score=0.839 total time= 11.2s
[CV 1/5; 2/18] START C=0.1, gamma=0.01, kernel=rbf.....
[CV 1/5; 2/18] END C=0.1, gamma=0.01, kernel=rbf;; score=0.780 total time= 26.5s
[CV 2/5; 2/18] START C=0.1, gamma=0.01, kernel=rbf.....
[CV 2/5; 2/18] END C=0.1, gamma=0.01, kernel=rbf;; score=0.778 total time= 26.9s
[CV 3/5; 2/18] START C=0.1, gamma=0.01, kernel=rbf.....
[CV 3/5; 2/18] END C=0.1, gamma=0.01, kernel=rbf;; score=0.788 total time= 25.3s
[CV 4/5; 2/18] START C=0.1, gamma=0.01, kernel=rbf.....
[CV 4/5; 2/18] END C=0.1, gamma=0.01, kernel=rbf;; score=0.785 total time= 24.4s
[CV 5/5; 2/18] START C=0.1, gamma=0.01, kernel=rbf.....
[CV 5/5; 2/18] END C=0.1, gamma=0.01, kernel=rbf;; score=0.782 total time= 24.2s
[CV 1/5; 3/18] START C=0.1, gamma=0.1, kernel=linear.....
[CV 1/5; 3/18] END C=0.1, gamma=0.1, kernel=linear;; score=0.835 total time= 10.9s
[CV 2/5; 3/18] START C=0.1, gamma=0.1, kernel=linear.....
[CV 2/5; 3/18] END C=0.1, gamma=0.1, kernel=linear;; score=0.844 total time= 11.2s
[CV 3/5; 3/18] START C=0.1, gamma=0.1, kernel=linear.....
[CV 3/5; 3/18] END C=0.1, gamma=0.1, kernel=linear;; score=0.840 total time= 11.5s
[CV 4/5; 3/18] START C=0.1, gamma=0.1, kernel=linear.....
[CV 4/5; 3/18] END C=0.1, gamma=0.1, kernel=linear;; score=0.842 total time= 11.2s
[CV 5/5; 3/18] START C=0.1, gamma=0.1, kernel=linear.....
[CV 5/5; 3/18] END C=0.1, gamma=0.1, kernel=linear;; score=0.839 total time= 11.3s
[CV 1/5; 4/18] START C=0.1, gamma=0.1, kernel=rbf.....
[CV 1/5; 4/18] END C=0.1, gamma=0.1, kernel=rbf;; score=0.837 total time= 18.6s
[CV 2/5; 4/18] START C=0.1, gamma=0.1, kernel=rbf.....
[CV 2/5; 4/18] END C=0.1, gamma=0.1, kernel=rbf;; score=0.837 total time= 18.2s
[CV 3/5; 4/18] START C=0.1, gamma=0.1, kernel=rbf.....
[CV 3/5; 4/18] END C=0.1, gamma=0.1, kernel=rbf;; score=0.848 total time= 18.5s
[CV 4/5; 4/18] START C=0.1, gamma=0.1, kernel=rbf.....
[CV 4/5; 4/18] END C=0.1, gamma=0.1, kernel=rbf;; score=0.849 total time= 18.3s
[CV 5/5; 4/18] START C=0.1, gamma=0.1, kernel=rbf.....
[CV 5/5; 4/18] END C=0.1, gamma=0.1, kernel=rbf;; score=0.838 total time= 18.3s
[CV 1/5; 5/18] START C=0.1, gamma=1, kernel=linear.....
[CV 1/5; 5/18] END C=0.1, gamma=1, kernel=linear;; score=0.835 total time= 10.9s
[CV 2/5; 5/18] START C=0.1, gamma=1, kernel=linear.....
[CV 2/5; 5/18] END C=0.1, gamma=1, kernel=linear;; score=0.844 total time= 11.3s
[CV 3/5; 5/18] START C=0.1, gamma=1, kernel=linear.....
[CV 3/5; 5/18] END C=0.1, gamma=1, kernel=linear;; score=0.840 total time= 11.5s
[CV 4/5; 5/18] START C=0.1, gamma=1, kernel=linear.....
[CV 4/5; 5/18] END C=0.1, gamma=1, kernel=linear;; score=0.842 total time= 11.2s
[CV 5/5; 5/18] START C=0.1, gamma=1, kernel=linear.....
[CV 5/5; 5/18] END C=0.1, gamma=1, kernel=linear;; score=0.839 total time= 11.3s
[CV 1/5; 6/18] START C=0.1, gamma=1, kernel=rbf.....
[CV 1/5; 6/18] END ..C=0.1, gamma=1, kernel=rbf;; score=0.865 total time= 17.2s
[CV 2/5; 6/18] START C=0.1, gamma=1, kernel=rbf.....

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```
[CV 2/5; 6/18] END ..C=0.1, gamma=1, kernel=rbf; score=0.879 total time= 17.7s
[CV 3/5; 6/18] START C=0.1, gamma=1, kernel=rbf.....
[CV 3/5; 6/18] END ..C=0.1, gamma=1, kernel=rbf; score=0.872 total time= 17.4s
[CV 4/5; 6/18] START C=0.1, gamma=1, kernel=rbf.....
[CV 4/5; 6/18] END ..C=0.1, gamma=1, kernel=rbf; score=0.867 total time= 17.4s
[CV 5/5; 6/18] START C=0.1, gamma=1, kernel=rbf.....
[CV 5/5; 6/18] END ..C=0.1, gamma=1, kernel=rbf; score=0.865 total time= 17.4s
[CV 1/5; 7/18] START C=1, gamma=0.01, kernel=linear.....
[CV 1/5; 7/18] END C=1, gamma=0.01, kernel=linear; score=0.835 total time= 7.9min
[CV 2/5; 7/18] START C=1, gamma=0.01, kernel=linear.....
[CV 2/5; 7/18] END C=1, gamma=0.01, kernel=linear; score=0.845 total time= 5.0min
[CV 3/5; 7/18] START C=1, gamma=0.01, kernel=linear.....
[CV 3/5; 7/18] END C=1, gamma=0.01, kernel=linear; score=0.847 total time= 5.2min
[CV 4/5; 7/18] START C=1, gamma=0.01, kernel=linear.....
[CV 4/5; 7/18] END C=1, gamma=0.01, kernel=linear; score=0.840 total time=34.6min
[CV 5/5; 7/18] START C=1, gamma=0.01, kernel=linear.....
[CV 5/5; 7/18] END C=1, gamma=0.01, kernel=linear; score=0.840 total time= 5.1min
[CV 1/5; 8/18] START C=1, gamma=0.01, kernel=rbf.....
[CV 1/5; 8/18] END .C=1, gamma=0.01, kernel=rbf; score=0.801 total time= 22.5s
[CV 2/5; 8/18] START C=1, gamma=0.01, kernel=rbf.....
[CV 2/5; 8/18] END .C=1, gamma=0.01, kernel=rbf; score=0.803 total time= 21.6s
[CV 3/5; 8/18] START C=1, gamma=0.01, kernel=rbf.....
[CV 3/5; 8/18] END .C=1, gamma=0.01, kernel=rbf; score=0.809 total time= 21.9s
[CV 4/5; 8/18] START C=1, gamma=0.01, kernel=rbf.....
[CV 4/5; 8/18] END .C=1, gamma=0.01, kernel=rbf; score=0.804 total time= 21.7s
[CV 5/5; 8/18] START C=1, gamma=0.01, kernel=rbf.....
[CV 5/5; 8/18] END .C=1, gamma=0.01, kernel=rbf; score=0.803 total time= 21.9s
[CV 1/5; 9/18] START C=1, gamma=0.1, kernel=linear.....
[CV 1/5; 9/18] END C=1, gamma=0.1, kernel=linear; score=0.835 total time= 8.9min
[CV 2/5; 9/18] START C=1, gamma=0.1, kernel=linear.....
[CV 2/5; 9/18] END C=1, gamma=0.1, kernel=linear; score=0.845 total time= 5.3min
[CV 3/5; 9/18] START C=1, gamma=0.1, kernel=linear.....
[CV 3/5; 9/18] END C=1, gamma=0.1, kernel=linear; score=0.847 total time= 5.9min
[CV 4/5; 9/18] START C=1, gamma=0.1, kernel=linear.....
[CV 4/5; 9/18] END C=1, gamma=0.1, kernel=linear; score=0.840 total time= 6.0min
[CV 5/5; 9/18] START C=1, gamma=0.1, kernel=linear.....
[CV 5/5; 9/18] END C=1, gamma=0.1, kernel=linear; score=0.840 total time= 5.2min
[CV 1/5; 10/18] START C=1, gamma=0.1, kernel=rbf.....
[CV 1/5; 10/18] END .C=1, gamma=0.1, kernel=rbf; score=0.867 total time= 16.5s
[CV 2/5; 10/18] START C=1, gamma=0.1, kernel=rbf.....
[CV 2/5; 10/18] END .C=1, gamma=0.1, kernel=rbf; score=0.882 total time= 16.8s
[CV 3/5; 10/18] START C=1, gamma=0.1, kernel=rbf.....
[CV 3/5; 10/18] END .C=1, gamma=0.1, kernel=rbf; score=0.879 total time= 16.6s
[CV 4/5; 10/18] START C=1, gamma=0.1, kernel=rbf.....
[CV 4/5; 10/18] END .C=1, gamma=0.1, kernel=rbf; score=0.875 total time= 16.7s
[CV 5/5; 10/18] START C=1, gamma=0.1, kernel=rbf.....
[CV 5/5; 10/18] END .C=1, gamma=0.1, kernel=rbf; score=0.870 total time= 16.7s
[CV 1/5; 11/18] START C=1, gamma=1, kernel=linear.....
[CV 1/5; 11/18] END C=1, gamma=1, kernel=linear; score=0.835 total time= 5.4min
[CV 2/5; 11/18] START C=1, gamma=1, kernel=linear.....
[CV 2/5; 11/18] END C=1, gamma=1, kernel=linear; score=0.845 total time=507.4min
[CV 3/5; 11/18] START C=1, gamma=1, kernel=linear.....
[CV 3/5; 11/18] END C=1, gamma=1, kernel=linear; score=0.847 total time= 5.4min
[CV 4/5; 11/18] START C=1, gamma=1, kernel=linear.....
[CV 4/5; 11/18] END C=1, gamma=1, kernel=linear; score=0.840 total time=15.3min
[CV 5/5; 11/18] START C=1, gamma=1, kernel=linear.....
[CV 5/5; 11/18] END C=1, gamma=1, kernel=linear; score=0.840 total time= 5.2min
[CV 1/5; 12/18] START C=1, gamma=1, kernel=rbf.....
[CV 1/5; 12/18] END ...C=1, gamma=1, kernel=rbf; score=0.871 total time= 15.4s
[CV 2/5; 12/18] START C=1, gamma=1, kernel=rbf.....
[CV 2/5; 12/18] END ...C=1, gamma=1, kernel=rbf; score=0.885 total time= 15.9s
[CV 3/5; 12/18] START C=1, gamma=1, kernel=rbf.....
[CV 3/5; 12/18] END ...C=1, gamma=1, kernel=rbf; score=0.877 total time= 15.5s
[CV 4/5; 12/18] START C=1, gamma=1, kernel=rbf.....
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[CV 4/5; 12/18] END ...C=1, gamma=1, kernel=rbf;; score=0.874 total time= 15.5s
[CV 5/5; 12/18] START C=1, gamma=1, kernel=rbf.....
[CV 5/5; 12/18] END ...C=1, gamma=1, kernel=rbf;; score=0.873 total time= 15.7s
[CV 1/5; 13/18] START C=10, gamma=0.01, kernel=linear.....
[CV 1/5; 13/18] END C=10, gamma=0.01, kernel=linear;; score=0.835 total time= 7.6m
in
[CV 2/5; 13/18] START C=10, gamma=0.01, kernel=linear.....
[CV 2/5; 13/18] END C=10, gamma=0.01, kernel=linear;; score=0.845 total time= 5.6m
in
[CV 3/5; 13/18] START C=10, gamma=0.01, kernel=linear.....
[CV 3/5; 13/18] END C=10, gamma=0.01, kernel=linear;; score=0.846 total time= 6.9m
in
[CV 4/5; 13/18] START C=10, gamma=0.01, kernel=linear.....
[CV 4/5; 13/18] END C=10, gamma=0.01, kernel=linear;; score=0.839 total time= 6.5m
in
[CV 5/5; 13/18] START C=10, gamma=0.01, kernel=linear.....
[CV 5/5; 13/18] END C=10, gamma=0.01, kernel=linear;; score=0.839 total time= 6.4m
in
[CV 1/5; 14/18] START C=10, gamma=0.01, kernel=rbf.....
[CV 1/5; 14/18] END C=10, gamma=0.01, kernel=rbf;; score=0.833 total time= 30.8s
[CV 2/5; 14/18] START C=10, gamma=0.01, kernel=rbf.....
[CV 2/5; 14/18] END C=10, gamma=0.01, kernel=rbf;; score=0.840 total time= 31.5s
[CV 3/5; 14/18] START C=10, gamma=0.01, kernel=rbf.....
[CV 3/5; 14/18] END C=10, gamma=0.01, kernel=rbf;; score=0.838 total time= 30.0s
[CV 4/5; 14/18] START C=10, gamma=0.01, kernel=rbf.....
[CV 4/5; 14/18] END C=10, gamma=0.01, kernel=rbf;; score=0.838 total time= 29.3s
[CV 5/5; 14/18] START C=10, gamma=0.01, kernel=rbf.....
[CV 5/5; 14/18] END C=10, gamma=0.01, kernel=rbf;; score=0.831 total time= 29.7s
[CV 1/5; 15/18] START C=10, gamma=0.1, kernel=linear.....
[CV 1/5; 15/18] END C=10, gamma=0.1, kernel=linear;; score=0.835 total time= 6.5mi
n
[CV 2/5; 15/18] START C=10, gamma=0.1, kernel=linear.....
[CV 2/5; 15/18] END C=10, gamma=0.1, kernel=linear;; score=0.845 total time= 5.9mi
n
[CV 3/5; 15/18] START C=10, gamma=0.1, kernel=linear.....
[CV 3/5; 15/18] END C=10, gamma=0.1, kernel=linear;; score=0.846 total time= 7.0mi
n
[CV 4/5; 15/18] START C=10, gamma=0.1, kernel=linear.....
[CV 4/5; 15/18] END C=10, gamma=0.1, kernel=linear;; score=0.839 total time= 6.7mi
n
[CV 5/5; 15/18] START C=10, gamma=0.1, kernel=linear.....
[CV 5/5; 15/18] END C=10, gamma=0.1, kernel=linear;; score=0.839 total time= 6.3mi
n
[CV 1/5; 16/18] START C=10, gamma=0.1, kernel=rbf.....
[CV 1/5; 16/18] END C=10, gamma=0.1, kernel=rbf;; score=0.868 total time= 44.5s
[CV 2/5; 16/18] START C=10, gamma=0.1, kernel=rbf.....
[CV 2/5; 16/18] END C=10, gamma=0.1, kernel=rbf;; score=0.885 total time= 46.1s
[CV 3/5; 16/18] START C=10, gamma=0.1, kernel=rbf.....
[CV 3/5; 16/18] END C=10, gamma=0.1, kernel=rbf;; score=0.879 total time= 45.2s
[CV 4/5; 16/18] START C=10, gamma=0.1, kernel=rbf.....
[CV 4/5; 16/18] END C=10, gamma=0.1, kernel=rbf;; score=0.875 total time= 47.1s
[CV 5/5; 16/18] START C=10, gamma=0.1, kernel=rbf.....
[CV 5/5; 16/18] END C=10, gamma=0.1, kernel=rbf;; score=0.872 total time= 45.0s
[CV 1/5; 17/18] START C=10, gamma=1, kernel=linear.....
[CV 1/5; 17/18] END C=10, gamma=1, kernel=linear;; score=0.835 total time= 6.5min
[CV 2/5; 17/18] START C=10, gamma=1, kernel=linear.....
[CV 2/5; 17/18] END C=10, gamma=1, kernel=linear;; score=0.845 total time= 6.0min
[CV 3/5; 17/18] START C=10, gamma=1, kernel=linear.....
[CV 3/5; 17/18] END C=10, gamma=1, kernel=linear;; score=0.846 total time= 7.1min
[CV 4/5; 17/18] START C=10, gamma=1, kernel=linear.....
[CV 4/5; 17/18] END C=10, gamma=1, kernel=linear;; score=0.839 total time= 6.5min
[CV 5/5; 17/18] START C=10, gamma=1, kernel=linear.....
[CV 5/5; 17/18] END C=10, gamma=1, kernel=linear;; score=0.839 total time= 6.5min
[CV 1/5; 18/18] START C=10, gamma=1, kernel=rbf.....
```

```
[CV 1/5; 18/18] END ..C=10, gamma=1, kernel=rbf; score=0.869 total time= 32.4s
[CV 2/5; 18/18] START C=10, gamma=1, kernel=rbf.....
[CV 2/5; 18/18] END ..C=10, gamma=1, kernel=rbf; score=0.880 total time= 32.0s
[CV 3/5; 18/18] START C=10, gamma=1, kernel=rbf.....
[CV 3/5; 18/18] END ..C=10, gamma=1, kernel=rbf; score=0.873 total time= 31.6s
[CV 4/5; 18/18] START C=10, gamma=1, kernel=rbf.....
[CV 4/5; 18/18] END ..C=10, gamma=1, kernel=rbf; score=0.872 total time= 31.8s
[CV 5/5; 18/18] START C=10, gamma=1, kernel=rbf.....
[CV 5/5; 18/18] END ..C=10, gamma=1, kernel=rbf; score=0.870 total time= 31.8s
```

```
In [30]: print(best_svm_params)
```

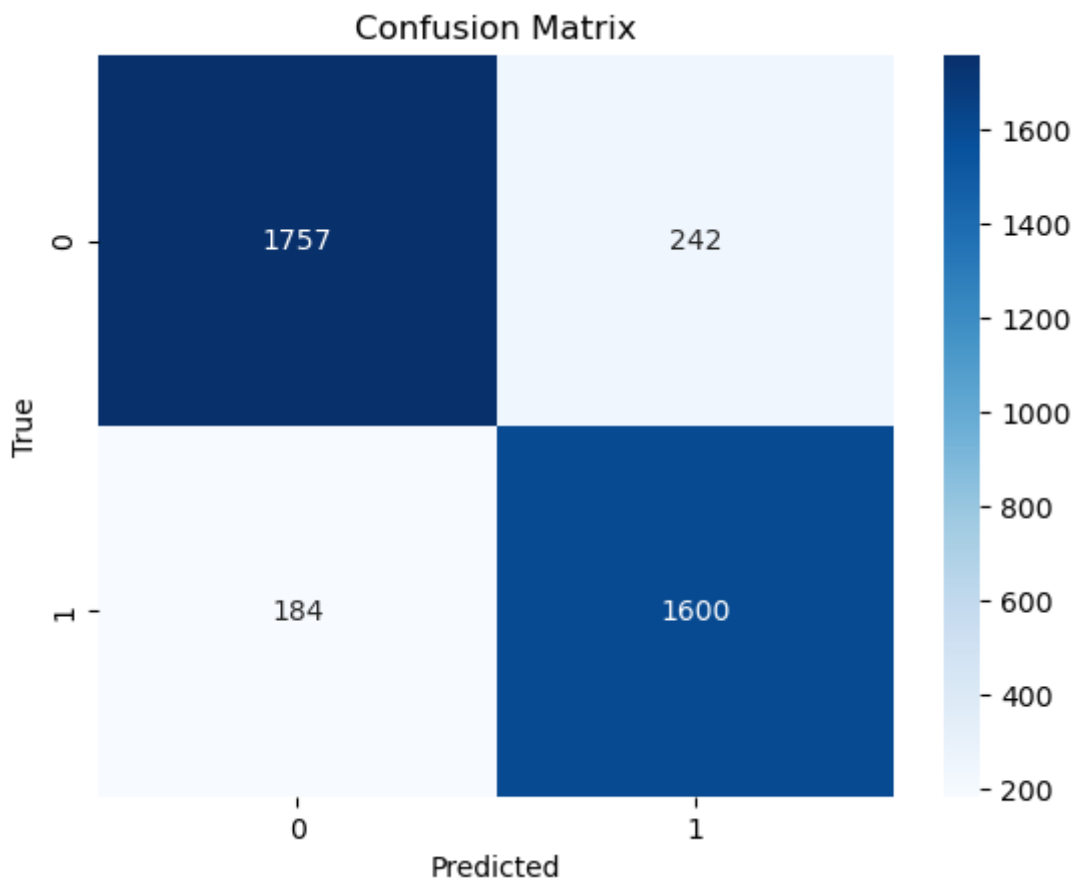
```
svm_y_pred = best_svm_model.predict(X_test)
print("\nClassification Report for Support Vector Machine Model:")
print(classification_report(y_test, svm_y_pred))
```

```
{'C': 1, 'gamma': 1, 'kernel': 'rbf'}
```

```
Classification Report for Support Vector Machine Model:
```

	precision	recall	f1-score	support
0	0.91	0.88	0.89	1999
1	0.87	0.90	0.88	1784
accuracy			0.89	3783
macro avg	0.89	0.89	0.89	3783
weighted avg	0.89	0.89	0.89	3783

```
In [31]: sns.heatmap(confusion_matrix(y_test, svm_y_pred), annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()
```



Decision Tree Model

```
In [32]: from sklearn.tree import DecisionTreeClassifier
```

```
In [51]: # Hyperparameter grid
ds_param_grid = {
    'criterion': ['gini', 'entropy', 'log_loss'],
    'max_depth': [None, 10, 20, 30],
    'min_samples_split': [2, 5, 10],
    'max_features': ['auto', 'sqrt', 'log2'] # Example values
}

ds = DecisionTreeClassifier(random_state=42)
ds_grid_search = GridSearchCV(ds, ds_param_grid, cv=kf, verbose=10)
ds_grid_search.fit(X_train, y_train)

# Access best model and params
best_ds_model = ds_grid_search.best_estimator_
best_ds_params = ds_grid_search.best_params_
```

```

Fitting 5 folds for each of 108 candidates, totalling 540 fits
[CV 1/5; 1/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=2
[CV 1/5; 1/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=2; score=0.814 total time= 0.0s
[CV 2/5; 1/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=2
[CV 2/5; 1/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=2; score=0.820 total time= 0.0s
[CV 3/5; 1/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=2
[CV 3/5; 1/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=2; score=0.822 total time= 0.0s
[CV 4/5; 1/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=2
[CV 4/5; 1/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=2; score=0.814 total time= 0.0s
[CV 5/5; 1/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=2
[CV 5/5; 1/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=2; score=0.814 total time= 0.0s
[CV 1/5; 2/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=5
[CV 1/5; 2/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=5; score=0.806 total time= 0.0s
[CV 2/5; 2/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=5
[CV 2/5; 2/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=5; score=0.831 total time= 0.0s
[CV 3/5; 2/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=5
[CV 3/5; 2/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=5; score=0.821 total time= 0.0s
[CV 4/5; 2/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=5
[CV 4/5; 2/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=5; score=0.814 total time= 0.0s
[CV 5/5; 2/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=5
[CV 5/5; 2/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=5; score=0.823 total time= 0.0s
[CV 1/5; 3/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=10
[CV 1/5; 3/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=10; score=0.824 total time= 0.0s
[CV 2/5; 3/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=10
[CV 2/5; 3/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=10; score=0.843 total time= 0.0s
[CV 3/5; 3/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=10
[CV 3/5; 3/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=10; score=0.833 total time= 0.0s
[CV 4/5; 3/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=10
[CV 4/5; 3/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=10; score=0.843 total time= 0.0s
[CV 5/5; 3/108] START criterion=gini, max_depth=None, max_features=auto, min_samples_split=10
[CV 5/5; 3/108] END criterion=gini, max_depth=None, max_features=auto, min_samples_split=10; score=0.836 total time= 0.0s
[CV 1/5; 4/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2
[CV 1/5; 4/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2

```

```
_split=2;; score=0.814 total time= 0.0s
[CV 2/5; 4/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2
[CV 2/5; 4/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2;; score=0.820 total time= 0.0s
[CV 3/5; 4/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2
[CV 3/5; 4/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2;; score=0.822 total time= 0.0s
[CV 4/5; 4/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2
[CV 4/5; 4/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 5/5; 4/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2
[CV 5/5; 4/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 5/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5
[CV 1/5; 5/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5;; score=0.806 total time= 0.0s
[CV 2/5; 5/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5
[CV 2/5; 5/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5;; score=0.831 total time= 0.0s
[CV 3/5; 5/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5
[CV 3/5; 5/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5;; score=0.821 total time= 0.0s
[CV 4/5; 5/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5
[CV 4/5; 5/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5;; score=0.814 total time= 0.0s
[CV 5/5; 5/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5
[CV 5/5; 5/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=5;; score=0.823 total time= 0.0s
[CV 1/5; 6/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10
[CV 1/5; 6/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10;; score=0.824 total time= 0.0s
[CV 2/5; 6/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10
[CV 2/5; 6/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10;; score=0.843 total time= 0.0s
[CV 3/5; 6/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10
[CV 3/5; 6/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10;; score=0.833 total time= 0.0s
[CV 4/5; 6/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10
[CV 4/5; 6/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10;; score=0.843 total time= 0.0s
[CV 5/5; 6/108] START criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10
[CV 5/5; 6/108] END criterion=gini, max_depth=None, max_features=sqrt, min_samples_split=10;; score=0.836 total time= 0.0s
[CV 1/5; 7/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=2
[CV 1/5; 7/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 2/5; 7/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=2
[CV 2/5; 7/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=2
```

```

_split=2;; score=0.820 total time= 0.0s
[CV 3/5; 7/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=2
[CV 3/5; 7/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=2;; score=0.822 total time= 0.0s
[CV 4/5; 7/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=2
[CV 4/5; 7/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 5/5; 7/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=2
[CV 5/5; 7/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 8/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=5
[CV 1/5; 8/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=5;; score=0.806 total time= 0.0s
[CV 2/5; 8/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=5
[CV 2/5; 8/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=5;; score=0.831 total time= 0.0s
[CV 3/5; 8/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=5
[CV 3/5; 8/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=5;; score=0.821 total time= 0.0s
[CV 4/5; 8/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=5
[CV 4/5; 8/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=5;; score=0.814 total time= 0.0s
[CV 5/5; 8/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=5
[CV 5/5; 8/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=5;; score=0.823 total time= 0.0s
[CV 1/5; 9/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=10
[CV 1/5; 9/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=10;; score=0.824 total time= 0.0s
[CV 2/5; 9/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=10
[CV 2/5; 9/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=10;; score=0.843 total time= 0.0s
[CV 3/5; 9/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=10
[CV 3/5; 9/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=10;; score=0.833 total time= 0.0s
[CV 4/5; 9/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=10
[CV 4/5; 9/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=10;; score=0.843 total time= 0.0s
[CV 5/5; 9/108] START criterion=gini, max_depth=None, max_features=log2, min_samples_split=10
[CV 5/5; 9/108] END criterion=gini, max_depth=None, max_features=log2, min_samples_split=10;; score=0.836 total time= 0.0s
[CV 1/5; 10/108] START criterion=gini, max_depth=10, max_features=auto, min_samples_split=2
[CV 1/5; 10/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_split=2;; score=0.865 total time= 0.0s
[CV 2/5; 10/108] START criterion=gini, max_depth=10, max_features=auto, min_samples_split=2
[CV 2/5; 10/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_split=2;; score=0.872 total time= 0.0s
[CV 3/5; 10/108] START criterion=gini, max_depth=10, max_features=auto, min_samples_split=2
[CV 3/5; 10/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_split=2

```

```
split=2;; score=0.867 total time= 0.0s
[CV 4/5; 10/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=2
[CV 4/5; 10/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=2;; score=0.869 total time= 0.0s
[CV 5/5; 10/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=2
[CV 5/5; 10/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=2;; score=0.872 total time= 0.0s
[CV 1/5; 11/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=5
[CV 1/5; 11/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=5;; score=0.841 total time= 0.0s
[CV 2/5; 11/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=5
[CV 2/5; 11/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=5;; score=0.886 total time= 0.0s
[CV 3/5; 11/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=5
[CV 3/5; 11/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=5;; score=0.837 total time= 0.0s
[CV 4/5; 11/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=5
[CV 4/5; 11/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=5;; score=0.869 total time= 0.0s
[CV 5/5; 11/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=5
[CV 5/5; 11/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=5;; score=0.864 total time= 0.0s
[CV 1/5; 12/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=10
[CV 1/5; 12/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=10;; score=0.862 total time= 0.0s
[CV 2/5; 12/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=10
[CV 2/5; 12/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=10;; score=0.791 total time= 0.0s
[CV 3/5; 12/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=10
[CV 3/5; 12/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=10;; score=0.870 total time= 0.0s
[CV 4/5; 12/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=10
[CV 4/5; 12/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=10;; score=0.847 total time= 0.0s
[CV 5/5; 12/108] START criterion=gini, max_depth=10, max_features=auto, min_sample
s_split=10
[CV 5/5; 12/108] END criterion=gini, max_depth=10, max_features=auto, min_samples_
split=10;; score=0.865 total time= 0.0s
[CV 1/5; 13/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=2
[CV 1/5; 13/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=2;; score=0.865 total time= 0.0s
[CV 2/5; 13/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=2
[CV 2/5; 13/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=2;; score=0.872 total time= 0.0s
[CV 3/5; 13/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=2
[CV 3/5; 13/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=2;; score=0.867 total time= 0.0s
[CV 4/5; 13/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=2
[CV 4/5; 13/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
```



```
split=2;; score=0.869 total time= 0.0s
[CV 5/5; 13/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=2
[CV 5/5; 13/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=2;; score=0.872 total time= 0.0s
[CV 1/5; 14/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=5
[CV 1/5; 14/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=5;; score=0.841 total time= 0.0s
[CV 2/5; 14/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=5
[CV 2/5; 14/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=5;; score=0.886 total time= 0.0s
[CV 3/5; 14/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=5
[CV 3/5; 14/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=5;; score=0.837 total time= 0.0s
[CV 4/5; 14/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=5
[CV 4/5; 14/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=5;; score=0.869 total time= 0.0s
[CV 5/5; 14/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=5
[CV 5/5; 14/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=5;; score=0.864 total time= 0.0s
[CV 1/5; 15/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=10
[CV 1/5; 15/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=10;; score=0.862 total time= 0.0s
[CV 2/5; 15/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=10
[CV 2/5; 15/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=10;; score=0.791 total time= 0.0s
[CV 3/5; 15/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=10
[CV 3/5; 15/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=10;; score=0.870 total time= 0.0s
[CV 4/5; 15/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=10
[CV 4/5; 15/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=10;; score=0.847 total time= 0.0s
[CV 5/5; 15/108] START criterion=gini, max_depth=10, max_features=sqrt, min_sample
s_split=10
[CV 5/5; 15/108] END criterion=gini, max_depth=10, max_features=sqrt, min_samples_
split=10;; score=0.865 total time= 0.0s
[CV 1/5; 16/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=2
[CV 1/5; 16/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=2;; score=0.865 total time= 0.0s
[CV 2/5; 16/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=2
[CV 2/5; 16/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=2;; score=0.872 total time= 0.0s
[CV 3/5; 16/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=2
[CV 3/5; 16/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=2;; score=0.867 total time= 0.0s
[CV 4/5; 16/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=2
[CV 4/5; 16/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=2;; score=0.869 total time= 0.0s
[CV 5/5; 16/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=2
[CV 5/5; 16/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
```

```
split=2;; score=0.872 total time= 0.0s
[CV 1/5; 17/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=5
[CV 1/5; 17/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=5;; score=0.841 total time= 0.0s
[CV 2/5; 17/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=5
[CV 2/5; 17/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=5;; score=0.886 total time= 0.0s
[CV 3/5; 17/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=5
[CV 3/5; 17/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=5;; score=0.837 total time= 0.0s
[CV 4/5; 17/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=5
[CV 4/5; 17/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=5;; score=0.869 total time= 0.0s
[CV 5/5; 17/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=5
[CV 5/5; 17/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=5;; score=0.864 total time= 0.0s
[CV 1/5; 18/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=10
[CV 1/5; 18/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=10;; score=0.862 total time= 0.0s
[CV 2/5; 18/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=10
[CV 2/5; 18/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=10;; score=0.791 total time= 0.0s
[CV 3/5; 18/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=10
[CV 3/5; 18/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=10;; score=0.870 total time= 0.0s
[CV 4/5; 18/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=10
[CV 4/5; 18/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=10;; score=0.847 total time= 0.0s
[CV 5/5; 18/108] START criterion=gini, max_depth=10, max_features=log2, min_sample
s_split=10
[CV 5/5; 18/108] END criterion=gini, max_depth=10, max_features=log2, min_samples_
split=10;; score=0.865 total time= 0.0s
[CV 1/5; 19/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=2
[CV 1/5; 19/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=2;; score=0.821 total time= 0.0s
[CV 2/5; 19/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=2
[CV 2/5; 19/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=2;; score=0.844 total time= 0.0s
[CV 3/5; 19/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=2
[CV 3/5; 19/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=2;; score=0.829 total time= 0.0s
[CV 4/5; 19/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=2
[CV 4/5; 19/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=2;; score=0.828 total time= 0.0s
[CV 5/5; 19/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=2
[CV 5/5; 19/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=2;; score=0.821 total time= 0.0s
[CV 1/5; 20/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=5
[CV 1/5; 20/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
```

```
split=5;; score=0.818 total time= 0.0s
[CV 2/5; 20/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=5
[CV 2/5; 20/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=5;; score=0.844 total time= 0.0s
[CV 3/5; 20/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=5
[CV 3/5; 20/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=5;; score=0.830 total time= 0.0s
[CV 4/5; 20/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=5
[CV 4/5; 20/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=5;; score=0.835 total time= 0.0s
[CV 5/5; 20/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=5
[CV 5/5; 20/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=5;; score=0.831 total time= 0.0s
[CV 1/5; 21/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=10
[CV 1/5; 21/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=10;; score=0.851 total time= 0.0s
[CV 2/5; 21/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=10
[CV 2/5; 21/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=10;; score=0.844 total time= 0.0s
[CV 3/5; 21/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=10
[CV 3/5; 21/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=10;; score=0.840 total time= 0.0s
[CV 4/5; 21/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=10
[CV 4/5; 21/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=10;; score=0.850 total time= 0.0s
[CV 5/5; 21/108] START criterion=gini, max_depth=20, max_features=auto, min_sample
s_split=10
[CV 5/5; 21/108] END criterion=gini, max_depth=20, max_features=auto, min_samples_
split=10;; score=0.851 total time= 0.0s
[CV 1/5; 22/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=2
[CV 1/5; 22/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=2;; score=0.821 total time= 0.0s
[CV 2/5; 22/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=2
[CV 2/5; 22/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=2;; score=0.844 total time= 0.0s
[CV 3/5; 22/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=2
[CV 3/5; 22/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=2;; score=0.829 total time= 0.0s
[CV 4/5; 22/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=2
[CV 4/5; 22/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=2;; score=0.828 total time= 0.0s
[CV 5/5; 22/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=2
[CV 5/5; 22/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=2;; score=0.821 total time= 0.0s
[CV 1/5; 23/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=5
[CV 1/5; 23/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=5;; score=0.818 total time= 0.0s
[CV 2/5; 23/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=5
[CV 2/5; 23/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
```

```
split=5;; score=0.844 total time= 0.0s
[CV 3/5; 23/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=5
[CV 3/5; 23/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=5;; score=0.830 total time= 0.0s
[CV 4/5; 23/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=5
[CV 4/5; 23/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=5;; score=0.835 total time= 0.0s
[CV 5/5; 23/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=5
[CV 5/5; 23/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=5;; score=0.831 total time= 0.0s
[CV 1/5; 24/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=10
[CV 1/5; 24/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=10;; score=0.851 total time= 0.0s
[CV 2/5; 24/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=10
[CV 2/5; 24/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=10;; score=0.844 total time= 0.0s
[CV 3/5; 24/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=10
[CV 3/5; 24/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=10;; score=0.840 total time= 0.0s
[CV 4/5; 24/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=10
[CV 4/5; 24/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=10;; score=0.850 total time= 0.0s
[CV 5/5; 24/108] START criterion=gini, max_depth=20, max_features=sqrt, min_sample
s_split=10
[CV 5/5; 24/108] END criterion=gini, max_depth=20, max_features=sqrt, min_samples_
split=10;; score=0.851 total time= 0.0s
[CV 1/5; 25/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=2
[CV 1/5; 25/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=2;; score=0.821 total time= 0.0s
[CV 2/5; 25/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=2
[CV 2/5; 25/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=2;; score=0.844 total time= 0.0s
[CV 3/5; 25/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=2
[CV 3/5; 25/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=2;; score=0.829 total time= 0.0s
[CV 4/5; 25/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=2
[CV 4/5; 25/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=2;; score=0.828 total time= 0.0s
[CV 5/5; 25/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=2
[CV 5/5; 25/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=2;; score=0.821 total time= 0.0s
[CV 1/5; 26/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=5
[CV 1/5; 26/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=5;; score=0.818 total time= 0.0s
[CV 2/5; 26/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=5
[CV 2/5; 26/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=5;; score=0.844 total time= 0.0s
[CV 3/5; 26/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=5
[CV 3/5; 26/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
```

```
split=5;; score=0.830 total time= 0.0s
[CV 4/5; 26/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=5
[CV 4/5; 26/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=5;; score=0.835 total time= 0.0s
[CV 5/5; 26/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=5
[CV 5/5; 26/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=5;; score=0.831 total time= 0.0s
[CV 1/5; 27/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=10
[CV 1/5; 27/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=10;; score=0.851 total time= 0.0s
[CV 2/5; 27/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=10
[CV 2/5; 27/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=10;; score=0.844 total time= 0.0s
[CV 3/5; 27/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=10
[CV 3/5; 27/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=10;; score=0.840 total time= 0.0s
[CV 4/5; 27/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=10
[CV 4/5; 27/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=10;; score=0.850 total time= 0.0s
[CV 5/5; 27/108] START criterion=gini, max_depth=20, max_features=log2, min_sample
s_split=10
[CV 5/5; 27/108] END criterion=gini, max_depth=20, max_features=log2, min_samples_
split=10;; score=0.851 total time= 0.0s
[CV 1/5; 28/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=2
[CV 1/5; 28/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 2/5; 28/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=2
[CV 2/5; 28/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=2;; score=0.817 total time= 0.0s
[CV 3/5; 28/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=2
[CV 3/5; 28/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=2;; score=0.817 total time= 0.0s
[CV 4/5; 28/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=2
[CV 4/5; 28/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 5/5; 28/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=2
[CV 5/5; 28/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 1/5; 29/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=5
[CV 1/5; 29/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=5;; score=0.806 total time= 0.0s
[CV 2/5; 29/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=5
[CV 2/5; 29/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=5;; score=0.831 total time= 0.0s
[CV 3/5; 29/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=5
[CV 3/5; 29/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=5;; score=0.821 total time= 0.0s
[CV 4/5; 29/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=5
[CV 4/5; 29/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
```

```
split=5;; score=0.814 total time= 0.0s
[CV 5/5; 29/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=5
[CV 5/5; 29/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=5;; score=0.821 total time= 0.0s
[CV 1/5; 30/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=10
[CV 1/5; 30/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=10;; score=0.824 total time= 0.0s
[CV 2/5; 30/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=10
[CV 2/5; 30/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=10;; score=0.843 total time= 0.0s
[CV 3/5; 30/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=10
[CV 3/5; 30/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=10;; score=0.833 total time= 0.0s
[CV 4/5; 30/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=10
[CV 4/5; 30/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=10;; score=0.843 total time= 0.0s
[CV 5/5; 30/108] START criterion=gini, max_depth=30, max_features=auto, min_sample
s_split=10
[CV 5/5; 30/108] END criterion=gini, max_depth=30, max_features=auto, min_samples_
split=10;; score=0.836 total time= 0.0s
[CV 1/5; 31/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=2
[CV 1/5; 31/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 2/5; 31/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=2
[CV 2/5; 31/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=2;; score=0.817 total time= 0.0s
[CV 3/5; 31/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=2
[CV 3/5; 31/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=2;; score=0.817 total time= 0.0s
[CV 4/5; 31/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=2
[CV 4/5; 31/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 5/5; 31/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=2
[CV 5/5; 31/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 1/5; 32/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=5
[CV 1/5; 32/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=5;; score=0.806 total time= 0.0s
[CV 2/5; 32/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=5
[CV 2/5; 32/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=5;; score=0.831 total time= 0.0s
[CV 3/5; 32/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=5
[CV 3/5; 32/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=5;; score=0.821 total time= 0.0s
[CV 4/5; 32/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=5
[CV 4/5; 32/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=5;; score=0.814 total time= 0.0s
[CV 5/5; 32/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=5
[CV 5/5; 32/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
```

```

split=5;; score=0.821 total time= 0.0s
[CV 1/5; 33/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=10
[CV 1/5; 33/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=10;; score=0.824 total time= 0.0s
[CV 2/5; 33/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=10
[CV 2/5; 33/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=10;; score=0.843 total time= 0.0s
[CV 3/5; 33/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=10
[CV 3/5; 33/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=10;; score=0.833 total time= 0.0s
[CV 4/5; 33/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=10
[CV 4/5; 33/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=10;; score=0.843 total time= 0.0s
[CV 5/5; 33/108] START criterion=gini, max_depth=30, max_features=sqrt, min_sample
s_split=10
[CV 5/5; 33/108] END criterion=gini, max_depth=30, max_features=sqrt, min_samples_
split=10;; score=0.836 total time= 0.0s
[CV 1/5; 34/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=2
[CV 1/5; 34/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 2/5; 34/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=2
[CV 2/5; 34/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=2;; score=0.817 total time= 0.0s
[CV 3/5; 34/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=2
[CV 3/5; 34/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=2;; score=0.817 total time= 0.0s
[CV 4/5; 34/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=2
[CV 4/5; 34/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 5/5; 34/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=2
[CV 5/5; 34/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=2;; score=0.814 total time= 0.0s
[CV 1/5; 35/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=5
[CV 1/5; 35/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=5;; score=0.806 total time= 0.0s
[CV 2/5; 35/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=5
[CV 2/5; 35/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=5;; score=0.831 total time= 0.0s
[CV 3/5; 35/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=5
[CV 3/5; 35/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=5;; score=0.821 total time= 0.0s
[CV 4/5; 35/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=5
[CV 4/5; 35/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=5;; score=0.814 total time= 0.0s
[CV 5/5; 35/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=5
[CV 5/5; 35/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=5;; score=0.821 total time= 0.0s
[CV 1/5; 36/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=10
[CV 1/5; 36/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_

```

```

split=10;; score=0.824 total time= 0.0s
[CV 2/5; 36/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=10
[CV 2/5; 36/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=10;; score=0.843 total time= 0.0s
[CV 3/5; 36/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=10
[CV 3/5; 36/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=10;; score=0.833 total time= 0.0s
[CV 4/5; 36/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=10
[CV 4/5; 36/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=10;; score=0.843 total time= 0.0s
[CV 5/5; 36/108] START criterion=gini, max_depth=30, max_features=log2, min_sample
s_split=10
[CV 5/5; 36/108] END criterion=gini, max_depth=30, max_features=log2, min_samples_
split=10;; score=0.836 total time= 0.0s
[CV 1/5; 37/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=2
[CV 1/5; 37/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=2;; score=0.810 total time= 0.0s
[CV 2/5; 37/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=2
[CV 2/5; 37/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 37/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=2
[CV 3/5; 37/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=2;; score=0.812 total time= 0.0s
[CV 4/5; 37/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=2
[CV 4/5; 37/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=2;; score=0.800 total time= 0.0s
[CV 5/5; 37/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=2
[CV 5/5; 37/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 38/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=5
[CV 1/5; 38/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=5;; score=0.811 total time= 0.0s
[CV 2/5; 38/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=5
[CV 2/5; 38/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=5;; score=0.834 total time= 0.0s
[CV 3/5; 38/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=5
[CV 3/5; 38/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 38/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=5
[CV 4/5; 38/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 38/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=5
[CV 5/5; 38/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 39/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=10
[CV 1/5; 39/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=10;; score=0.835 total time= 0.0s
[CV 2/5; 39/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=10
[CV 2/5; 39/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam

```



```
ples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 39/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=10
[CV 3/5; 39/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 39/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=10
[CV 4/5; 39/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 39/108] START criterion=entropy, max_depth=None, max_features=auto, min_s
amples_split=10
[CV 5/5; 39/108] END criterion=entropy, max_depth=None, max_features=auto, min_sam
ples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 40/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=2
[CV 1/5; 40/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=2;; score=0.810 total time= 0.0s
[CV 2/5; 40/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=2
[CV 2/5; 40/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 40/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=2
[CV 3/5; 40/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=2;; score=0.812 total time= 0.0s
[CV 4/5; 40/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=2
[CV 4/5; 40/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=2;; score=0.800 total time= 0.0s
[CV 5/5; 40/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=2
[CV 5/5; 40/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 41/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=5
[CV 1/5; 41/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=5;; score=0.811 total time= 0.0s
[CV 2/5; 41/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=5
[CV 2/5; 41/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=5;; score=0.834 total time= 0.0s
[CV 3/5; 41/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=5
[CV 3/5; 41/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 41/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=5
[CV 4/5; 41/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 41/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=5
[CV 5/5; 41/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 42/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=10
[CV 1/5; 42/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=10;; score=0.835 total time= 0.0s
[CV 2/5; 42/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=10
[CV 2/5; 42/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 42/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=10
[CV 3/5; 42/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
```

```
ples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 42/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=10
[CV 4/5; 42/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 42/108] START criterion=entropy, max_depth=None, max_features=sqrt, min_s
amples_split=10
[CV 5/5; 42/108] END criterion=entropy, max_depth=None, max_features=sqrt, min_sam
ples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 43/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=2
[CV 1/5; 43/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=2;; score=0.810 total time= 0.0s
[CV 2/5; 43/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=2
[CV 2/5; 43/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 43/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=2
[CV 3/5; 43/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=2;; score=0.812 total time= 0.0s
[CV 4/5; 43/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=2
[CV 4/5; 43/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=2;; score=0.800 total time= 0.0s
[CV 5/5; 43/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=2
[CV 5/5; 43/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 44/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=5
[CV 1/5; 44/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=5;; score=0.811 total time= 0.0s
[CV 2/5; 44/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=5
[CV 2/5; 44/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=5;; score=0.834 total time= 0.0s
[CV 3/5; 44/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=5
[CV 3/5; 44/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 44/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=5
[CV 4/5; 44/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 44/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=5
[CV 5/5; 44/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 45/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=10
[CV 1/5; 45/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=10;; score=0.835 total time= 0.0s
[CV 2/5; 45/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=10
[CV 2/5; 45/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 45/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=10
[CV 3/5; 45/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 45/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=10
[CV 4/5; 45/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
```

```
ples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 45/108] START criterion=entropy, max_depth=None, max_features=log2, min_s
amples_split=10
[CV 5/5; 45/108] END criterion=entropy, max_depth=None, max_features=log2, min_sam
ples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 46/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=2
[CV 1/5; 46/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=2;; score=0.851 total time= 0.0s
[CV 2/5; 46/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=2
[CV 2/5; 46/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=2;; score=0.879 total time= 0.0s
[CV 3/5; 46/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=2
[CV 3/5; 46/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=2;; score=0.846 total time= 0.0s
[CV 4/5; 46/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=2
[CV 4/5; 46/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=2;; score=0.849 total time= 0.0s
[CV 5/5; 46/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=2
[CV 5/5; 46/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=2;; score=0.859 total time= 0.0s
[CV 1/5; 47/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=5
[CV 1/5; 47/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=5;; score=0.854 total time= 0.0s
[CV 2/5; 47/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=5
[CV 2/5; 47/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=5;; score=0.886 total time= 0.0s
[CV 3/5; 47/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=5
[CV 3/5; 47/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=5;; score=0.848 total time= 0.0s
[CV 4/5; 47/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=5
[CV 4/5; 47/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=5;; score=0.838 total time= 0.0s
[CV 5/5; 47/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=5
[CV 5/5; 47/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=5;; score=0.780 total time= 0.0s
[CV 1/5; 48/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 1/5; 48/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=10;; score=0.861 total time= 0.0s
[CV 2/5; 48/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 2/5; 48/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=10;; score=0.877 total time= 0.0s
[CV 3/5; 48/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 3/5; 48/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=10;; score=0.872 total time= 0.0s
[CV 4/5; 48/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 4/5; 48/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
es_split=10;; score=0.867 total time= 0.0s
[CV 5/5; 48/108] START criterion=entropy, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 5/5; 48/108] END criterion=entropy, max_depth=10, max_features=auto, min_sampl
```

```
es_split=10;; score=0.852 total time= 0.0s
[CV 1/5; 49/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2
[CV 1/5; 49/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2; score=0.851 total time= 0.0s
[CV 2/5; 49/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2
[CV 2/5; 49/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2; score=0.879 total time= 0.0s
[CV 3/5; 49/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2
[CV 3/5; 49/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2; score=0.846 total time= 0.0s
[CV 4/5; 49/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2
[CV 4/5; 49/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2; score=0.849 total time= 0.0s
[CV 5/5; 49/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2
[CV 5/5; 49/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=2; score=0.859 total time= 0.0s
[CV 1/5; 50/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5
[CV 1/5; 50/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5; score=0.854 total time= 0.0s
[CV 2/5; 50/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5
[CV 2/5; 50/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5; score=0.886 total time= 0.0s
[CV 3/5; 50/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5
[CV 3/5; 50/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5; score=0.848 total time= 0.0s
[CV 4/5; 50/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5
[CV 4/5; 50/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5; score=0.838 total time= 0.0s
[CV 5/5; 50/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5
[CV 5/5; 50/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=5; score=0.780 total time= 0.0s
[CV 1/5; 51/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10
[CV 1/5; 51/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10; score=0.861 total time= 0.0s
[CV 2/5; 51/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10
[CV 2/5; 51/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10; score=0.877 total time= 0.0s
[CV 3/5; 51/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10
[CV 3/5; 51/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10; score=0.872 total time= 0.0s
[CV 4/5; 51/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10
[CV 4/5; 51/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10; score=0.867 total time= 0.0s
[CV 5/5; 51/108] START criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10
[CV 5/5; 51/108] END criterion=entropy, max_depth=10, max_features=sqrt, min_samples_split=10; score=0.852 total time= 0.0s
[CV 1/5; 52/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2
[CV 1/5; 52/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2
```

```
es_split=2;; score=0.851 total time= 0.0s
[CV 2/5; 52/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2
[CV 2/5; 52/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2; score=0.879 total time= 0.0s
[CV 3/5; 52/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2
[CV 3/5; 52/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2; score=0.846 total time= 0.0s
[CV 4/5; 52/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2
[CV 4/5; 52/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2; score=0.849 total time= 0.0s
[CV 5/5; 52/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2
[CV 5/5; 52/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=2; score=0.859 total time= 0.0s
[CV 1/5; 53/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5
[CV 1/5; 53/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5; score=0.854 total time= 0.0s
[CV 2/5; 53/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5
[CV 2/5; 53/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5; score=0.886 total time= 0.0s
[CV 3/5; 53/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5
[CV 3/5; 53/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5; score=0.848 total time= 0.0s
[CV 4/5; 53/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5
[CV 4/5; 53/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5; score=0.838 total time= 0.0s
[CV 5/5; 53/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5
[CV 5/5; 53/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=5; score=0.780 total time= 0.0s
[CV 1/5; 54/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10
[CV 1/5; 54/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10; score=0.861 total time= 0.0s
[CV 2/5; 54/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10
[CV 2/5; 54/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10; score=0.877 total time= 0.0s
[CV 3/5; 54/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10
[CV 3/5; 54/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10; score=0.872 total time= 0.0s
[CV 4/5; 54/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10
[CV 4/5; 54/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10; score=0.867 total time= 0.0s
[CV 5/5; 54/108] START criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10
[CV 5/5; 54/108] END criterion=entropy, max_depth=10, max_features=log2, min_samples_split=10; score=0.852 total time= 0.0s
[CV 1/5; 55/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2
[CV 1/5; 55/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2; score=0.824 total time= 0.0s
[CV 2/5; 55/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2
[CV 2/5; 55/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2
```

```
es_split=2;; score=0.837 total time= 0.0s
[CV 3/5; 55/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2
[CV 3/5; 55/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2; score=0.832 total time= 0.0s
[CV 4/5; 55/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2
[CV 4/5; 55/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2; score=0.832 total time= 0.0s
[CV 5/5; 55/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2
[CV 5/5; 55/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=2; score=0.833 total time= 0.0s
[CV 1/5; 56/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5
[CV 1/5; 56/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5; score=0.831 total time= 0.0s
[CV 2/5; 56/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5
[CV 2/5; 56/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5; score=0.840 total time= 0.0s
[CV 3/5; 56/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5
[CV 3/5; 56/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5; score=0.831 total time= 0.0s
[CV 4/5; 56/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5
[CV 4/5; 56/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5; score=0.828 total time= 0.0s
[CV 5/5; 56/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5
[CV 5/5; 56/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=5; score=0.832 total time= 0.0s
[CV 1/5; 57/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10
[CV 1/5; 57/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10; score=0.829 total time= 0.0s
[CV 2/5; 57/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10
[CV 2/5; 57/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10; score=0.857 total time= 0.0s
[CV 3/5; 57/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10
[CV 3/5; 57/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10; score=0.841 total time= 0.0s
[CV 4/5; 57/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10
[CV 4/5; 57/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10; score=0.848 total time= 0.0s
[CV 5/5; 57/108] START criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10
[CV 5/5; 57/108] END criterion=entropy, max_depth=20, max_features=auto, min_samples_split=10; score=0.836 total time= 0.0s
[CV 1/5; 58/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2
[CV 1/5; 58/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2; score=0.824 total time= 0.0s
[CV 2/5; 58/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2
[CV 2/5; 58/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2; score=0.837 total time= 0.0s
[CV 3/5; 58/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2
[CV 3/5; 58/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2
```

```
es_split=2;; score=0.832 total time= 0.0s
[CV 4/5; 58/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2
[CV 4/5; 58/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2; score=0.832 total time= 0.0s
[CV 5/5; 58/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2
[CV 5/5; 58/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=2; score=0.833 total time= 0.0s
[CV 1/5; 59/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5
[CV 1/5; 59/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5; score=0.831 total time= 0.0s
[CV 2/5; 59/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5
[CV 2/5; 59/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5; score=0.840 total time= 0.0s
[CV 3/5; 59/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5
[CV 3/5; 59/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5; score=0.831 total time= 0.0s
[CV 4/5; 59/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5
[CV 4/5; 59/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5; score=0.828 total time= 0.0s
[CV 5/5; 59/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5
[CV 5/5; 59/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=5; score=0.832 total time= 0.0s
[CV 1/5; 60/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10
[CV 1/5; 60/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10; score=0.829 total time= 0.0s
[CV 2/5; 60/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10
[CV 2/5; 60/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10; score=0.857 total time= 0.0s
[CV 3/5; 60/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10
[CV 3/5; 60/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10; score=0.841 total time= 0.0s
[CV 4/5; 60/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10
[CV 4/5; 60/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10; score=0.848 total time= 0.0s
[CV 5/5; 60/108] START criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10
[CV 5/5; 60/108] END criterion=entropy, max_depth=20, max_features=sqrt, min_samples_split=10; score=0.836 total time= 0.0s
[CV 1/5; 61/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2
[CV 1/5; 61/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2; score=0.824 total time= 0.0s
[CV 2/5; 61/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2
[CV 2/5; 61/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2; score=0.837 total time= 0.0s
[CV 3/5; 61/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2
[CV 3/5; 61/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2; score=0.832 total time= 0.0s
[CV 4/5; 61/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2
[CV 4/5; 61/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2
```

```
es_split=2;; score=0.832 total time= 0.0s
[CV 5/5; 61/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2
[CV 5/5; 61/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=2; score=0.833 total time= 0.0s
[CV 1/5; 62/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5
[CV 1/5; 62/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5; score=0.831 total time= 0.0s
[CV 2/5; 62/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5
[CV 2/5; 62/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5; score=0.840 total time= 0.0s
[CV 3/5; 62/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5
[CV 3/5; 62/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5; score=0.831 total time= 0.0s
[CV 4/5; 62/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5
[CV 4/5; 62/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5; score=0.828 total time= 0.0s
[CV 5/5; 62/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5
[CV 5/5; 62/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=5; score=0.832 total time= 0.0s
[CV 1/5; 63/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10
[CV 1/5; 63/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10; score=0.829 total time= 0.0s
[CV 2/5; 63/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10
[CV 2/5; 63/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10; score=0.857 total time= 0.0s
[CV 3/5; 63/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10
[CV 3/5; 63/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10; score=0.841 total time= 0.0s
[CV 4/5; 63/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10
[CV 4/5; 63/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10; score=0.848 total time= 0.0s
[CV 5/5; 63/108] START criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10
[CV 5/5; 63/108] END criterion=entropy, max_depth=20, max_features=log2, min_samples_split=10; score=0.836 total time= 0.0s
[CV 1/5; 64/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2
[CV 1/5; 64/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2; score=0.811 total time= 0.0s
[CV 2/5; 64/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2
[CV 2/5; 64/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2; score=0.819 total time= 0.0s
[CV 3/5; 64/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2
[CV 3/5; 64/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2; score=0.814 total time= 0.0s
[CV 4/5; 64/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2
[CV 4/5; 64/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2; score=0.798 total time= 0.0s
[CV 5/5; 64/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2
[CV 5/5; 64/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=2
```



```
es_split=2;; score=0.813 total time= 0.0s
[CV 1/5; 65/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5
[CV 1/5; 65/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5;; score=0.809 total time= 0.0s
[CV 2/5; 65/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5
[CV 2/5; 65/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5;; score=0.828 total time= 0.0s
[CV 3/5; 65/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5
[CV 3/5; 65/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 65/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5
[CV 4/5; 65/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 65/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5
[CV 5/5; 65/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 66/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10
[CV 1/5; 66/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10;; score=0.833 total time= 0.0s
[CV 2/5; 66/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10
[CV 2/5; 66/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 66/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10
[CV 3/5; 66/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 66/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10
[CV 4/5; 66/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 66/108] START criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10
[CV 5/5; 66/108] END criterion=entropy, max_depth=30, max_features=auto, min_samples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 67/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2
[CV 1/5; 67/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2;; score=0.811 total time= 0.0s
[CV 2/5; 67/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2
[CV 2/5; 67/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 67/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2
[CV 3/5; 67/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 4/5; 67/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2
[CV 4/5; 67/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2;; score=0.798 total time= 0.0s
[CV 5/5; 67/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2
[CV 5/5; 67/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=2;; score=0.813 total time= 0.0s
[CV 1/5; 68/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5
[CV 1/5; 68/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5
```

```
es_split=5;; score=0.809 total time= 0.0s
[CV 2/5; 68/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5
[CV 2/5; 68/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5; score=0.828 total time= 0.0s
[CV 3/5; 68/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5
[CV 3/5; 68/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5; score=0.818 total time= 0.0s
[CV 4/5; 68/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5
[CV 4/5; 68/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5; score=0.821 total time= 0.0s
[CV 5/5; 68/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5
[CV 5/5; 68/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=5; score=0.816 total time= 0.0s
[CV 1/5; 69/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10
[CV 1/5; 69/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10; score=0.833 total time= 0.0s
[CV 2/5; 69/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10
[CV 2/5; 69/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10; score=0.851 total time= 0.0s
[CV 3/5; 69/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10
[CV 3/5; 69/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10; score=0.843 total time= 0.0s
[CV 4/5; 69/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10
[CV 4/5; 69/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10; score=0.836 total time= 0.0s
[CV 5/5; 69/108] START criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10
[CV 5/5; 69/108] END criterion=entropy, max_depth=30, max_features=sqrt, min_samples_split=10; score=0.839 total time= 0.0s
[CV 1/5; 70/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2
[CV 1/5; 70/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2; score=0.811 total time= 0.0s
[CV 2/5; 70/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2
[CV 2/5; 70/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2; score=0.819 total time= 0.0s
[CV 3/5; 70/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2
[CV 3/5; 70/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2; score=0.814 total time= 0.0s
[CV 4/5; 70/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2
[CV 4/5; 70/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2; score=0.798 total time= 0.0s
[CV 5/5; 70/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2
[CV 5/5; 70/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=2; score=0.813 total time= 0.0s
[CV 1/5; 71/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5
[CV 1/5; 71/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5; score=0.809 total time= 0.0s
[CV 2/5; 71/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5
[CV 2/5; 71/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5; score=0.809 total time= 0.0s
```

```

es_split=5;; score=0.828 total time= 0.0s
[CV 3/5; 71/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5
[CV 3/5; 71/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 71/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5
[CV 4/5; 71/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 71/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5
[CV 5/5; 71/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 72/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10
[CV 1/5; 72/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10;; score=0.833 total time= 0.0s
[CV 2/5; 72/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10
[CV 2/5; 72/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 72/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10
[CV 3/5; 72/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 72/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10
[CV 4/5; 72/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 72/108] START criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10
[CV 5/5; 72/108] END criterion=entropy, max_depth=30, max_features=log2, min_samples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 73/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2
[CV 1/5; 73/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2;; score=0.810 total time= 0.0s
[CV 2/5; 73/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2
[CV 2/5; 73/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 73/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2
[CV 3/5; 73/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2;; score=0.812 total time= 0.0s
[CV 4/5; 73/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2
[CV 4/5; 73/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2;; score=0.800 total time= 0.0s
[CV 5/5; 73/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2
[CV 5/5; 73/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 74/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=5
[CV 1/5; 74/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=5;; score=0.811 total time= 0.0s
[CV 2/5; 74/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=5
[CV 2/5; 74/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=5;; score=0.834 total time= 0.0s
[CV 3/5; 74/108] START criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=5
[CV 3/5; 74/108] END criterion=log_loss, max_depth=None, max_features=auto, min_samples_split=5

```

```
mple_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 74/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=5
[CV 4/5; 74/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 74/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=5
[CV 5/5; 74/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 75/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=10
[CV 1/5; 75/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=10;; score=0.835 total time= 0.0s
[CV 2/5; 75/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=10
[CV 2/5; 75/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 75/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=10
[CV 3/5; 75/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 75/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=10
[CV 4/5; 75/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 75/108] START criterion=log_loss, max_depth=None, max_features=auto, min_
samples_split=10
[CV 5/5; 75/108] END criterion=log_loss, max_depth=None, max_features=auto, min_sa
mple_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 76/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=2
[CV 1/5; 76/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=2;; score=0.810 total time= 0.0s
[CV 2/5; 76/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=2
[CV 2/5; 76/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 76/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=2
[CV 3/5; 76/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=2;; score=0.812 total time= 0.0s
[CV 4/5; 76/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=2
[CV 4/5; 76/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=2;; score=0.800 total time= 0.0s
[CV 5/5; 76/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=2
[CV 5/5; 76/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 77/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=5
[CV 1/5; 77/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=5;; score=0.811 total time= 0.0s
[CV 2/5; 77/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=5
[CV 2/5; 77/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=5;; score=0.834 total time= 0.0s
[CV 3/5; 77/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=5
[CV 3/5; 77/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mple_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 77/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=5
[CV 4/5; 77/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
```

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mples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 77/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=5
[CV 5/5; 77/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 78/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=10
[CV 1/5; 78/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mples_split=10;; score=0.835 total time= 0.0s
[CV 2/5; 78/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=10
[CV 2/5; 78/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 78/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=10
[CV 3/5; 78/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 78/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=10
[CV 4/5; 78/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 78/108] START criterion=log_loss, max_depth=None, max_features=sqrt, min_
samples_split=10
[CV 5/5; 78/108] END criterion=log_loss, max_depth=None, max_features=sqrt, min_sa
mples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 79/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=2
[CV 1/5; 79/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=2;; score=0.810 total time= 0.0s
[CV 2/5; 79/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=2
[CV 2/5; 79/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 79/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=2
[CV 3/5; 79/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=2;; score=0.812 total time= 0.0s
[CV 4/5; 79/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=2
[CV 4/5; 79/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=2;; score=0.800 total time= 0.0s
[CV 5/5; 79/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=2
[CV 5/5; 79/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=2;; score=0.814 total time= 0.0s
[CV 1/5; 80/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=5
[CV 1/5; 80/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=5;; score=0.811 total time= 0.0s
[CV 2/5; 80/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=5
[CV 2/5; 80/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=5;; score=0.834 total time= 0.0s
[CV 3/5; 80/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=5
[CV 3/5; 80/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 80/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=5
[CV 4/5; 80/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 80/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=5
[CV 5/5; 80/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa

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```
mple_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 81/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=10
[CV 1/5; 81/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mple_split=10;; score=0.835 total time= 0.0s
[CV 2/5; 81/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=10
[CV 2/5; 81/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mple_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 81/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=10
[CV 3/5; 81/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mple_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 81/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=10
[CV 4/5; 81/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mple_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 81/108] START criterion=log_loss, max_depth=None, max_features=log2, min_
samples_split=10
[CV 5/5; 81/108] END criterion=log_loss, max_depth=None, max_features=log2, min_sa
mple_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 82/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=2
[CV 1/5; 82/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=2;; score=0.851 total time= 0.0s
[CV 2/5; 82/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=2
[CV 2/5; 82/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=2;; score=0.879 total time= 0.0s
[CV 3/5; 82/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=2
[CV 3/5; 82/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=2;; score=0.846 total time= 0.0s
[CV 4/5; 82/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=2
[CV 4/5; 82/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=2;; score=0.849 total time= 0.0s
[CV 5/5; 82/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=2
[CV 5/5; 82/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=2;; score=0.859 total time= 0.0s
[CV 1/5; 83/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=5
[CV 1/5; 83/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=5;; score=0.854 total time= 0.0s
[CV 2/5; 83/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=5
[CV 2/5; 83/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=5;; score=0.886 total time= 0.0s
[CV 3/5; 83/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=5
[CV 3/5; 83/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=5;; score=0.848 total time= 0.0s
[CV 4/5; 83/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=5
[CV 4/5; 83/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=5;; score=0.838 total time= 0.0s
[CV 5/5; 83/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=5
[CV 5/5; 83/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=5;; score=0.780 total time= 0.0s
[CV 1/5; 84/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sa
mple_split=10
[CV 1/5; 84/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
```

```
les_split=10;; score=0.861 total time= 0.0s
[CV 2/5; 84/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 2/5; 84/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=10;; score=0.877 total time= 0.0s
[CV 3/5; 84/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 3/5; 84/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=10;; score=0.872 total time= 0.0s
[CV 4/5; 84/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 4/5; 84/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=10;; score=0.867 total time= 0.0s
[CV 5/5; 84/108] START criterion=log_loss, max_depth=10, max_features=auto, min_sam
ples_split=10
[CV 5/5; 84/108] END criterion=log_loss, max_depth=10, max_features=auto, min_samp
les_split=10;; score=0.852 total time= 0.0s
[CV 1/5; 85/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=2
[CV 1/5; 85/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=2;; score=0.851 total time= 0.0s
[CV 2/5; 85/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=2
[CV 2/5; 85/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=2;; score=0.879 total time= 0.0s
[CV 3/5; 85/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=2
[CV 3/5; 85/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=2;; score=0.846 total time= 0.0s
[CV 4/5; 85/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=2
[CV 4/5; 85/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=2;; score=0.849 total time= 0.0s
[CV 5/5; 85/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=2
[CV 5/5; 85/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=2;; score=0.859 total time= 0.0s
[CV 1/5; 86/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=5
[CV 1/5; 86/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=5;; score=0.854 total time= 0.0s
[CV 2/5; 86/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=5
[CV 2/5; 86/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=5;; score=0.886 total time= 0.0s
[CV 3/5; 86/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=5
[CV 3/5; 86/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=5;; score=0.848 total time= 0.0s
[CV 4/5; 86/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=5
[CV 4/5; 86/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=5;; score=0.838 total time= 0.0s
[CV 5/5; 86/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=5
[CV 5/5; 86/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=5;; score=0.780 total time= 0.0s
[CV 1/5; 87/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=10
[CV 1/5; 87/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=10;; score=0.861 total time= 0.0s
[CV 2/5; 87/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=10
[CV 2/5; 87/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
```

```
les_split=10;; score=0.877 total time= 0.0s
[CV 3/5; 87/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=10
[CV 3/5; 87/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=10;; score=0.872 total time= 0.0s
[CV 4/5; 87/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=10
[CV 4/5; 87/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=10;; score=0.867 total time= 0.0s
[CV 5/5; 87/108] START criterion=log_loss, max_depth=10, max_features=sqrt, min_sam
ples_split=10
[CV 5/5; 87/108] END criterion=log_loss, max_depth=10, max_features=sqrt, min_samp
les_split=10;; score=0.852 total time= 0.0s
[CV 1/5; 88/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=2
[CV 1/5; 88/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=2;; score=0.851 total time= 0.0s
[CV 2/5; 88/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=2
[CV 2/5; 88/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=2;; score=0.879 total time= 0.0s
[CV 3/5; 88/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=2
[CV 3/5; 88/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=2;; score=0.846 total time= 0.0s
[CV 4/5; 88/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=2
[CV 4/5; 88/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=2;; score=0.849 total time= 0.0s
[CV 5/5; 88/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=2
[CV 5/5; 88/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=2;; score=0.859 total time= 0.0s
[CV 1/5; 89/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=5
[CV 1/5; 89/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=5;; score=0.854 total time= 0.0s
[CV 2/5; 89/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=5
[CV 2/5; 89/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=5;; score=0.886 total time= 0.0s
[CV 3/5; 89/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=5
[CV 3/5; 89/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=5;; score=0.848 total time= 0.0s
[CV 4/5; 89/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=5
[CV 4/5; 89/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=5;; score=0.838 total time= 0.0s
[CV 5/5; 89/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=5
[CV 5/5; 89/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=5;; score=0.780 total time= 0.0s
[CV 1/5; 90/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=10
[CV 1/5; 90/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=10;; score=0.861 total time= 0.0s
[CV 2/5; 90/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=10
[CV 2/5; 90/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=10;; score=0.877 total time= 0.0s
[CV 3/5; 90/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=10
[CV 3/5; 90/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
```



```
les_split=10;; score=0.872 total time= 0.0s
[CV 4/5; 90/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=10
[CV 4/5; 90/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=10;; score=0.867 total time= 0.0s
[CV 5/5; 90/108] START criterion=log_loss, max_depth=10, max_features=log2, min_sam
ples_split=10
[CV 5/5; 90/108] END criterion=log_loss, max_depth=10, max_features=log2, min_samp
les_split=10;; score=0.852 total time= 0.0s
[CV 1/5; 91/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=2
[CV 1/5; 91/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=2;; score=0.824 total time= 0.0s
[CV 2/5; 91/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=2
[CV 2/5; 91/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=2;; score=0.837 total time= 0.0s
[CV 3/5; 91/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=2
[CV 3/5; 91/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=2;; score=0.832 total time= 0.0s
[CV 4/5; 91/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=2
[CV 4/5; 91/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=2;; score=0.832 total time= 0.0s
[CV 5/5; 91/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=2
[CV 5/5; 91/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=2;; score=0.833 total time= 0.0s
[CV 1/5; 92/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=5
[CV 1/5; 92/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=5;; score=0.831 total time= 0.0s
[CV 2/5; 92/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=5
[CV 2/5; 92/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=5;; score=0.840 total time= 0.0s
[CV 3/5; 92/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=5
[CV 3/5; 92/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=5;; score=0.831 total time= 0.0s
[CV 4/5; 92/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=5
[CV 4/5; 92/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=5;; score=0.828 total time= 0.0s
[CV 5/5; 92/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=5
[CV 5/5; 92/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=5;; score=0.832 total time= 0.0s
[CV 1/5; 93/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=10
[CV 1/5; 93/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=10;; score=0.829 total time= 0.0s
[CV 2/5; 93/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=10
[CV 2/5; 93/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=10;; score=0.857 total time= 0.0s
[CV 3/5; 93/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=10
[CV 3/5; 93/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=10;; score=0.841 total time= 0.0s
[CV 4/5; 93/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=10
[CV 4/5; 93/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
```

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les_split=10;; score=0.848 total time= 0.0s
[CV 5/5; 93/108] START criterion=log_loss, max_depth=20, max_features=auto, min_sam
ples_split=10
[CV 5/5; 93/108] END criterion=log_loss, max_depth=20, max_features=auto, min_samp
les_split=10;; score=0.836 total time= 0.0s
[CV 1/5; 94/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=2
[CV 1/5; 94/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=2;; score=0.824 total time= 0.0s
[CV 2/5; 94/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=2
[CV 2/5; 94/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=2;; score=0.837 total time= 0.0s
[CV 3/5; 94/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=2
[CV 3/5; 94/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=2;; score=0.832 total time= 0.0s
[CV 4/5; 94/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=2
[CV 4/5; 94/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=2;; score=0.832 total time= 0.0s
[CV 5/5; 94/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=2
[CV 5/5; 94/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=2;; score=0.833 total time= 0.0s
[CV 1/5; 95/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=5
[CV 1/5; 95/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=5;; score=0.831 total time= 0.0s
[CV 2/5; 95/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=5
[CV 2/5; 95/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=5;; score=0.840 total time= 0.0s
[CV 3/5; 95/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=5
[CV 3/5; 95/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=5;; score=0.831 total time= 0.0s
[CV 4/5; 95/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=5
[CV 4/5; 95/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=5;; score=0.828 total time= 0.0s
[CV 5/5; 95/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=5
[CV 5/5; 95/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=5;; score=0.832 total time= 0.0s
[CV 1/5; 96/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=10
[CV 1/5; 96/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=10;; score=0.829 total time= 0.0s
[CV 2/5; 96/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=10
[CV 2/5; 96/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=10;; score=0.857 total time= 0.0s
[CV 3/5; 96/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=10
[CV 3/5; 96/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=10;; score=0.841 total time= 0.0s
[CV 4/5; 96/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=10
[CV 4/5; 96/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
les_split=10;; score=0.848 total time= 0.0s
[CV 5/5; 96/108] START criterion=log_loss, max_depth=20, max_features=sqrt, min_sa
mples_split=10
[CV 5/5; 96/108] END criterion=log_loss, max_depth=20, max_features=sqrt, min_samp
```

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les_split=10;; score=0.836 total time= 0.0s
[CV 1/5; 97/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=2
[CV 1/5; 97/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=2;; score=0.824 total time= 0.0s
[CV 2/5; 97/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=2
[CV 2/5; 97/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=2;; score=0.837 total time= 0.0s
[CV 3/5; 97/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=2
[CV 3/5; 97/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=2;; score=0.832 total time= 0.0s
[CV 4/5; 97/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=2
[CV 4/5; 97/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=2;; score=0.832 total time= 0.0s
[CV 5/5; 97/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=2
[CV 5/5; 97/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=2;; score=0.833 total time= 0.0s
[CV 1/5; 98/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=5
[CV 1/5; 98/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=5;; score=0.831 total time= 0.0s
[CV 2/5; 98/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=5
[CV 2/5; 98/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=5;; score=0.840 total time= 0.0s
[CV 3/5; 98/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=5
[CV 3/5; 98/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=5;; score=0.831 total time= 0.0s
[CV 4/5; 98/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=5
[CV 4/5; 98/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=5;; score=0.828 total time= 0.0s
[CV 5/5; 98/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=5
[CV 5/5; 98/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=5;; score=0.832 total time= 0.0s
[CV 1/5; 99/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=10
[CV 1/5; 99/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=10;; score=0.829 total time= 0.0s
[CV 2/5; 99/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=10
[CV 2/5; 99/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=10;; score=0.857 total time= 0.0s
[CV 3/5; 99/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=10
[CV 3/5; 99/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=10;; score=0.841 total time= 0.0s
[CV 4/5; 99/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=10
[CV 4/5; 99/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=10;; score=0.848 total time= 0.0s
[CV 5/5; 99/108] START criterion=log_loss, max_depth=20, max_features=log2, min_sam
ples_split=10
[CV 5/5; 99/108] END criterion=log_loss, max_depth=20, max_features=log2, min_samp
les_split=10;; score=0.836 total time= 0.0s
[CV 1/5; 100/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=2
[CV 1/5; 100/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam

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ples_split=2;; score=0.811 total time= 0.0s
[CV 2/5; 100/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=2
[CV 2/5; 100/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 100/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=2
[CV 3/5; 100/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=2;; score=0.814 total time= 0.0s
[CV 4/5; 100/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=2
[CV 4/5; 100/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=2;; score=0.798 total time= 0.0s
[CV 5/5; 100/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=2
[CV 5/5; 100/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=2;; score=0.813 total time= 0.0s
[CV 1/5; 101/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=5
[CV 1/5; 101/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=5;; score=0.809 total time= 0.0s
[CV 2/5; 101/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=5
[CV 2/5; 101/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=5;; score=0.828 total time= 0.0s
[CV 3/5; 101/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=5
[CV 3/5; 101/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 101/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=5
[CV 4/5; 101/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 101/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=5
[CV 5/5; 101/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 102/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=10
[CV 1/5; 102/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=10;; score=0.833 total time= 0.0s
[CV 2/5; 102/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=10
[CV 2/5; 102/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 102/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=10
[CV 3/5; 102/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 102/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=10
[CV 4/5; 102/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 102/108] START criterion=log_loss, max_depth=30, max_features=auto, min_s
amples_split=10
[CV 5/5; 102/108] END criterion=log_loss, max_depth=30, max_features=auto, min_sam
ples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 103/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=2
[CV 1/5; 103/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=2;; score=0.811 total time= 0.0s
[CV 2/5; 103/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=2
[CV 2/5; 103/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam

```

```
ples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 103/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=2
[CV 3/5; 103/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=2;; score=0.814 total time= 0.0s
[CV 4/5; 103/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=2
[CV 4/5; 103/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=2;; score=0.798 total time= 0.0s
[CV 5/5; 103/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=2
[CV 5/5; 103/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=2;; score=0.813 total time= 0.0s
[CV 1/5; 104/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=5
[CV 1/5; 104/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=5;; score=0.809 total time= 0.0s
[CV 2/5; 104/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=5
[CV 2/5; 104/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=5;; score=0.828 total time= 0.0s
[CV 3/5; 104/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=5
[CV 3/5; 104/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 104/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=5
[CV 4/5; 104/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 104/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=5
[CV 5/5; 104/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 105/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=10
[CV 1/5; 105/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=10;; score=0.833 total time= 0.0s
[CV 2/5; 105/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=10
[CV 2/5; 105/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 105/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=10
[CV 3/5; 105/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 105/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=10
[CV 4/5; 105/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 105/108] START criterion=log_loss, max_depth=30, max_features=sqrt, min_s
amples_split=10
[CV 5/5; 105/108] END criterion=log_loss, max_depth=30, max_features=sqrt, min_sam
ples_split=10;; score=0.839 total time= 0.0s
[CV 1/5; 106/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=2
[CV 1/5; 106/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=2;; score=0.811 total time= 0.0s
[CV 2/5; 106/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=2
[CV 2/5; 106/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=2;; score=0.819 total time= 0.0s
[CV 3/5; 106/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=2
[CV 3/5; 106/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
```

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ples_split=2;; score=0.814 total time= 0.0s
[CV 4/5; 106/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=2
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ples_split=2;; score=0.798 total time= 0.0s
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amples_split=2
[CV 5/5; 106/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=2;; score=0.813 total time= 0.0s
[CV 1/5; 107/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=5
[CV 1/5; 107/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=5;; score=0.809 total time= 0.0s
[CV 2/5; 107/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=5
[CV 2/5; 107/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=5;; score=0.828 total time= 0.0s
[CV 3/5; 107/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=5
[CV 3/5; 107/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=5;; score=0.818 total time= 0.0s
[CV 4/5; 107/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=5
[CV 4/5; 107/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=5;; score=0.821 total time= 0.0s
[CV 5/5; 107/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=5
[CV 5/5; 107/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=5;; score=0.816 total time= 0.0s
[CV 1/5; 108/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=10
[CV 1/5; 108/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=10;; score=0.833 total time= 0.0s
[CV 2/5; 108/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=10
[CV 2/5; 108/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=10;; score=0.851 total time= 0.0s
[CV 3/5; 108/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=10
[CV 3/5; 108/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=10;; score=0.843 total time= 0.0s
[CV 4/5; 108/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=10
[CV 4/5; 108/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=10;; score=0.836 total time= 0.0s
[CV 5/5; 108/108] START criterion=log_loss, max_depth=30, max_features=log2, min_s
amples_split=10
[CV 5/5; 108/108] END criterion=log_loss, max_depth=30, max_features=log2, min_sam
ples_split=10;; score=0.839 total time= 0.0s

```

```

In [34]: print(best_ds_params)

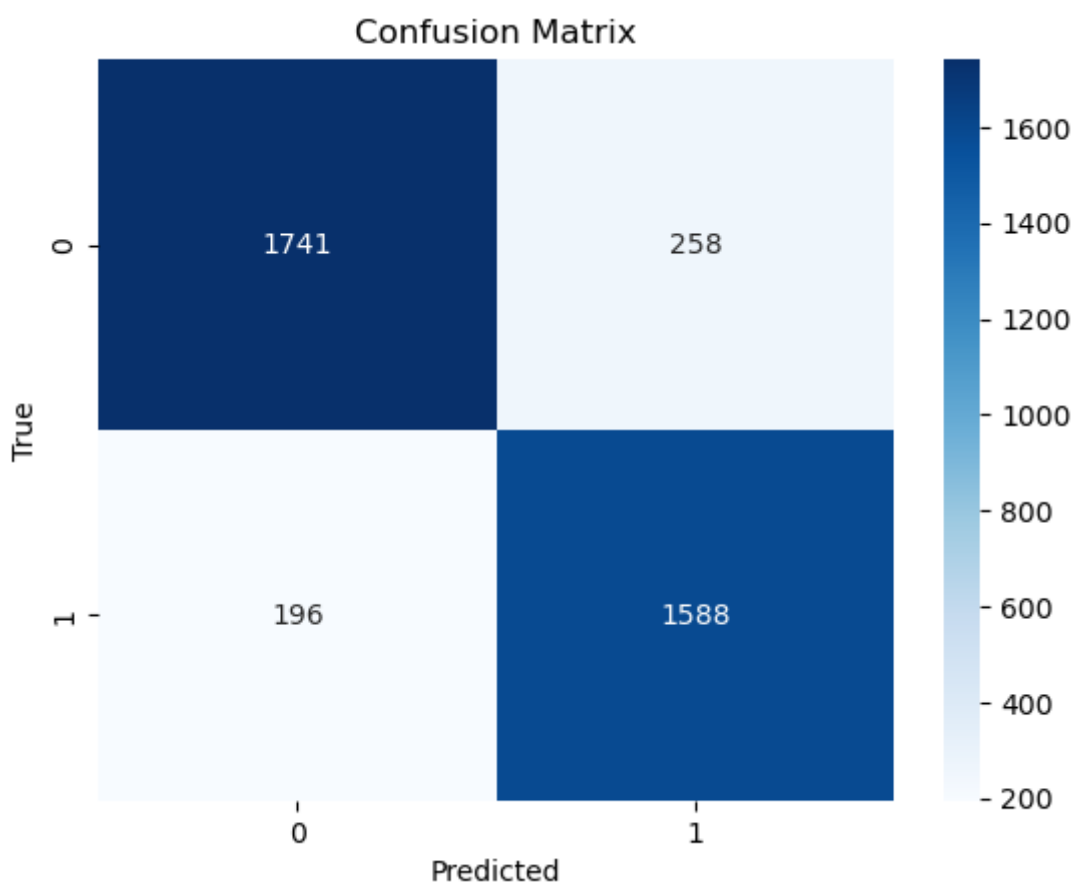
ds_y_pred = best_ds_model.predict(X_test)
print(classification_report(y_test, ds_y_pred))

```

```
{'criterion': 'gini', 'max_depth': 10, 'max_features': 'auto', 'min_samples_split': 2}
```

	precision	recall	f1-score	support
0	0.90	0.87	0.88	1999
1	0.86	0.89	0.87	1784
accuracy			0.88	3783
macro avg	0.88	0.88	0.88	3783
weighted avg	0.88	0.88	0.88	3783

```
In [35]: sns.heatmap(confusion_matrix(y_test, ds_y_pred), annot=True, fmt='d', cmap='Blues')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')
plt.show()
```



MODEL EVALUATION

```
In [50]: model_names = ["K-Nearest Neighbors", "Random Forest", "Logistic Regression", "Support Vector Machine"]
accuracies = [accuracy_score(y_test, knn_y_pred), accuracy_score(y_test, rf_y_pred), accuracy_score(y_test, lr_y_pred), accuracy_score(y_test, svm_y_pred)]
f1_scores = [f1_score(y_test, knn_y_pred), f1_score(y_test, rf_y_pred), f1_score(y_test, lr_y_pred), f1_score(y_test, svm_y_pred)]

#Create an array for the x-axis positions of bars
x = np.arange(len(model_names))

#Set the width of the bars
bar_width = 0.35

#Create subplots (two bar charts side by side)
fig, ax = plt.subplots(figsize=(12, 6))
```

```

#Create the bar chart for accuracy
bar1 = ax.bar(x - bar_width/2, accuracies, bar_width, label='Accuracy', color='b')

#Create the bar chart for F1-score
bar2 = ax.bar(x + bar_width/2, f1_scores, bar_width, label='F1-Score', color='g')

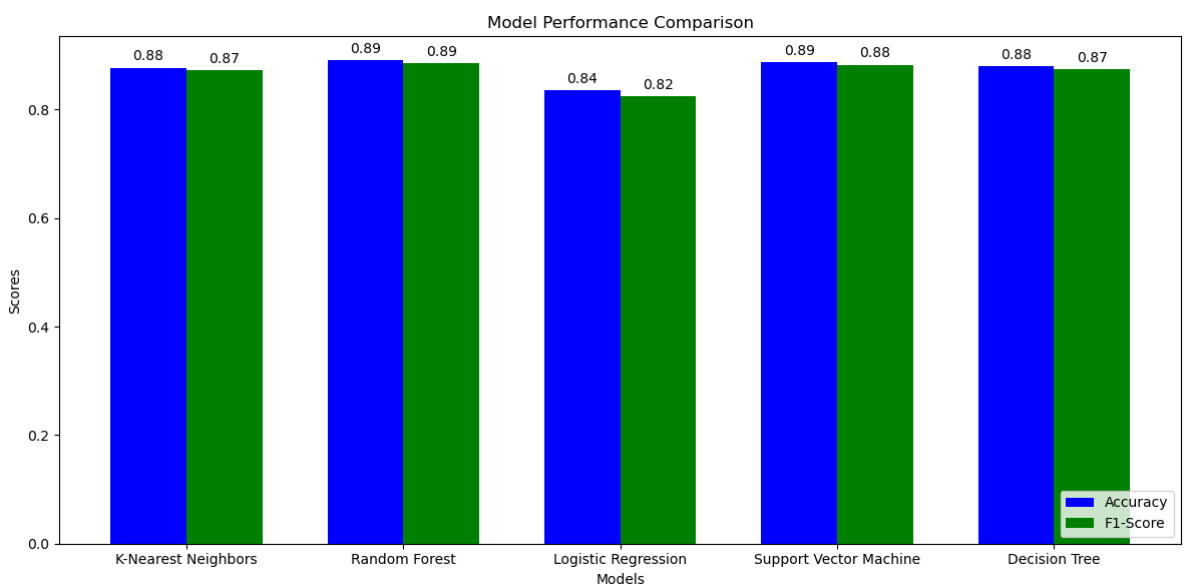
#Set Labels, title, and Legend
ax.set_xlabel('Models')
ax.set_ylabel('Scores')
ax.set_title('Model Performance Comparison')
ax.set_xticks(x)
ax.set_xticklabels(model_names)
ax.legend(loc='lower right')

#Add actual value Labels on each bar
def add_labels(bars):
    for bar in bars:
        height = bar.get_height()
        ax.annotate(f'{height:.2f}', # Format the label as desired
                    xy=(bar.get_x() + bar.get_width() / 2, height),
                    xytext=(0, 3), # 3 points vertical offset
                    textcoords="offset points",
                    ha='center', va='bottom')

add_labels(bar1) # Add labels for the Accuracy bars
add_labels(bar2) # Add labels for the F1-Score bars

#Display the bar chart
plt.tight_layout()
plt.show()

```



ROC Curve & AUC value

```

In [43]: # Define a list of model names and their respective classifiers
model_names = ["K-Nearest Neighbors", "Random Forest", "Logistic Regression", "Support Vector Machine", "Decision Tree"]
classifiers = [best_knn_model, best_rf_model, best_lr_model, best_svm_model, best_dt_model]

# Create a figure for ROC curves
plt.figure(figsize=(8, 6))

# Plot ROC curves for each model
for model, model_name in zip(classifiers, model_names):
    y_prob = model.predict_proba(X_test)[: , 1] # Probabilities for class 1

```



```

fpr, tpr, thresholds = roc_curve(y_test, y_prob)
roc_auc = auc(fpr, tpr)

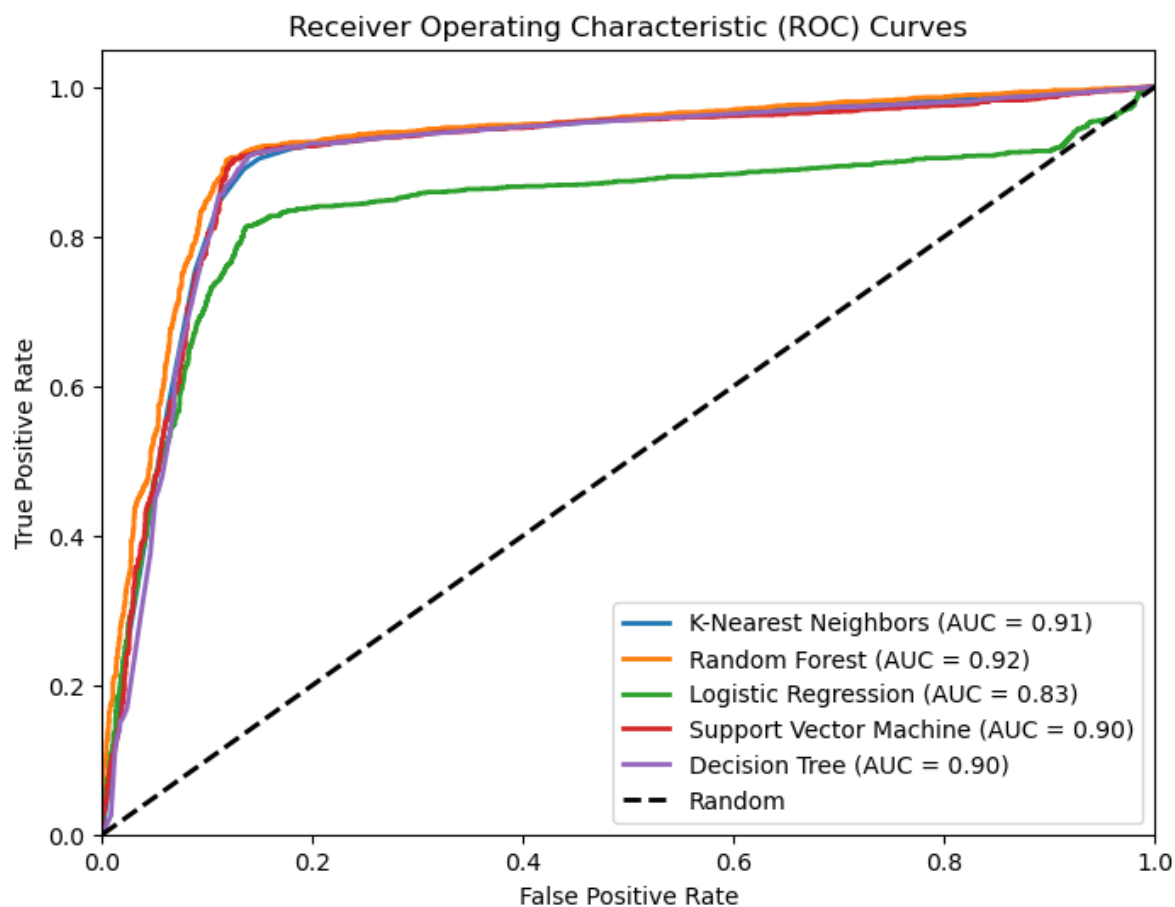
plt.plot(fpr, tpr, lw=2, label=f'{model_name} (AUC = {roc_auc:.2f})')

# Plot the random classifier line
plt.plot([0, 1], [0, 1], 'k--', lw=2, label='Random')

# Customize the plot
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curves')
plt.legend(loc='lower right')

# Show the plot
plt.show()

```



In []: