```
In [127... pip install hyperopt  # Hyperopt Optimization
```

```
Requirement already satisfied: hyperopt in ./anaconda3/lib/python3.11/site-packages (0.2.7)
Requirement already satisfied: numpy in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (1.24.3)
Requirement already satisfied: scipy in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (1.10.1)
Requirement already satisfied: six in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (1.16.0)
Requirement already satisfied: networkx>=2.2 in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (3.
1)
Requirement already satisfied: future in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (0.18.3)
Requirement already satisfied: tqdm in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (4.65.0)
Requirement already satisfied: cloudpickle in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (2.2.
1)
Requirement already satisfied: py4j in ./anaconda3/lib/python3.11/site-packages (from hyperopt) (0.10.9.7)
Note: you may need to restart the kernel to use updated packages.
```

```python
In [128... import numpy as np
import pandas as pd
from sklearn.ensemble import RandomForestClassifier
from sklearn import metrics
from sklearn.model_selection import cross_val_score
from sklearn.preprocessing import StandardScaler
from hyperopt import tpe, hp, fmin, STATUS_OK,Trials
from hyperopt.pyll.base import scope

import warnings
warnings.filterwarnings("ignore")
```

```python
In [129... data = pd.read_csv("test.csv")
data = pd.read_csv("train.csv")
```

```python
In [130... data.head()
```

Out[130]:

	battery_power	blue	clock_speed	dual_sim	fc	four_g	int_memory	m_dep	mobile_wt	n_cores	...	px_height	px_width	ra
0	842	0	2.2	0	1	0	7	0.6	188	2	...	20	756	254
1	1021	1	0.5	1	0	1	53	0.7	136	3	...	905	1988	263
2	563	1	0.5	1	2	1	41	0.9	145	5	...	1263	1716	260
3	615	1	2.5	0	0	0	10	0.8	131	6	...	1216	1786	276
4	1821	1	1.2	0	13	1	44	0.6	141	2	...	1208	1212	141

5 rows × 21 columns

In [131…]:
```python
data.shape
```

Out[131]:
```
(2000, 21)
```

In [132…]:
```python
list(data.columns)
```

Out[132]:
```
['battery_power',
 'blue',
 'clock_speed',
 'dual_sim',
 'fc',
 'four_g',
 'int_memory',
 'm_dep',
 'mobile_wt',
 'n_cores',
 'pc',
 'px_height',
 'px_width',
 'ram',
 'sc_h',
 'sc_w',
 'talk_time',
 'three_g',
 'touch_screen',
 'wifi',
 'price_range']
```

In [133…]:
```python
X = data.drop("price_range", axis=1).values        # spliting data into features and target
y = data.price_range.values
```

```python
In [134…   scaler = StandardScaler()                              # standardizing the feature variables
           X_scaled = scaler.fit_transform(X)
```

```python
In [135…   space = {
               "n_estimators": hp.choice("n_estimators", [50, 100, 200, 300,400,500]),
               "max_depth": hp.quniform("max_depth", 2, 30,2),
               "criterion": hp.choice("criterion", ["gini", "entropy"]),
           }
```

```python
In [136…   def hyperparameter_tuning(params):                      # defining objective function
               clf = RandomForestClassifier(**params,n_jobs=-1)
               acc = cross_val_score(clf, X_scaled, y,scoring="accuracy").mean()
               return {"loss": -acc, "status": STATUS_OK}
```

```python
In [137…   from hyperopt import fmin, tpe, Trials, hp
           from sklearn.model_selection import cross_val_score
           from sklearn.ensemble import RandomForestClassifier

           # Defining the search space
           space = {
               'n_estimators': hp.choice('n_estimators', range(10, 100)),
               'max_depth': hp.choice('max_depth', range(1, 21)),  # Adjust the range for integer values
               'criterion': hp.choice('criterion', ["gini", "entropy"])
           }

           # Defining the hyperparameter tuning function
           def hyperparameter_tuning(params):
               clf = RandomForestClassifier(**params, n_jobs=-1)
               acc = cross_val_score(clf, X_scaled, y, scoring="accuracy").mean()
               return {'loss': -acc, 'status': 'ok'}

           # Initializing trials object
           trials = Trials()

           # Run hyperparameter optimization
           best = fmin(
               fn=hyperparameter_tuning,
               space=space,
               algo=tpe.suggest,
               max_evals=100,
               trials=trials
           )
```

```
print("Best: {}".format(best))
```

```
100%|████████████████| 100/100 [00:25<00:00,  3.98trial/s, best loss: −0.8875]
Best: {'criterion': 1, 'max_depth': 15, 'n_estimators': 78}
```

In [138… | `trials.results`

```
Out[138]:  [{'loss': -0.8615, 'status': 'ok'},
           {'loss': -0.8665, 'status': 'ok'},
           {'loss': -0.8145, 'status': 'ok'},
           {'loss': -0.8825, 'status': 'ok'},
           {'loss': -0.8435, 'status': 'ok'},
           {'loss': -0.8604999999999998, 'status': 'ok'},
           {'loss': -0.8625, 'status': 'ok'},
           {'loss': -0.7955, 'status': 'ok'},
           {'loss': -0.8024999999999999, 'status': 'ok'},
           {'loss': -0.7725, 'status': 'ok'},
           {'loss': -0.8465, 'status': 'ok'},
           {'loss': -0.8610000000000001, 'status': 'ok'},
           {'loss': -0.883, 'status': 'ok'},
           {'loss': -0.8700000000000001, 'status': 'ok'},
           {'loss': -0.8305, 'status': 'ok'},
           {'loss': -0.8800000000000001, 'status': 'ok'},
           {'loss': -0.875, 'status': 'ok'},
           {'loss': -0.8295, 'status': 'ok'},
           {'loss': -0.693, 'status': 'ok'},
           {'loss': -0.844, 'status': 'ok'},
           {'loss': -0.8789999999999999, 'status': 'ok'},
           {'loss': -0.6675000000000001, 'status': 'ok'},
           {'loss': -0.8815000000000002, 'status': 'ok'},
           {'loss': -0.861, 'status': 'ok'},
           {'loss': -0.8674999999999999, 'status': 'ok'},
           {'loss': -0.5609999999999999, 'status': 'ok'},
           {'loss': -0.8775000000000001, 'status': 'ok'},
           {'loss': -0.8695, 'status': 'ok'},
           {'loss': -0.883, 'status': 'ok'},
           {'loss': -0.8855000000000001, 'status': 'ok'},
           {'loss': -0.876, 'status': 'ok'},
           {'loss': -0.8805, 'status': 'ok'},
           {'loss': -0.8805, 'status': 'ok'},
           {'loss': -0.876, 'status': 'ok'},
           {'loss': -0.877, 'status': 'ok'},
           {'loss': -0.8480000000000001, 'status': 'ok'},
           {'loss': -0.8875, 'status': 'ok'},
           {'loss': -0.8765000000000001, 'status': 'ok'},
           {'loss': -0.8559999999999999, 'status': 'ok'},
           {'loss': -0.8215, 'status': 'ok'},
           {'loss': -0.8355, 'status': 'ok'},
           {'loss': -0.807, 'status': 'ok'},
           {'loss': -0.8744999999999999, 'status': 'ok'},
           {'loss': -0.8089999999999999, 'status': 'ok'},
           {'loss': -0.8795, 'status': 'ok'},
```

```
{'loss': -0.875, 'status': 'ok'},
{'loss': -0.8365, 'status': 'ok'},
{'loss': -0.884, 'status': 'ok'},
{'loss': -0.8870000000000001, 'status': 'ok'},
{'loss': -0.8709999999999999, 'status': 'ok'},
{'loss': -0.874, 'status': 'ok'},
{'loss': -0.8310000000000001, 'status': 'ok'},
{'loss': -0.7585, 'status': 'ok'},
{'loss': -0.8775000000000001, 'status': 'ok'},
{'loss': -0.5494999999999999, 'status': 'ok'},
{'loss': -0.8855000000000001, 'status': 'ok'},
{'loss': -0.8675, 'status': 'ok'},
{'loss': -0.8125, 'status': 'ok'},
{'loss': -0.876, 'status': 'ok'},
{'loss': -0.74, 'status': 'ok'},
{'loss': -0.876, 'status': 'ok'},
{'loss': -0.8474999999999999, 'status': 'ok'},
{'loss': -0.837, 'status': 'ok'},
{'loss': -0.869, 'status': 'ok'},
{'loss': -0.744, 'status': 'ok'},
{'loss': -0.8664999999999999, 'status': 'ok'},
{'loss': -0.8734999999999999, 'status': 'ok'},
{'loss': -0.8574999999999999, 'status': 'ok'},
{'loss': -0.6635000000000001, 'status': 'ok'},
{'loss': -0.884, 'status': 'ok'},
{'loss': -0.8844999999999998, 'status': 'ok'},
{'loss': -0.876, 'status': 'ok'},
{'loss': -0.8795, 'status': 'ok'},
{'loss': -0.876, 'status': 'ok'},
{'loss': -0.8585, 'status': 'ok'},
{'loss': -0.8365, 'status': 'ok'},
{'loss': -0.8835000000000001, 'status': 'ok'},
{'loss': -0.8545, 'status': 'ok'},
{'loss': -0.8584999999999999, 'status': 'ok'},
{'loss': -0.8785000000000001, 'status': 'ok'},
{'loss': -0.548, 'status': 'ok'},
{'loss': -0.873, 'status': 'ok'},
{'loss': -0.8825, 'status': 'ok'},
{'loss': -0.865, 'status': 'ok'},
{'loss': -0.852, 'status': 'ok'},
{'loss': -0.7389999999999999, 'status': 'ok'},
{'loss': -0.8690000000000001, 'status': 'ok'},
{'loss': -0.8445, 'status': 'ok'},
{'loss': -0.8779999999999999, 'status': 'ok'},
{'loss': -0.8515, 'status': 'ok'},
```

```
 {'loss': −0.8545, 'status': 'ok'},
 {'loss': −0.799, 'status': 'ok'},
 {'loss': −0.8320000000000001, 'status': 'ok'},
 {'loss': −0.8675, 'status': 'ok'},
 {'loss': −0.8780000000000001, 'status': 'ok'},
 {'loss': −0.8620000000000001, 'status': 'ok'},
 {'loss': −0.8765000000000001, 'status': 'ok'},
 {'loss': −0.86, 'status': 'ok'},
 {'loss': −0.633, 'status': 'ok'},
 {'loss': −0.8674999999999999, 'status': 'ok'}]
```

In [139… `trials.losses()`

```
Out[139]:  [-0.8615,
            -0.8665,
            -0.8145,
            -0.8825,
            -0.8435,
            -0.8604999999999998,
            -0.8625,
            -0.7955,
            -0.8024999999999999,
            -0.7725,
            -0.8465,
            -0.8610000000000001,
            -0.883,
            -0.8700000000000001,
            -0.8305,
            -0.8800000000000001,
            -0.875,
            -0.8295,
            -0.693,
            -0.844,
            -0.8789999999999999,
            -0.6675000000000001,
            -0.8815000000000002,
            -0.861,
            -0.8674999999999999,
            -0.5609999999999999,
            -0.8775000000000001,
            -0.8695,
            -0.883,
            -0.8855000000000001,
            -0.876,
            -0.8805,
            -0.8805,
            -0.876,
            -0.877,
            -0.8480000000000001,
            -0.8875,
            -0.8765000000000001,
            -0.8559999999999999,
            -0.8215,
            -0.8355,
            -0.807,
            -0.8744999999999999,
            -0.8089999999999999,
            -0.8795,
```

```
-0.875,
-0.8365,
-0.884,
-0.8870000000000001,
-0.8709999999999999,
-0.874,
-0.8310000000000001,
-0.7585,
-0.8775000000000001,
-0.5494999999999999,
-0.8855000000000001,
-0.8675,
-0.8125,
-0.876,
-0.74,
-0.876,
-0.8474999999999999,
-0.837,
-0.869,
-0.744,
-0.8664999999999999,
-0.8734999999999999,
-0.8574999999999999,
-0.6635000000000001,
-0.884,
-0.8844999999999998,
-0.876,
-0.8795,
-0.876,
-0.8585,
-0.8365,
-0.8835000000000001,
-0.8545,
-0.8584999999999999,
-0.8785000000000001,
-0.548,
-0.873,
-0.8825,
-0.865,
-0.852,
-0.7389999999999999,
-0.8690000000000001,
-0.8445,
-0.8779999999999999,
-0.8515,
```

```
            -0.8545,
            -0.799,
            -0.8320000000000001,
            -0.8675,
            -0.8780000000000001,
            -0.8620000000000001,
            -0.8765000000000001,
            -0.86,
            -0.633,
            -0.8674999999999999]
```

In [140… `trials.statuses()`

```
Out[140]:  ['ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
```

```
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
             'ok',
```

```
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok',
            'ok']
```

In [141…
```
pip install scikit-optimize                          #Scikit Optimization
```

```
Requirement already satisfied: scikit-optimize in ./anaconda3/lib/python3.11/site-packages (0.10.1)
Requirement already satisfied: joblib>=0.11 in ./anaconda3/lib/python3.11/site-packages (from scikit-optimiz
e) (1.2.0)
Requirement already satisfied: pyaml>=16.9 in ./anaconda3/lib/python3.11/site-packages (from scikit-optimize)
(24.4.0)
Requirement already satisfied: numpy>=1.20.3 in ./anaconda3/lib/python3.11/site-packages (from scikit-optimiz
e) (1.24.3)
Requirement already satisfied: scipy>=1.1.0 in ./anaconda3/lib/python3.11/site-packages (from scikit-optimiz
e) (1.10.1)
Requirement already satisfied: scikit-learn>=1.0.0 in ./anaconda3/lib/python3.11/site-packages (from scikit-o
ptimize) (1.3.0)
Requirement already satisfied: packaging>=21.3 in ./anaconda3/lib/python3.11/site-packages (from scikit-optim
ize) (23.0)
Requirement already satisfied: PyYAML in ./anaconda3/lib/python3.11/site-packages (from pyaml>=16.9->scikit-o
ptimize) (6.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in ./anaconda3/lib/python3.11/site-packages (from scikit-
learn>=1.0.0->scikit-optimize) (2.2.0)
Note: you may need to restart the kernel to use updated packages.
```

In [142…
```
# defining search space
params = {
    "n_estimators": [50, 100, 200, 500],
    "max_depth": (1, 10),
    "criterion": ["gini", "entropy"],
}
```

In [143…
```
from sklearn.ensemble import RandomForestClassifier
from skopt.searchcv import BayesSearchCV

# Instantiating the random forest classifier
rf_classifier = RandomForestClassifier()
```

```python
# Defining the search
search = BayesSearchCV(
    estimator=rf_classifier,
    search_spaces=params,
    n_jobs=2,
    cv=10,
    n_iter=60,
    scoring="accuracy",
    verbose=8,
    random_state=84
)
```

In [144…
```python
# search
search.fit(X_scaled,y)
```

```
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
```

```
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
[CV 1/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.780 total time=   0.5s
[CV 4/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.780 total time=   0.5s
[CV 6/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.760 total time=   0.5s
[CV 8/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.780 total time=   0.5s
[CV 10/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.775 total time=   0.5s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.860 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.860 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.910 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.865 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.835 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.885 total time=   0.4s
[CV 4/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.880 total time=   0.4s
[CV 6/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.905 total time=   0.4s
[CV 8/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.870 total time=   0.4s
[CV 10/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.880 total time=   0.4s
[CV 2/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.850 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.835 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.870 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.800 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.840 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.760 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.730 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.760 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.755 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.745 total time=   0.1s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.875 total time=   0.4s
[CV 2/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.885 total time=   0.5s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.875 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.855 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.880 total time=   0.5s
[CV 3/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.890 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.870 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.895 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.905 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.875 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.835 total time=   0.7s
[CV 2/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.855 total time=   0.7s
[CV 5/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.865 total time=   0.7s
```

```
[CV 6/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.880 total time=    0.7s
[CV 9/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.830 total time=    0.7s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.755 total time=    0.1s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.755 total time=    0.1s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.780 total time=    0.1s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.730 total time=    0.1s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.730 total time=    0.1s
[CV 1/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.820 total time=    0.4s
[CV 2/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.845 total time=    0.3s
[CV 5/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.850 total time=    0.3s
[CV 6/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.895 total time=    0.3s
[CV 9/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.810 total time=    0.3s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.880 total time=    0.2s
[CV 2/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.850 total time=    0.1s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.890 total time=    0.1s
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.900 total time=    0.1s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.850 total time=    0.1s
[CV 1/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.885 total time=    0.5s
[CV 2/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.875 total time=    0.4s
[CV 5/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.920 total time=    0.4s
[CV 6/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.895 total time=    0.4s
[CV 9/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.840 total time=    0.4s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.890 total time=    0.5s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.875 total time=    0.4s
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.920 total time=    0.4s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.900 total time=    0.4s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.840 total time=    0.4s
[CV 1/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.830 total time=    0.7s
[CV 2/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.815 total time=    0.6s
[CV 5/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.830 total time=    0.6s
[CV 6/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.830 total time=    0.6s
[CV 9/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.805 total time=    0.6s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.875 total time=    1.0s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.875 total time=    0.9s
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.885 total time=    0.9s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.920 total time=    1.0s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.850 total time=    0.9s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.850 total time=    0.1s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.880 total time=    0.1s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.845 total time=    0.1s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.865 total time=    0.1s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.855 total time=    0.1s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.895 total time=    0.4s
[CV 2/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.870 total time=    0.2s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.890 total time=    0.2s
```

```
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.895 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.855 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.855 total time=   0.1s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.890 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.895 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.905 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.820 total time=   0.1s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.895 total time=   1.2s
[CV 2/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.880 total time=   1.1s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.925 total time=   1.2s
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.895 total time=   1.2s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.855 total time=   1.1s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.835 total time=   0.3s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.865 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.880 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.900 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.840 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.900 total time=   1.2s
[CV 2/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.875 total time=   1.0s
[CV 5/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.915 total time=   1.0s
[CV 6/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.905 total time=   1.1s
[CV 9/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.860 total time=   1.0s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.865 total time=   0.4s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.865 total time=   0.4s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.875 total time=   0.3s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.845 total time=   0.3s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.870 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.660 total time=   0.6s
[CV 4/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.690 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.735 total time=   0.5s
[CV 8/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.730 total time=   0.5s
[CV 10/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.680 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.835 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.835 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.850 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.815 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.825 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.865 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.880 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.845 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.835 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.870 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.880 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.875 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.875 total time=   0.2s
```

```
[CV 8/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.850 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.875 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.655 total time=   0.5s
[CV 2/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.675 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.680 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.735 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.660 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.845 total time=   0.1s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.840 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.850 total time=   0.1s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.835 total time=   0.1s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.845 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.885 total time=   0.8s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.860 total time=   0.9s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.865 total time=   0.8s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.845 total time=   0.8s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.855 total time=   0.8s
[CV 3/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.865 total time=   0.5s
[CV 4/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.850 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.860 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.840 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.855 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.905 total time=   1.1s
[CV 4/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.870 total time=   1.1s
[CV 7/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.880 total time=   1.1s
[CV 8/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.860 total time=   1.1s
[CV 10/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.880 total time=   1.1s
[CV 3/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.870 total time=   0.5s
[CV 4/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.870 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.880 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.855 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.875 total time=   0.4s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.900 total time=   0.1s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.855 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.885 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.860 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.850 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.905 total time=   0.3s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.875 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.885 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.875 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.880 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.855 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.865 total time=   0.1s
[CV 2/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.760 total time=   0.5s
```

```
[CV 3/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.825 total time=    0.5s
[CV 5/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.790 total time=    0.5s
[CV 7/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.790 total time=    0.5s
[CV 9/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.750 total time=    0.5s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.865 total time=    0.2s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.880 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.905 total time=    0.2s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.875 total time=    0.2s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=100;, score=0.875 total time=    0.2s
[CV 2/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.860 total time=    0.4s
[CV 3/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.910 total time=    0.4s
[CV 5/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.890 total time=    0.4s
[CV 7/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.890 total time=    0.4s
[CV 9/10] END criterion=gini, max_depth=9, n_estimators=200;, score=0.830 total time=    0.4s
[CV 1/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.815 total time=    0.2s
[CV 3/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.850 total time=    0.2s
[CV 5/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.855 total time=    0.2s
[CV 7/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.880 total time=    0.2s
[CV 9/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.790 total time=    0.2s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.760 total time=    0.1s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.750 total time=    0.1s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.810 total time=    0.1s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.785 total time=    0.1s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.720 total time=    0.1s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.900 total time=    0.4s
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.875 total time=    0.4s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.925 total time=    0.4s
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.905 total time=    0.4s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.875 total time=    0.4s
[CV 1/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.885 total time=    0.2s
[CV 2/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.875 total time=    0.2s
[CV 7/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.830 total time=    0.2s
[CV 8/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.845 total time=    0.2s
[CV 9/10] END criterion=entropy, max_depth=9, n_estimators=100;, score=0.860 total time=    0.2s
[CV 3/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.855 total time=    0.7s
[CV 4/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.870 total time=    0.7s
[CV 7/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.865 total time=    0.7s
[CV 8/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.825 total time=    0.7s
[CV 10/10] END criterion=gini, max_depth=6, n_estimators=500;, score=0.855 total time=    0.7s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.710 total time=    0.1s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.690 total time=    0.1s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.760 total time=    0.1s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.730 total time=    0.1s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=100;, score=0.770 total time=    0.1s
[CV 3/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.865 total time=    0.4s
```

```
[CV 4/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.860 total time=   0.3s
[CV 7/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.845 total time=   0.3s
[CV 8/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.800 total time=   0.3s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=200;, score=0.845 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.865 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.885 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.880 total time=   0.1s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.845 total time=   0.1s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.875 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.890 total time=   0.5s
[CV 4/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.855 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.880 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.860 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=8, n_estimators=200;, score=0.865 total time=   0.4s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.905 total time=   0.5s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.870 total time=   0.4s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.880 total time=   0.4s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.865 total time=   0.4s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.880 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.840 total time=   0.7s
[CV 4/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.805 total time=   0.6s
[CV 7/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.840 total time=   0.6s
[CV 8/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.800 total time=   0.6s
[CV 10/10] END criterion=entropy, max_depth=4, n_estimators=500;, score=0.830 total time=   0.6s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.915 total time=   1.0s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.880 total time=   0.9s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.880 total time=   0.9s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.870 total time=   1.0s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=500;, score=0.885 total time=   0.9s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.870 total time=   0.1s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.855 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.885 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.910 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.855 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.905 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.865 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.865 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.880 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.870 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.875 total time=   0.1s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.860 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.865 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.875 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.855 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.900 total time=   1.2s
```
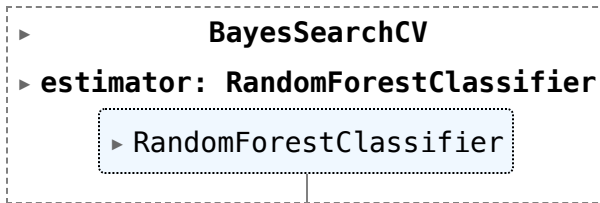
```
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.885 total time=   1.1s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.875 total time=   1.2s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.865 total time=   1.2s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=500;, score=0.870 total time=   1.1s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.890 total time=   0.3s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.870 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.870 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.870 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.885 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.895 total time=   1.1s
[CV 4/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.875 total time=   1.1s
[CV 7/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.880 total time=   1.0s
[CV 8/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.860 total time=   1.1s
[CV 10/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.880 total time=   1.0s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.880 total time=   0.4s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.865 total time=   0.4s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.895 total time=   0.3s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.905 total time=   0.3s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.825 total time=   0.3s
[CV 1/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.685 total time=   0.6s
[CV 2/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.670 total time=   0.5s
[CV 5/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.710 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.665 total time=   0.5s
[CV 9/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.660 total time=   0.4s
[CV 1/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.850 total time=   0.2s
[CV 2/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.825 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.840 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.845 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.805 total time=   0.1s
[CV 1/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.875 total time=   0.3s
[CV 2/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.870 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.900 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.895 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=7, n_estimators=100;, score=0.845 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.865 total time=   0.3s
[CV 2/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.865 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.895 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.900 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=8, n_estimators=100;, score=0.835 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.685 total time=   0.5s
[CV 4/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.650 total time=   0.4s
[CV 5/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.685 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.655 total time=   0.4s
[CV 9/10] END criterion=entropy, max_depth=2, n_estimators=500;, score=0.665 total time=   0.4s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.830 total time=   0.1s
```

```
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.835 total time=   0.1s
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.890 total time=   0.1s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.855 total time=   0.1s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.825 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.855 total time=   0.8s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.865 total time=   0.9s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.890 total time=   0.8s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.895 total time=   0.8s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.815 total time=   0.8s
[CV 1/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.840 total time=   0.5s
[CV 2/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.870 total time=   0.4s
[CV 5/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.890 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.895 total time=   0.4s
[CV 9/10] END criterion=entropy, max_depth=7, n_estimators=200;, score=0.845 total time=   0.4s
[CV 1/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.910 total time=   1.1s
[CV 2/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.890 total time=   1.1s
[CV 5/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.900 total time=   1.1s
[CV 6/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.900 total time=   1.1s
[CV 9/10] END criterion=entropy, max_depth=9, n_estimators=500;, score=0.845 total time=   1.1s
[CV 1/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.885 total time=   0.5s
[CV 2/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.875 total time=   0.4s
[CV 5/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.915 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.910 total time=   0.4s
[CV 9/10] END criterion=entropy, max_depth=9, n_estimators=200;, score=0.845 total time=   0.4s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.855 total time=   0.1s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.860 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.850 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.870 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=50;, score=0.850 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.870 total time=   0.3s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.875 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.895 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.905 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.865 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.845 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.870 total time=   0.1s
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
Fitting 10 folds for each of 1 candidates, totalling 10 fits
```

Out[144]:
```
    ▸      BayesSearchCV

    ▸ estimator: RandomForestClassifier

         ▸ RandomForestClassifier
```

In [145…
```python
#best result

print(search.best_score_)
print(search.best_params_)
```
```
0.8850000000000001
OrderedDict([('criterion', 'entropy'), ('max_depth', 10), ('n_estimators', 200)])
```

In [146…
```python
# defining the space of hyperparameters        (The Second Approach)
#In the second approach, we first define the search space by using the space methods provided by scikit-optim
search_space = list()
search_space.append(Categorical([50, 100, 200, 300], name='n_estimators'))
search_space.append(Categorical(['gini', 'entropy'], name='criterion'))
search_space.append(Integer(1, 10, name='max_depth'))
```

In [147…
```python
# defining the function used to evaluate a given configuration

@use_named_args(search_space)
def evaluate_model(**params):
    # configuration of the model with specific hyperparameters
    clf = RandomForestClassifier(**params, n_jobs=-1)
    acc = cross_val_score(clf, X_scaled, y, scoring="accuracy").mean()
```

In [148…
```python
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score
import numpy as np

def evaluate_model(params):
    # Extracting hyperparameters
    n_estimators, criterion, max_depth = params

    # Instantiating RandomForestClassifier with given hyperparameters
    clf = RandomForestClassifier(
        n_estimators=n_estimators,
        criterion=criterion,
        max_depth=max_depth,
        n_jobs=-1
```

```python
    )

    # cross-validation
    scores = cross_val_score(clf, X_scaled, y, cv=5, scoring='accuracy')

    # mean accuracy (as a scalar)
    return -np.mean(scores)  # Minimizing negative accuracy

# evaluate_model function in gp_minimize
result = gp_minimize(
    func=evaluate_model,
    dimensions=search_space,
    n_calls=60,
    random_state=84,
    verbose=True,
    n_jobs=1,
)
```

```
Iteration No: 1 started. Evaluating function at random point.
[CV 5/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.870 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.865 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.800 total time=   0.1s
[CV 1/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.820 total time=   0.1s
[CV 2/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.825 total time=   0.1s
[CV 5/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.850 total time=   0.1s
[CV 6/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.775 total time=   0.1s
[CV 9/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.765 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.540 total time=   0.1s
[CV 2/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.630 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.655 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.530 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.550 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.805 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.795 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.840 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.820 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.790 total time=   0.1s
[CV 1/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.820 total time=   0.2s
[CV 2/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.830 total time=   0.1s
[CV 5/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.865 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.830 total time=   0.1s
[CV 9/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.800 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.875 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.835 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.865 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.845 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.810 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.860 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.850 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.880 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.880 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.820 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.800 total time=   0.1s
[CV 2/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.800 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.830 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.835 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.795 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.800 total time=   0.3s
[CV 2/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.825 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.845 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.845 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.820 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.580 total time=   0.4s
```

```
[CV 2/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.600 total time=    0.4s
[CV 5/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.615 total time=    0.3s
[CV 7/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.595 total time=    0.3s
[CV 9/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.575 total time=    0.3s
[CV 1/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.825 total time=    0.7s
[CV 2/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.850 total time=    0.7s
[CV 5/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.885 total time=    0.7s
[CV 7/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.860 total time=    0.7s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.830 total time=    0.7s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.770 total time=    0.2s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.750 total time=    0.2s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.735 total time=    0.2s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.760 total time=    0.2s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.735 total time=    0.2s
[CV 1/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.775 total time=    0.6s
[CV 2/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.790 total time=    0.5s
[CV 5/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.775 total time=    0.5s
[CV 7/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.825 total time=    0.5s
[CV 9/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.770 total time=    0.5s
[CV 1/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.835 total time=    1.0s
[CV 2/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.875 total time=    0.9s
[CV 5/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.910 total time=    0.9s
[CV 7/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.865 total time=    0.9s
[CV 9/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.835 total time=    0.9s
[CV 1/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.820 total time=    0.3s
[CV 2/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.855 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.855 total time=    0.2s
[CV 8/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.820 total time=    0.2s
[CV 9/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.785 total time=    0.2s
[CV 1/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.870 total time=    0.1s
[CV 2/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.850 total time=    0.1s
[CV 5/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.875 total time=    0.1s
[CV 7/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.895 total time=    0.1s
[CV 9/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.840 total time=    0.1s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.865 total time=    0.4s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.870 total time=    0.3s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.900 total time=    0.3s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.865 total time=    0.3s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.835 total time=    0.3s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.830 total time=    0.2s
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.860 total time=    0.2s
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.885 total time=    0.2s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.850 total time=    0.2s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.845 total time=    0.2s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.835 total time=    0.1s
```

```
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.815 total time=   0.1s
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.880 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.840 total time=   0.1s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.785 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.850 total time=   0.8s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.865 total time=   0.8s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.900 total time=   0.8s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.885 total time=   0.8s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.865 total time=   0.8s
[CV 1/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.865 total time=   0.9s
[CV 2/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.870 total time=   0.9s
[CV 5/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.890 total time=   0.9s
[CV 7/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.870 total time=   0.9s
[CV 9/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.825 total time=   0.9s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.840 total time=   0.4s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.850 total time=   0.3s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.885 total time=   0.3s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.860 total time=   0.3s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.835 total time=   0.3s
[CV 1/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.795 total time=   0.1s
[CV 2/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.790 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.790 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.780 total time=   0.0s
[CV 9/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.760 total time=   0.0s
[CV 1/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.870 total time=   1.0s
[CV 2/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.875 total time=   1.0s
[CV 5/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.915 total time=   1.0s
[CV 7/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.870 total time=   1.0s
[CV 9/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.840 total time=   1.0s
[CV 1/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.875 total time=   0.9s
[CV 2/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.880 total time=   0.9s
[CV 5/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.900 total time=   0.9s
[CV 7/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.890 total time=   0.9s
[CV 9/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.840 total time=   0.9s
[CV 1/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.830 total time=   0.2s
[CV 2/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.815 total time=   0.1s
[CV 5/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.845 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.820 total time=   0.1s
[CV 9/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.820 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.860 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.840 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.830 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.775 total time=   0.1s
[CV 4/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.775 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.820 total time=   0.1s
```

```
[CV 8/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.795 total time=   0.1s
[CV 10/10] END criterion=entropy, max_depth=4, n_estimators=50;, score=0.810 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.585 total time=   0.1s
[CV 4/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.575 total time=   0.1s
[CV 7/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.615 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.590 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=1, n_estimators=100;, score=0.530 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.830 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.810 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.835 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.815 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=4, n_estimators=100;, score=0.835 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.840 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.835 total time=   0.1s
[CV 6/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.880 total time=   0.1s
[CV 8/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.805 total time=   0.1s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=100;, score=0.835 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.880 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.875 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.880 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.825 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=6, n_estimators=100;, score=0.845 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.875 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.865 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.875 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.830 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=100;, score=0.860 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.855 total time=   0.1s
[CV 4/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.835 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.890 total time=   0.1s
[CV 8/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.825 total time=   0.1s
[CV 10/10] END criterion=gini, max_depth=5, n_estimators=50;, score=0.855 total time=   0.1s
[CV 3/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.865 total time=   0.3s
[CV 4/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.855 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.870 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.810 total time=   0.3s
[CV 10/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.840 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.630 total time=   0.4s
[CV 4/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.550 total time=   0.4s
[CV 6/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.565 total time=   0.3s
[CV 8/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.580 total time=   0.3s
[CV 10/10] END criterion=gini, max_depth=1, n_estimators=500;, score=0.605 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.855 total time=   0.7s
[CV 4/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.845 total time=   0.7s
[CV 6/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.850 total time=   0.7s
```

```
[CV 8/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.815 total time=    0.7s
[CV 9/10] END criterion=entropy, max_depth=5, n_estimators=500;, score=0.825 total time=    0.7s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.760 total time=    0.2s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.750 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.755 total time=    0.2s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.750 total time=    0.2s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=200;, score=0.775 total time=    0.2s
[CV 3/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.815 total time=    0.6s
[CV 4/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.770 total time=    0.5s
[CV 6/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.790 total time=    0.5s
[CV 8/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.740 total time=    0.5s
[CV 10/10] END criterion=entropy, max_depth=3, n_estimators=500;, score=0.785 total time=    0.5s
[CV 3/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.875 total time=    1.0s
[CV 4/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.865 total time=    0.9s
[CV 6/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.890 total time=    0.9s
[CV 8/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.835 total time=    0.9s
[CV 10/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.870 total time=    0.9s
[CV 3/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.850 total time=    0.3s
[CV 4/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.865 total time=    0.2s
[CV 5/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.865 total time=    0.2s
[CV 7/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.860 total time=    0.2s
[CV 10/10] END criterion=gini, max_depth=5, n_estimators=200;, score=0.850 total time=    0.2s
[CV 3/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.855 total time=    0.1s
[CV 4/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.860 total time=    0.1s
[CV 6/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.890 total time=    0.1s
[CV 8/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.825 total time=    0.1s
[CV 10/10] END criterion=entropy, max_depth=8, n_estimators=50;, score=0.860 total time=    0.1s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.880 total time=    0.4s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.865 total time=    0.3s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.910 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.855 total time=    0.3s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=200;, score=0.855 total time=    0.3s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.850 total time=    0.2s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.875 total time=    0.2s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.860 total time=    0.2s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.835 total time=    0.2s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=100;, score=0.850 total time=    0.2s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.870 total time=    0.1s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.845 total time=    0.1s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.860 total time=    0.1s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.815 total time=    0.1s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=50;, score=0.835 total time=    0.1s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.875 total time=    0.8s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.865 total time=    0.8s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.905 total time=    0.8s
```

```
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.840 total time=   0.8s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=500;, score=0.820 total time=   0.8s
[CV 3/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.860 total time=   0.9s
[CV 4/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.865 total time=   0.9s
[CV 6/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.885 total time=   0.9s
[CV 8/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.845 total time=   0.9s
[CV 10/10] END criterion=entropy, max_depth=7, n_estimators=500;, score=0.875 total time=   0.9s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.885 total time=   0.4s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.870 total time=   0.3s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.895 total time=   0.3s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.855 total time=   0.3s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=200;, score=0.870 total time=   0.3s
[CV 3/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.775 total time=   0.1s
[CV 4/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.760 total time=   0.1s
[CV 6/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.760 total time=   0.0s
[CV 8/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.750 total time=   0.0s
[CV 10/10] END criterion=gini, max_depth=3, n_estimators=50;, score=0.735 total time=   0.0s
[CV 3/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.905 total time=   1.0s
[CV 4/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.870 total time=   1.0s
[CV 6/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.890 total time=   1.0s
[CV 8/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.845 total time=   1.0s
[CV 10/10] END criterion=entropy, max_depth=8, n_estimators=500;, score=0.865 total time=   1.0s
[CV 3/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.880 total time=   0.9s
[CV 4/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.860 total time=   0.9s
[CV 6/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.920 total time=   0.9s
[CV 8/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.860 total time=   0.9s
[CV 10/10] END criterion=gini, max_depth=9, n_estimators=500;, score=0.885 total time=   0.9s
[CV 3/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.825 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.805 total time=   0.1s
[CV 6/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.825 total time=   0.1s
[CV 8/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.785 total time=   0.1s
[CV 10/10] END criterion=entropy, max_depth=4, n_estimators=100;, score=0.800 total time=   0.1s
Iteration No: 1 ended. Evaluation done at random point.
Time taken: 1.3364
Function value obtained: -0.8280
Current minimum: -0.8280
Iteration No: 2 started. Evaluating function at random point.
Iteration No: 2 ended. Evaluation done at random point.
Time taken: 0.2661
Function value obtained: -0.7715
Current minimum: -0.8280
Iteration No: 3 started. Evaluating function at random point.
Iteration No: 3 ended. Evaluation done at random point.
Time taken: 0.1917
Function value obtained: -0.8480
```

```
Current minimum: -0.8480
Iteration No: 4 started. Evaluating function at random point.
Iteration No: 4 ended. Evaluation done at random point.
Time taken: 0.1935
Function value obtained: -0.8605
Current minimum: -0.8605
Iteration No: 5 started. Evaluating function at random point.
Iteration No: 5 ended. Evaluation done at random point.
Time taken: 0.1276
Function value obtained: -0.5485
Current minimum: -0.8605
Iteration No: 6 started. Evaluating function at random point.
Iteration No: 6 ended. Evaluation done at random point.
Time taken: 0.1748
Function value obtained: -0.8145
Current minimum: -0.8605
Iteration No: 7 started. Evaluating function at random point.
Iteration No: 7 ended. Evaluation done at random point.
Time taken: 0.4903
Function value obtained: -0.8370
Current minimum: -0.8605
Iteration No: 8 started. Evaluating function at random point.
Iteration No: 8 ended. Evaluation done at random point.
Time taken: 0.7689
Function value obtained: -0.8525
Current minimum: -0.8605
Iteration No: 9 started. Evaluating function at random point.
Iteration No: 9 ended. Evaluation done at random point.
Time taken: 1.0284
Function value obtained: -0.8760
Current minimum: -0.8760
Iteration No: 10 started. Evaluating function at random point.
Iteration No: 10 ended. Evaluation done at random point.
Time taken: 0.7980
Function value obtained: -0.8775
Current minimum: -0.8775
Iteration No: 11 started. Searching for the next optimal point.
Iteration No: 11 ended. Search finished for the next optimal point.
Time taken: 0.8939
Function value obtained: -0.8770
Current minimum: -0.8775
Iteration No: 12 started. Searching for the next optimal point.
Iteration No: 12 ended. Search finished for the next optimal point.
Time taken: 0.4329
Function value obtained: -0.8635
```

```
Current minimum: −0.8775
Iteration No: 13 started. Searching for the next optimal point.
Iteration No: 13 ended. Search finished for the next optimal point.
Time taken: 0.5771
Function value obtained: −0.8710
Current minimum: −0.8775
Iteration No: 14 started. Searching for the next optimal point.
Iteration No: 14 ended. Search finished for the next optimal point.
Time taken: 0.4552
Function value obtained: −0.8725
Current minimum: −0.8775
Iteration No: 15 started. Searching for the next optimal point.
Iteration No: 15 ended. Search finished for the next optimal point.
Time taken: 1.2106
Function value obtained: −0.8830
Current minimum: −0.8830
Iteration No: 16 started. Searching for the next optimal point.
Iteration No: 16 ended. Search finished for the next optimal point.
Time taken: 0.6190
Function value obtained: −0.8685
Current minimum: −0.8830
Iteration No: 17 started. Searching for the next optimal point.
Iteration No: 17 ended. Search finished for the next optimal point.
Time taken: 1.2114
Function value obtained: −0.8775
Current minimum: −0.8830
Iteration No: 18 started. Searching for the next optimal point.
Iteration No: 18 ended. Search finished for the next optimal point.
Time taken: 0.9290
Function value obtained: −0.8835
Current minimum: −0.8835
Iteration No: 19 started. Searching for the next optimal point.
Iteration No: 19 ended. Search finished for the next optimal point.
Time taken: 0.5837
Function value obtained: −0.8580
Current minimum: −0.8835
Iteration No: 20 started. Searching for the next optimal point.
Iteration No: 20 ended. Search finished for the next optimal point.
Time taken: 0.8184
Function value obtained: −0.8745
Current minimum: −0.8835
Iteration No: 21 started. Searching for the next optimal point.
Iteration No: 21 ended. Search finished for the next optimal point.
Time taken: 0.4643
Function value obtained: −0.8605
```

```
Current minimum: -0.8835
Iteration No: 22 started. Searching for the next optimal point.
Iteration No: 22 ended. Search finished for the next optimal point.
Time taken: 1.0664
Function value obtained: -0.8680
Current minimum: -0.8835
Iteration No: 23 started. Searching for the next optimal point.
Iteration No: 23 ended. Search finished for the next optimal point.
Time taken: 0.6963
Function value obtained: -0.8770
Current minimum: -0.8835
Iteration No: 24 started. Searching for the next optimal point.
Iteration No: 24 ended. Search finished for the next optimal point.
Time taken: 0.6606
Function value obtained: -0.7650
Current minimum: -0.8835
Iteration No: 25 started. Searching for the next optimal point.
Iteration No: 25 ended. Search finished for the next optimal point.
Time taken: 0.7667
Function value obtained: -0.8220
Current minimum: -0.8835
Iteration No: 26 started. Searching for the next optimal point.
Iteration No: 26 ended. Search finished for the next optimal point.
Time taken: 1.2111
Function value obtained: -0.8825
Current minimum: -0.8835
Iteration No: 27 started. Searching for the next optimal point.
Iteration No: 27 ended. Search finished for the next optimal point.
Time taken: 0.7945
Function value obtained: -0.8565
Current minimum: -0.8835
Iteration No: 28 started. Searching for the next optimal point.
Iteration No: 28 ended. Search finished for the next optimal point.
Time taken: 0.7652
Function value obtained: -0.7775
Current minimum: -0.8835
Iteration No: 29 started. Searching for the next optimal point.
Iteration No: 29 ended. Search finished for the next optimal point.
Time taken: 0.4916
Function value obtained: -0.8695
Current minimum: -0.8835
Iteration No: 30 started. Searching for the next optimal point.
Iteration No: 30 ended. Search finished for the next optimal point.
Time taken: 0.8537
Function value obtained: -0.8655
```

```
Current minimum: -0.8835
Iteration No: 31 started. Searching for the next optimal point.
Iteration No: 31 ended. Search finished for the next optimal point.
Time taken: 0.8316
Function value obtained: -0.8520
Current minimum: -0.8835
Iteration No: 32 started. Searching for the next optimal point.
Iteration No: 32 ended. Search finished for the next optimal point.
Time taken: 0.5553
Function value obtained: -0.7905
Current minimum: -0.8835
Iteration No: 33 started. Searching for the next optimal point.
Iteration No: 33 ended. Search finished for the next optimal point.
Time taken: 0.4470
Function value obtained: -0.8610
Current minimum: -0.8835
Iteration No: 34 started. Searching for the next optimal point.
Iteration No: 34 ended. Search finished for the next optimal point.
Time taken: 0.7329
Function value obtained: -0.5810
Current minimum: -0.8835
Iteration No: 35 started. Searching for the next optimal point.
Iteration No: 35 ended. Search finished for the next optimal point.
Time taken: 0.9854
Function value obtained: -0.5540
Current minimum: -0.8835
Iteration No: 36 started. Searching for the next optimal point.
Iteration No: 36 ended. Search finished for the next optimal point.
Time taken: 0.5340
Function value obtained: -0.5895
Current minimum: -0.8835
Iteration No: 37 started. Searching for the next optimal point.
Iteration No: 37 ended. Search finished for the next optimal point.
Time taken: 0.7460
Function value obtained: -0.7450
Current minimum: -0.8835
Iteration No: 38 started. Searching for the next optimal point.
Iteration No: 38 ended. Search finished for the next optimal point.
Time taken: 0.4820
Function value obtained: -0.8310
Current minimum: -0.8835
Iteration No: 39 started. Searching for the next optimal point.
Iteration No: 39 ended. Search finished for the next optimal point.
Time taken: 1.2564
Function value obtained: -0.8795
```

```
Current minimum: -0.8835
Iteration No: 40 started. Searching for the next optimal point.
Iteration No: 40 ended. Search finished for the next optimal point.
Time taken: 1.0557
Function value obtained: -0.8845
Current minimum: -0.8845
Iteration No: 41 started. Searching for the next optimal point.
Iteration No: 41 ended. Search finished for the next optimal point.
Time taken: 0.4928
Function value obtained: -0.7565
Current minimum: -0.8845
Iteration No: 42 started. Searching for the next optimal point.
Iteration No: 42 ended. Search finished for the next optimal point.
Time taken: 0.8408
Function value obtained: -0.8020
Current minimum: -0.8845
Iteration No: 43 started. Searching for the next optimal point.
Iteration No: 43 ended. Search finished for the next optimal point.
Time taken: 1.2651
Function value obtained: -0.8660
Current minimum: -0.8845
Iteration No: 44 started. Searching for the next optimal point.
Iteration No: 44 ended. Search finished for the next optimal point.
Time taken: 0.9369
Function value obtained: -0.8465
Current minimum: -0.8845
Iteration No: 45 started. Searching for the next optimal point.
Iteration No: 45 ended. Search finished for the next optimal point.
Time taken: 1.2099
Function value obtained: -0.8640
Current minimum: -0.8845
Iteration No: 46 started. Searching for the next optimal point.
Iteration No: 46 ended. Search finished for the next optimal point.
Time taken: 0.6320
Function value obtained: -0.8375
Current minimum: -0.8845
Iteration No: 47 started. Searching for the next optimal point.
Iteration No: 47 ended. Search finished for the next optimal point.
Time taken: 0.7570
Function value obtained: -0.8405
Current minimum: -0.8845
Iteration No: 48 started. Searching for the next optimal point.
Iteration No: 48 ended. Search finished for the next optimal point.
Time taken: 0.9556
Function value obtained: -0.8620
```

```
Current minimum: −0.8845
Iteration No: 49 started. Searching for the next optimal point.
Iteration No: 49 ended. Search finished for the next optimal point.
Time taken: 0.5892
Function value obtained: −0.7755
Current minimum: −0.8845
Iteration No: 50 started. Searching for the next optimal point.
Iteration No: 50 ended. Search finished for the next optimal point.
Time taken: 1.0059
Function value obtained: −0.8180
Current minimum: −0.8845
Iteration No: 51 started. Searching for the next optimal point.
Iteration No: 51 ended. Search finished for the next optimal point.
Time taken: 0.6353
Function value obtained: −0.6960
Current minimum: −0.8845
Iteration No: 52 started. Searching for the next optimal point.
Iteration No: 52 ended. Search finished for the next optimal point.
Time taken: 1.0099
Function value obtained: −0.8610
Current minimum: −0.8845
Iteration No: 53 started. Searching for the next optimal point.
Iteration No: 53 ended. Search finished for the next optimal point.
Time taken: 0.6282
Function value obtained: −0.8670
Current minimum: −0.8845
Iteration No: 54 started. Searching for the next optimal point.
Iteration No: 54 ended. Search finished for the next optimal point.
Time taken: 0.8172
Function value obtained: −0.8675
Current minimum: −0.8845
Iteration No: 55 started. Searching for the next optimal point.
Iteration No: 55 ended. Search finished for the next optimal point.
Time taken: 0.7074
Function value obtained: −0.6725
Current minimum: −0.8845
Iteration No: 56 started. Searching for the next optimal point.
Iteration No: 56 ended. Search finished for the next optimal point.
Time taken: 0.7331
Function value obtained: −0.8640
Current minimum: −0.8845
Iteration No: 57 started. Searching for the next optimal point.
Iteration No: 57 ended. Search finished for the next optimal point.
Time taken: 1.4425
Function value obtained: −0.8710
```

```
Current minimum: −0.8845
Iteration No: 58 started. Searching for the next optimal point.
Iteration No: 58 ended. Search finished for the next optimal point.
Time taken: 1.0297
Function value obtained: −0.6725
Current minimum: −0.8845
Iteration No: 59 started. Searching for the next optimal point.
Iteration No: 59 ended. Search finished for the next optimal point.
Time taken: 0.8822
Function value obtained: −0.8740
Current minimum: −0.8845
Iteration No: 60 started. Searching for the next optimal point.
Iteration No: 60 ended. Search finished for the next optimal point.
Time taken: 0.6911
Function value obtained: −0.7325
Current minimum: −0.8845
```

In [149…
```python
# summarizing finding:

print('Best Accuracy: %.3f' % (result.fun))
print('Best Parameters: %s' % (result.x))
```

```
Best Accuracy: −0.885
Best Parameters: [200, 'entropy', 9]
```

In [150…
```python
print(result.func_vals)
```

```
[−0.828  −0.7715 −0.848  −0.8605 −0.5485 −0.8145 −0.837  −0.8525 −0.876
 −0.8775 −0.877  −0.8635 −0.871  −0.8725 −0.883  −0.8685 −0.8775 −0.8835
 −0.858  −0.8745 −0.8605 −0.868  −0.877  −0.765  −0.822  −0.8825 −0.8565
 −0.7775 −0.8695 −0.8655 −0.852  −0.7905 −0.861  −0.581  −0.554  −0.5895
 −0.745  −0.831  −0.8795 −0.8845 −0.7565 −0.802  −0.866  −0.8465 −0.864
 −0.8375 −0.8405 −0.862  −0.7755 −0.818  −0.696  −0.861  −0.867  −0.8675
 −0.6725 −0.864  −0.871  −0.6725 −0.874  −0.7325]
```

In [151…
```python
# plot convergence

from skopt.plots import plot_convergence

plot_convergence(result)
```

Out[151]:
```
<Axes: title={'center': 'Convergence plot'}, xlabel='Number of calls $n$', ylabel='$\\min f(x)$ after $n$ ca
lls'>
```

Convergence plot
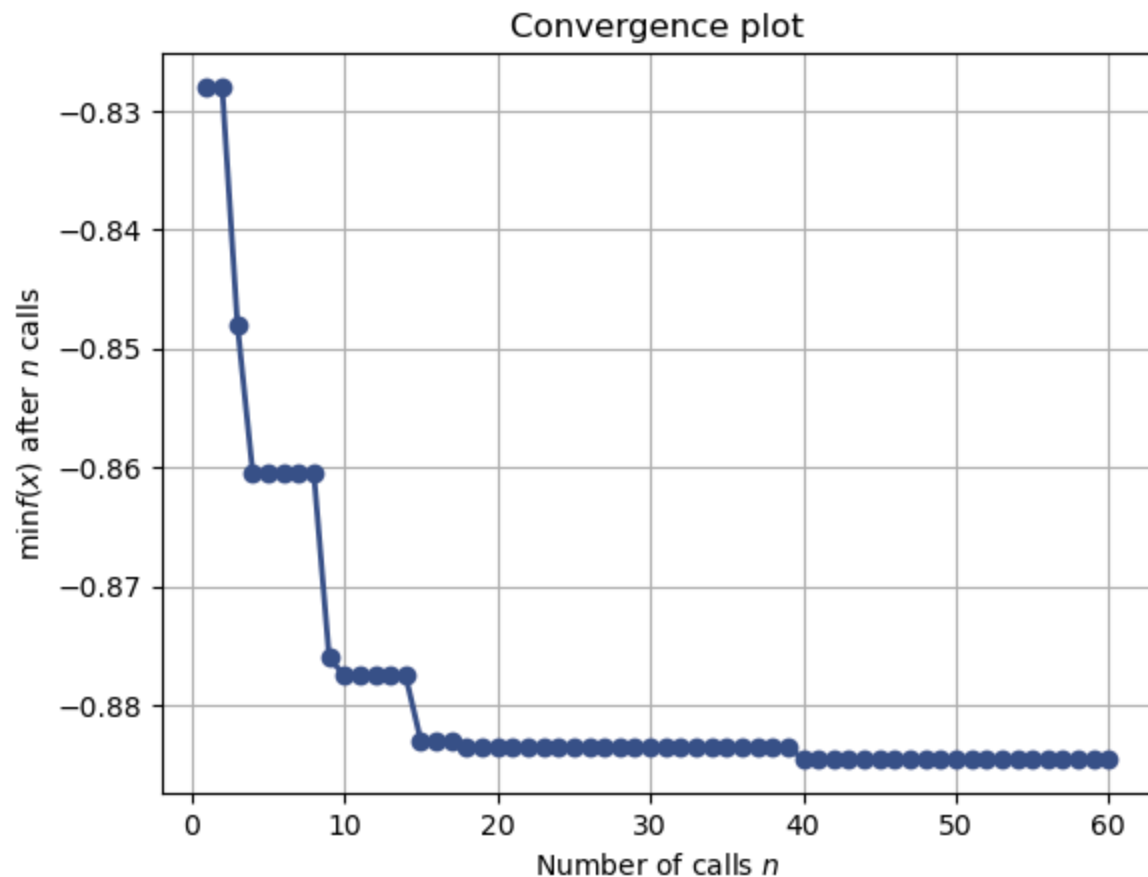

```python
def objective(trial):                                          # Optuna

    # Define the search space
    criterions = trial.suggest_categorical('criterion', ['gini', 'entropy'])
    max_depths = trial.suggest_int('max_depth', 2, 9, 2)
    n_estimators = trial.suggest_int('n_estimators', 200, 1000, 200)

    clf = sklearn.ensemble.RandomForestClassifier(n_estimators=n_estimators,
                                criterion=criterions,
                                max_depth=max_depths,
                                n_jobs=-1)

    score = cross_val_score(clf, X_scaled, y, scoring="accuracy").mean()

    return score
```

```python
    study = optuna.create_study()
    study.optimize(objective, n_trials=200)
```

In [153… `pip install optuna`

```
Requirement already satisfied: optuna in ./anaconda3/lib/python3.11/site-packages (3.6.1)
Requirement already satisfied: alembic>=1.5.0 in ./anaconda3/lib/python3.11/site-packages (from optuna) (1.1
3.1)
Requirement already satisfied: colorlog in ./anaconda3/lib/python3.11/site-packages (from optuna) (6.8.2)
Requirement already satisfied: numpy in ./anaconda3/lib/python3.11/site-packages (from optuna) (1.24.3)
Requirement already satisfied: packaging>=20.0 in ./anaconda3/lib/python3.11/site-packages (from optuna) (23.
0)
Requirement already satisfied: sqlalchemy>=1.3.0 in ./anaconda3/lib/python3.11/site-packages (from optuna)
(1.4.39)
Requirement already satisfied: tqdm in ./anaconda3/lib/python3.11/site-packages (from optuna) (4.65.0)
Requirement already satisfied: PyYAML in ./anaconda3/lib/python3.11/site-packages (from optuna) (6.0)
Requirement already satisfied: Mako in ./anaconda3/lib/python3.11/site-packages (from alembic>=1.5.0->optuna)
(1.3.3)
Requirement already satisfied: typing-extensions>=4 in ./anaconda3/lib/python3.11/site-packages (from alembic
>=1.5.0->optuna) (4.5.0)
Requirement already satisfied: MarkupSafe>=0.9.2 in ./anaconda3/lib/python3.11/site-packages (from Mako->alem
bic>=1.5.0->optuna) (2.1.1)
Note: you may need to restart the kernel to use updated packages.
```

In [154…
```python
import numpy as np
import pandas as pd
from sklearn.ensemble import RandomForestClassifier
from sklearn import metrics
from sklearn.model_selection import cross_val_score
from sklearn.preprocessing import StandardScaler
import joblib

import optuna
from optuna.samplers import TPESampler


import warnings
warnings.filterwarnings("ignore")
```

In [155…
```python
# defining the search space and the objecive function


def objective(trial):
    # Define the search space
    criterions = trial.suggest_categorical('criterion', ['gini', 'entropy'])
```

```python
    max_depths = trial.suggest_int('max_depth', 2, 9, 2)
    n_estimators = trial.suggest_int('n_estimators', 200, 1000, 200)

    clf = RandomForestClassifier(n_estimators=n_estimators,
                                 criterion=criterions,
                                 max_depth=max_depths,
                                 n_jobs=-1)
    score = cross_val_score(clf, X_scaled, y, scoring="accuracy").mean()

    return score
```

In [156…
```python
#study object

study = optuna.create_study(study_name="randomForest_optimization",
                            direction="maximize",
                            sampler=TPESampler())
```

[I 2024-04-29 22:23:31,552] A new study created in memory with name: randomForest_optimization

In [157…
```python
# passing the objective function to method optimize()

study.optimize(objective, n_trials=10)
```

[I 2024-04-29 22:23:33,778] Trial 0 finished with value: 0.8770000000000001 and parameters: {'criterion': 'entropy', 'max_depth': 8, 'n_estimators': 800}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:35,509] Trial 1 finished with value: 0.8705 and parameters: {'criterion': 'entropy', 'max_depth': 8, 'n_estimators': 600}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:37,182] Trial 2 finished with value: 0.875 and parameters: {'criterion': 'gini', 'max_depth': 8, 'n_estimators': 600}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:38,933] Trial 3 finished with value: 0.8525 and parameters: {'criterion': 'gini', 'max_depth': 6, 'n_estimators': 800}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:41,220] Trial 4 finished with value: 0.876 and parameters: {'criterion': 'entropy', 'max_depth': 8, 'n_estimators': 800}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:42,990] Trial 5 finished with value: 0.6785 and parameters: {'criterion': 'entropy', 'max_depth': 2, 'n_estimators': 1000}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:45,482] Trial 6 finished with value: 0.8770000000000001 and parameters: {'criterion': 'gini', 'max_depth': 8, 'n_estimators': 1000}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:46,889] Trial 7 finished with value: 0.687 and parameters: {'criterion': 'entropy', 'max_depth': 2, 'n_estimators': 800}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:48,621] Trial 8 finished with value: 0.875 and parameters: {'criterion': 'entropy', 'max_depth': 8, 'n_estimators': 600}. Best is trial 0 with value: 0.8770000000000001.
[I 2024-04-29 22:23:49,550] Trial 9 finished with value: 0.8225000000000001 and parameters: {'criterion': 'gini', 'max_depth': 4, 'n_estimators': 400}. Best is trial 0 with value: 0.8770000000000001.

In [158…
```python
print(study.best_params)
```

{'criterion': 'entropy', 'max_depth': 8, 'n_estimators': 800}

In [159…
```python
print(study.best_value)
```

0.8770000000000001

In [160…
```python
optuna.visualization.plot_optimization_history(study)
```

In [161…
```python
from sklearn.ensemble import RandomForestClassifier        #Random Search
from sklearn.model_selection import RandomizedSearchCV
```

```python
from scipy.stats import randint

# Define the hyperparameter search space
param_dist = {
    'n_estimators': randint(100, 1000),
    'max_depth': randint(1, 10),
    'criterion': ['gini', 'entropy']
}

# Instantiate a RandomForestClassifier
rf_classifier = RandomForestClassifier()

# Instantiate RandomizedSearchCV
random_search = RandomizedSearchCV(
    estimator=rf_classifier,
    param_distributions=param_dist,
    n_iter=60,
    cv=10,
    scoring='accuracy',
    random_state=84,
    verbose=8,
    n_jobs=1
)

# Perform optimization
random_search.fit(X_scaled, y)

# Report the best results
print("Best Accuracy:", random_search.best_score_)
print("Best Parameters:", random_search.best_params_)
```

```
Fitting 10 folds for each of 60 candidates, totalling 600 fits
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.765 total time=   0.7s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.745 total time=   0.7s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.760 total time=   0.7s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.710 total time=   0.7s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.805 total time=   0.7s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.760 total time=   0.7s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.795 total time=   0.7s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.750 total time=   0.7s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.770 total time=   0.7s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=957;, score=0.745 total time=   0.7s
[CV 1/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.850 total time=   0.6s
[CV 2/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.855 total time=   0.6s
[CV 3/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.870 total time=   0.6s
[CV 4/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.865 total time=   0.6s
[CV 5/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.875 total time=   0.6s
[CV 6/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.890 total time=   0.6s
[CV 7/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.860 total time=   0.6s
[CV 8/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.830 total time=   0.6s
[CV 9/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.815 total time=   0.6s
[CV 10/10] END criterion=gini, max_depth=6, n_estimators=480;, score=0.855 total time=   0.6s
[CV 1/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.595 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.630 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.605 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.530 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.590 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.590 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.625 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.580 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.575 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=1, n_estimators=338;, score=0.590 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.840 total time=   1.0s
[CV 2/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.850 total time=   1.0s
[CV 3/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.850 total time=   1.1s
[CV 4/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.845 total time=   1.1s
[CV 5/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.860 total time=   1.0s
[CV 6/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.855 total time=   1.0s
[CV 7/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.865 total time=   1.0s
[CV 8/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.815 total time=   1.0s
[CV 9/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.830 total time=   1.0s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=773;, score=0.845 total time=   1.1s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.835 total time=   0.3s
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.850 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.865 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.855 total time=   0.3s
```

```
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.870 total time=    0.3s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.880 total time=    0.3s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.850 total time=    0.3s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.830 total time=    0.3s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.830 total time=    0.3s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=177;, score=0.845 total time=    0.3s
[CV 1/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.875 total time=    0.3s
[CV 2/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.865 total time=    0.3s
[CV 3/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.895 total time=    0.3s
[CV 4/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.850 total time=    0.3s
[CV 5/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.910 total time=    0.3s
[CV 6/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.930 total time=    0.3s
[CV 7/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.870 total time=    0.3s
[CV 8/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.870 total time=    0.3s
[CV 9/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.845 total time=    0.3s
[CV 10/10] END criterion=entropy, max_depth=9, n_estimators=164;, score=0.855 total time=    0.3s
[CV 1/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.580 total time=    0.4s
[CV 2/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.585 total time=    0.4s
[CV 3/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.565 total time=    0.4s
[CV 4/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.535 total time=    0.4s
[CV 5/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.565 total time=    0.4s
[CV 6/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.515 total time=    0.4s
[CV 7/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.520 total time=    0.4s
[CV 8/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.575 total time=    0.4s
[CV 9/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.555 total time=    0.4s
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=593;, score=0.550 total time=    0.4s
[CV 1/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.820 total time=    0.7s
[CV 2/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.855 total time=    0.7s
[CV 3/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.860 total time=    0.7s
[CV 4/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.835 total time=    0.7s
[CV 5/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.855 total time=    0.7s
[CV 6/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.860 total time=    0.7s
[CV 7/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.855 total time=    0.7s
[CV 8/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.815 total time=    0.7s
[CV 9/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.815 total time=    0.7s
[CV 10/10] END criterion=gini, max_depth=5, n_estimators=552;, score=0.835 total time=    0.7s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.860 total time=    0.8s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.875 total time=    0.8s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.885 total time=    0.8s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.880 total time=    0.8s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.895 total time=    0.8s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.915 total time=    0.8s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.875 total time=    0.8s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.840 total time=    0.8s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.840 total time=    0.8s
```

```
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=486;, score=0.880 total time=   0.8s
[CV 1/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.875 total time=   1.0s
[CV 2/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.875 total time=   1.0s
[CV 3/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.905 total time=   1.0s
[CV 4/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.870 total time=   1.0s
[CV 5/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.905 total time=   1.0s
[CV 6/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.915 total time=   1.0s
[CV 7/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.880 total time=   1.0s
[CV 8/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.860 total time=   1.0s
[CV 9/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.860 total time=   1.2s
[CV 10/10] END criterion=entropy, max_depth=9, n_estimators=479;, score=0.900 total time=   1.0s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.765 total time=   0.5s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.755 total time=   0.5s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.740 total time=   0.5s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.725 total time=   0.6s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.800 total time=   0.5s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.790 total time=   0.5s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.785 total time=   0.5s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.750 total time=   0.5s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.730 total time=   0.4s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=596;, score=0.765 total time=   0.5s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.775 total time=   0.7s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.750 total time=   0.8s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.750 total time=   0.7s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.745 total time=   0.7s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.805 total time=   0.7s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.750 total time=   0.8s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.785 total time=   0.9s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.765 total time=   0.7s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.755 total time=   0.9s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=963;, score=0.770 total time=   0.8s
[CV 1/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.580 total time=   0.1s
[CV 2/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.580 total time=   0.1s
[CV 3/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.575 total time=   0.1s
[CV 4/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.565 total time=   0.1s
[CV 5/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.525 total time=   0.1s
[CV 6/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.545 total time=   0.1s
[CV 7/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.565 total time=   0.1s
[CV 8/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.580 total time=   0.1s
[CV 9/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.510 total time=   0.1s
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=110;, score=0.525 total time=   0.1s
[CV 1/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.815 total time=   1.0s
[CV 2/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.830 total time=   1.0s
[CV 3/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.830 total time=   1.0s
[CV 4/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.820 total time=   1.0s
```

```
[CV  5/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.845 total time=   1.0s
[CV  6/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.845 total time=   1.0s
[CV  7/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.850 total time=   1.1s
[CV  8/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.815 total time=   1.0s
[CV  9/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.785 total time=   1.2s
[CV 10/10] END criterion=gini, max_depth=4, n_estimators=999;, score=0.820 total time=   1.0s
[CV  1/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.830 total time=   0.5s
[CV  2/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.845 total time=   0.4s
[CV  3/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.845 total time=   0.4s
[CV  4/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.850 total time=   0.4s
[CV  5/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.875 total time=   0.4s
[CV  6/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.855 total time=   0.4s
[CV  7/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.855 total time=   0.4s
[CV  8/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.815 total time=   0.4s
[CV  9/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.815 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=321;, score=0.845 total time=   0.5s
[CV  1/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.830 total time=   0.8s
[CV  2/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.855 total time=   0.8s
[CV  3/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.850 total time=   0.8s
[CV  4/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.865 total time=   0.8s
[CV  5/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.880 total time=   0.8s
[CV  6/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.870 total time=   0.8s
[CV  7/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.865 total time=   0.8s
[CV  8/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.820 total time=   0.8s
[CV  9/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.830 total time=   0.8s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=508;, score=0.855 total time=   0.8s
[CV  1/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.580 total time=   0.4s
[CV  2/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.585 total time=   0.4s
[CV  3/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.555 total time=   0.4s
[CV  4/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.540 total time=   0.4s
[CV  5/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.560 total time=   0.4s
[CV  6/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.535 total time=   0.4s
[CV  7/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.525 total time=   0.4s
[CV  8/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.585 total time=   0.4s
[CV  9/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.570 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=648;, score=0.535 total time=   0.4s
[CV  1/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.770 total time=   0.7s
[CV  2/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.755 total time=   0.7s
[CV  3/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.750 total time=   0.7s
[CV  4/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.735 total time=   0.7s
[CV  5/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.805 total time=   0.7s
[CV  6/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.765 total time=   0.7s
[CV  7/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.785 total time=   0.7s
[CV  8/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.750 total time=   0.7s
[CV  9/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.740 total time=   0.7s
```

```
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=931;, score=0.755 total time=   0.7s
[CV 1/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.820 total time=   0.8s
[CV 2/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.785 total time=   0.8s
[CV 3/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.790 total time=   0.8s
[CV 4/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.825 total time=   0.8s
[CV 5/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.830 total time=   0.7s
[CV 6/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.830 total time=   0.7s
[CV 7/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.830 total time=   0.8s
[CV 8/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.795 total time=   0.8s
[CV 9/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.800 total time=   0.8s
[CV 10/10] END criterion=gini, max_depth=3, n_estimators=817;, score=0.830 total time=   0.8s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.850 total time=   1.3s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.870 total time=   1.1s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.885 total time=   1.1s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.865 total time=   1.1s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.885 total time=   1.2s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.905 total time=   1.1s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.880 total time=   1.1s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.845 total time=   1.1s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.810 total time=   1.1s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=728;, score=0.865 total time=   1.1s
[CV 1/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.710 total time=   0.3s
[CV 2/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.665 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.665 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.665 total time=   0.3s
[CV 5/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.685 total time=   0.3s
[CV 6/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.670 total time=   0.3s
[CV 7/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.690 total time=   0.3s
[CV 8/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.720 total time=   0.3s
[CV 9/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.660 total time=   0.3s
[CV 10/10] END criterion=entropy, max_depth=2, n_estimators=405;, score=0.620 total time=   0.3s
[CV 1/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.705 total time=   0.8s
[CV 2/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.675 total time=   0.8s
[CV 3/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.650 total time=   0.8s
[CV 4/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.650 total time=   0.8s
[CV 5/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.720 total time=   0.8s
[CV 6/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.675 total time=   0.8s
[CV 7/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.750 total time=   0.8s
[CV 8/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.700 total time=   0.8s
[CV 9/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.645 total time=   0.8s
[CV 10/10] END criterion=entropy, max_depth=2, n_estimators=962;, score=0.695 total time=   0.8s
[CV 1/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.695 total time=   0.3s
[CV 2/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.705 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.680 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.595 total time=   0.3s
```

```
[CV 5/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.690 total time=    0.2s
[CV 6/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.625 total time=    0.3s
[CV 7/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.670 total time=    0.2s
[CV 8/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.725 total time=    0.3s
[CV 9/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.680 total time=    0.3s
[CV 10/10] END criterion=entropy, max_depth=2, n_estimators=312;, score=0.690 total time=    0.3s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.860 total time=    1.1s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.865 total time=    1.1s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.895 total time=    1.1s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.880 total time=    1.1s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.885 total time=    1.1s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.915 total time=    1.1s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.880 total time=    1.1s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.850 total time=    1.1s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.830 total time=    1.1s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=693;, score=0.875 total time=    1.1s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.885 total time=    0.7s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.870 total time=    0.7s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.880 total time=    0.7s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.870 total time=    0.7s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.900 total time=    0.7s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.910 total time=    0.7s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.880 total time=    0.7s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.870 total time=    0.7s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.850 total time=    0.7s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=449;, score=0.875 total time=    0.7s
[CV 1/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.815 total time=    0.7s
[CV 2/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.835 total time=    0.7s
[CV 3/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.835 total time=    0.7s
[CV 4/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.835 total time=    0.7s
[CV 5/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.835 total time=    0.7s
[CV 6/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.850 total time=    0.8s
[CV 7/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.830 total time=    0.7s
[CV 8/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.815 total time=    0.8s
[CV 9/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.785 total time=    0.7s
[CV 10/10] END criterion=gini, max_depth=4, n_estimators=713;, score=0.825 total time=    0.7s
[CV 1/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.840 total time=    0.6s
[CV 2/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.785 total time=    0.6s
[CV 3/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.770 total time=    0.6s
[CV 4/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.810 total time=    0.6s
[CV 5/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.815 total time=    0.6s
[CV 6/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.830 total time=    0.6s
[CV 7/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.835 total time=    0.6s
[CV 8/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.795 total time=    0.6s
[CV 9/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.800 total time=    0.6s
```

```
[CV 10/10] END criterion=gini, max_depth=3, n_estimators=626;, score=0.820 total time=   0.6s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.850 total time=   0.8s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.865 total time=   0.8s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.885 total time=   0.8s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.865 total time=   0.8s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.890 total time=   0.8s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.895 total time=   0.8s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.875 total time=   0.8s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.860 total time=   0.8s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.825 total time=   0.8s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=552;, score=0.865 total time=   0.8s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.880 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.865 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.885 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.875 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.885 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.900 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.865 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.845 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.830 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=146;, score=0.865 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.835 total time=   0.3s
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.850 total time=   0.3s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.845 total time=   0.3s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.845 total time=   0.3s
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.870 total time=   0.3s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.875 total time=   0.3s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.860 total time=   0.3s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.820 total time=   0.3s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.810 total time=   0.3s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=180;, score=0.860 total time=   0.3s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.845 total time=   0.6s
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.880 total time=   0.6s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.870 total time=   0.6s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.855 total time=   0.6s
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.890 total time=   0.6s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.860 total time=   0.6s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.860 total time=   0.6s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.820 total time=   0.6s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.815 total time=   0.6s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=375;, score=0.870 total time=   0.6s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.890 total time=   1.5s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.865 total time=   1.5s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.895 total time=   1.5s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.865 total time=   1.5s
```

```
[CV  5/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.890 total time=   1.5s
[CV  6/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.925 total time=   1.5s
[CV  7/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.870 total time=   1.5s
[CV  8/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.860 total time=   1.5s
[CV  9/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.825 total time=   1.5s
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=919;, score=0.865 total time=   1.5s
[CV  1/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.830 total time=   0.9s
[CV  2/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.835 total time=   0.9s
[CV  3/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.845 total time=   0.9s
[CV  4/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.800 total time=   0.9s
[CV  5/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.840 total time=   0.9s
[CV  6/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.820 total time=   0.9s
[CV  7/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.850 total time=   0.9s
[CV  8/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.805 total time=   0.9s
[CV  9/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.810 total time=   0.9s
[CV 10/10] END criterion=entropy, max_depth=4, n_estimators=736;, score=0.835 total time=   0.8s
[CV  1/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.585 total time=   0.3s
[CV  2/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.590 total time=   0.3s
[CV  3/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.550 total time=   0.3s
[CV  4/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.540 total time=   0.3s
[CV  5/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.545 total time=   0.3s
[CV  6/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.555 total time=   0.3s
[CV  7/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.520 total time=   0.3s
[CV  8/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.555 total time=   0.3s
[CV  9/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.530 total time=   0.3s
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=522;, score=0.535 total time=   0.3s
[CV  1/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.895 total time=   0.6s
[CV  2/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.875 total time=   0.6s
[CV  3/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.905 total time=   0.6s
[CV  4/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.870 total time=   0.6s
[CV  5/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.890 total time=   0.6s
[CV  6/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.910 total time=   0.6s
[CV  7/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.885 total time=   0.6s
[CV  8/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.865 total time=   0.6s
[CV  9/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.830 total time=   0.6s
[CV 10/10] END criterion=gini, max_depth=9, n_estimators=331;, score=0.865 total time=   0.6s
[CV  1/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.595 total time=   0.1s
[CV  2/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.600 total time=   0.1s
[CV  3/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.530 total time=   0.1s
[CV  4/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.565 total time=   0.1s
[CV  5/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.535 total time=   0.1s
[CV  6/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.555 total time=   0.1s
[CV  7/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.555 total time=   0.1s
[CV  8/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.575 total time=   0.1s
[CV  9/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.550 total time=   0.1s
```

```
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=109;, score=0.520 total time=    0.1s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.760 total time=    0.3s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.765 total time=    0.3s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.765 total time=    0.3s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.730 total time=    0.3s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.805 total time=    0.3s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.780 total time=    0.3s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.775 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.770 total time=    0.3s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.760 total time=    0.3s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=423;, score=0.730 total time=    0.3s
[CV 1/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.895 total time=    1.4s
[CV 2/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.875 total time=    1.4s
[CV 3/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.880 total time=    1.4s
[CV 4/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.875 total time=    1.4s
[CV 5/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.905 total time=    1.4s
[CV 6/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.905 total time=    1.4s
[CV 7/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.885 total time=    1.4s
[CV 8/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.855 total time=    1.4s
[CV 9/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.830 total time=    1.4s
[CV 10/10] END criterion=entropy, max_depth=8, n_estimators=744;, score=0.885 total time=    1.4s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.755 total time=    0.7s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.760 total time=    0.7s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.755 total time=    0.7s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.735 total time=    0.7s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.795 total time=    0.7s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.735 total time=    0.8s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.765 total time=    0.7s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.765 total time=    0.7s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.740 total time=    0.7s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=878;, score=0.780 total time=    0.7s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.760 total time=    0.6s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.745 total time=    0.6s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.760 total time=    0.6s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.735 total time=    0.6s
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.795 total time=    0.6s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.785 total time=    0.6s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.775 total time=    0.6s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.765 total time=    0.6s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.755 total time=    0.6s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=853;, score=0.740 total time=    0.6s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.840 total time=    1.5s
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.870 total time=    1.5s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.855 total time=    1.6s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.860 total time=    1.5s
```

```
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.900 total time=   1.5s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.875 total time=   1.5s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.860 total time=   1.5s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.810 total time=   1.5s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.840 total time=   1.5s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=982;, score=0.850 total time=   1.5s
[CV 1/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.885 total time=   0.2s
[CV 2/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.865 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.900 total time=   0.2s
[CV 4/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.890 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.900 total time=   0.2s
[CV 6/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.910 total time=   0.2s
[CV 7/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.875 total time=   0.2s
[CV 8/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.860 total time=   0.2s
[CV 9/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.845 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=9, n_estimators=117;, score=0.880 total time=   0.2s
[CV 1/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.590 total time=   0.4s
[CV 2/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.625 total time=   0.4s
[CV 3/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.605 total time=   0.4s
[CV 4/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.525 total time=   0.4s
[CV 5/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.625 total time=   0.4s
[CV 6/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.565 total time=   0.4s
[CV 7/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.610 total time=   0.4s
[CV 8/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.580 total time=   0.4s
[CV 9/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.595 total time=   0.4s
[CV 10/10] END criterion=gini, max_depth=1, n_estimators=703;, score=0.570 total time=   0.4s
[CV 1/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.805 total time=   0.4s
[CV 2/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.840 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.845 total time=   0.4s
[CV 4/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.825 total time=   0.4s
[CV 5/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.845 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.845 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.825 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.815 total time=   0.4s
[CV 9/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.800 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=4, n_estimators=346;, score=0.795 total time=   0.4s
[CV 1/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.570 total time=   0.2s
[CV 2/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.590 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.560 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.495 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.565 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.520 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.575 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.585 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.555 total time=   0.2s
```

```
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=338;, score=0.510 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.840 total time=   1.5s
[CV 2/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.870 total time=   1.5s
[CV 3/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.850 total time=   1.5s
[CV 4/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.865 total time=   1.5s
[CV 5/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.890 total time=   1.5s
[CV 6/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.880 total time=   1.5s
[CV 7/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.865 total time=   1.5s
[CV 8/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.825 total time=   1.5s
[CV 9/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.830 total time=   1.5s
[CV 10/10] END criterion=entropy, max_depth=6, n_estimators=957;, score=0.850 total time=   1.5s
[CV 1/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.830 total time=   0.5s
[CV 2/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.860 total time=   0.5s
[CV 3/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.865 total time=   0.5s
[CV 4/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.865 total time=   0.5s
[CV 5/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.875 total time=   0.6s
[CV 6/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.875 total time=   0.5s
[CV 7/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.860 total time=   0.5s
[CV 8/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.845 total time=   0.5s
[CV 9/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.830 total time=   0.5s
[CV 10/10] END criterion=gini, max_depth=6, n_estimators=401;, score=0.845 total time=   0.5s
[CV 1/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.800 total time=   0.5s
[CV 2/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.815 total time=   0.5s
[CV 3/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.830 total time=   0.5s
[CV 4/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.810 total time=   0.5s
[CV 5/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.825 total time=   0.5s
[CV 6/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.840 total time=   0.5s
[CV 7/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.830 total time=   0.5s
[CV 8/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.805 total time=   0.5s
[CV 9/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.780 total time=   0.5s
[CV 10/10] END criterion=entropy, max_depth=4, n_estimators=407;, score=0.805 total time=   0.5s
[CV 1/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.845 total time=   0.6s
[CV 2/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.860 total time=   0.6s
[CV 3/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.860 total time=   0.6s
[CV 4/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.865 total time=   0.6s
[CV 5/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.875 total time=   0.6s
[CV 6/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.875 total time=   0.6s
[CV 7/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.865 total time=   0.6s
[CV 8/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.840 total time=   0.6s
[CV 9/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.815 total time=   0.6s
[CV 10/10] END criterion=gini, max_depth=6, n_estimators=446;, score=0.850 total time=   0.6s
[CV 1/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.775 total time=   0.5s
[CV 2/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.725 total time=   0.5s
[CV 3/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.750 total time=   0.5s
[CV 4/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.750 total time=   0.5s
```

```
[CV 5/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.800 total time=    0.5s
[CV 6/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.770 total time=    0.5s
[CV 7/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.785 total time=    0.5s
[CV 8/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.750 total time=    0.5s
[CV 9/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.770 total time=    0.5s
[CV 10/10] END criterion=gini, max_depth=2, n_estimators=656;, score=0.735 total time=    0.5s
[CV 1/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.780 total time=    0.1s
[CV 2/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.765 total time=    0.1s
[CV 3/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.810 total time=    0.1s
[CV 4/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.735 total time=    0.1s
[CV 5/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.770 total time=    0.1s
[CV 6/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.730 total time=    0.1s
[CV 7/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.795 total time=    0.1s
[CV 8/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.765 total time=    0.1s
[CV 9/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.765 total time=    0.1s
[CV 10/10] END criterion=entropy, max_depth=3, n_estimators=133;, score=0.750 total time=    0.1s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.850 total time=    1.1s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.875 total time=    1.1s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.870 total time=    1.2s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.855 total time=    1.1s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.895 total time=    1.1s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.910 total time=    1.1s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.865 total time=    1.1s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.850 total time=    1.1s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.815 total time=    1.1s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=771;, score=0.865 total time=    1.1s
[CV 1/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.830 total time=    0.6s
[CV 2/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.845 total time=    0.6s
[CV 3/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.845 total time=    0.6s
[CV 4/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.840 total time=    0.6s
[CV 5/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.845 total time=    0.6s
[CV 6/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.850 total time=    0.6s
[CV 7/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.845 total time=    0.6s
[CV 8/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.800 total time=    0.6s
[CV 9/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.805 total time=    0.6s
[CV 10/10] END criterion=gini, max_depth=4, n_estimators=568;, score=0.835 total time=    0.6s
[CV 1/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.875 total time=    0.5s
[CV 2/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.870 total time=    0.5s
[CV 3/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.880 total time=    0.5s
[CV 4/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.860 total time=    0.5s
[CV 5/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.895 total time=    0.5s
[CV 6/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.915 total time=    0.5s
[CV 7/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.870 total time=    0.5s
[CV 8/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.865 total time=    0.5s
[CV 9/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.845 total time=    0.5s
```

```
[CV 10/10] END criterion=gini, max_depth=8, n_estimators=332;, score=0.870 total time=   0.5s
[CV 1/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.825 total time=   0.2s
[CV 2/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.840 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.845 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.825 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.875 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.845 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.850 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.835 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.830 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=5, n_estimators=117;, score=0.850 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.860 total time=   0.4s
[CV 2/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.875 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.895 total time=   0.4s
[CV 4/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.860 total time=   0.4s
[CV 5/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.915 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.895 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.870 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.835 total time=   0.4s
[CV 9/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.830 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=8, n_estimators=204;, score=0.870 total time=   0.4s
[CV 1/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.810 total time=   0.5s
[CV 2/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.780 total time=   0.5s
[CV 3/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.785 total time=   0.5s
[CV 4/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.805 total time=   0.5s
[CV 5/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.830 total time=   0.5s
[CV 6/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.840 total time=   0.5s
[CV 7/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.840 total time=   0.5s
[CV 8/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.775 total time=   0.5s
[CV 9/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.790 total time=   0.5s
[CV 10/10] END criterion=gini, max_depth=3, n_estimators=553;, score=0.830 total time=   0.5s
[CV 1/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.865 total time=   1.0s
[CV 2/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.875 total time=   0.9s
[CV 3/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.885 total time=   1.0s
[CV 4/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.865 total time=   0.9s
[CV 5/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.885 total time=   0.9s
[CV 6/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.885 total time=   1.0s
[CV 7/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.875 total time=   1.0s
[CV 8/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.830 total time=   1.0s
[CV 9/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.830 total time=   0.9s
[CV 10/10] END criterion=entropy, max_depth=7, n_estimators=548;, score=0.870 total time=   1.0s
[CV 1/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.575 total time=   0.4s
[CV 2/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.590 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.560 total time=   0.4s
[CV 4/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.545 total time=   0.4s
```

```
[CV 5/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.550 total time=   0.5s
[CV 6/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.515 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.540 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.585 total time=   0.4s
[CV 9/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.555 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=1, n_estimators=716;, score=0.520 total time=   0.4s
[CV 1/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.870 total time=   1.3s
[CV 2/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.865 total time=   1.3s
[CV 3/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.885 total time=   1.3s
[CV 4/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.860 total time=   1.3s
[CV 5/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.895 total time=   1.3s
[CV 6/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.900 total time=   1.3s
[CV 7/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.875 total time=   1.3s
[CV 8/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.850 total time=   1.3s
[CV 9/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.815 total time=   1.3s
[CV 10/10] END criterion=gini, max_depth=7, n_estimators=876;, score=0.870 total time=   1.3s
Best Accuracy: 0.8845000000000001
Best Parameters: {'criterion': 'entropy', 'max_depth': 9, 'n_estimators': 479}
```

In [162…
```python
from sklearn.model_selection import GridSearchCV        #Grid Search
from sklearn.ensemble import RandomForestClassifier

# Defining the search space
params = {
    "n_estimators": [50, 100, 200, 300],
    "max_depth": [None, 10, 20, 30],
    "criterion": ["gini", "entropy"]
}

# RandomForestClassifier
rf_classifier = RandomForestClassifier()

# GridSearchCV
grid_search = GridSearchCV(
    estimator=rf_classifier,
    param_grid=params,
    scoring="accuracy",
    cv=10,
    verbose=8,
    n_jobs=-1
)

# Fiting the GridSearchCV instance to the data
grid_search.fit(X_scaled, y)
```

```python
print("Best Accuracy:", grid_search.best_score_)
print("Best Parameters:", grid_search.best_params_)
```

```
Fitting 10 folds for each of 32 candidates, totalling 320 fits
Best Accuracy: 0.8955
Best Parameters: {'criterion': 'entropy', 'max_depth': 20, 'n_estimators': 100}
```

In [163…
```python
from skopt import gp_minimize                                    #Model-based reinforcement learning (MBRL)
from skopt.space import Real, Integer, Categorical
from skopt.utils import use_named_args
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score
from sklearn.datasets import load_iris

iris = load_iris()
X = iris.data
y = iris.target

search_space = [
    Integer(200, 1000, name='n_estimators'),
    Integer(1, 9, name='max_depth'),
    Categorical(['gini', 'entropy'], name='criterion')
]

@use_named_args(search_space)
def objective_function(n_estimators, max_depth, criterion):
    clf = RandomForestClassifier(n_estimators=n_estimators, max_depth=max_depth, criterion=criterion)
    score = cross_val_score(clf, X, y, scoring='accuracy', cv=5).mean()
    return -score  # Minimizing negative accuracy (equivalent to maximizing accuracy)

# Performing optimization using Gaussian process regression
result = gp_minimize(objective_function, search_space, n_calls=30, random_state=42, verbose=True)

# accuracy and best parameters
best_accuracy = -result.fun  # Converting back to positive value
best_parameters = result.x

print("Best Accuracy:", best_accuracy)
print("Best Parameters:", best_parameters)
```

```
Iteration No: 1 started. Evaluating function at random point.
Iteration No: 1 ended. Evaluation done at random point.
Time taken: 1.6865
Function value obtained: -0.9467
Current minimum: -0.9467
Iteration No: 2 started. Evaluating function at random point.
Iteration No: 2 ended. Evaluation done at random point.
Time taken: 1.4092
Function value obtained: -0.9600
Current minimum: -0.9600
Iteration No: 3 started. Evaluating function at random point.
Iteration No: 3 ended. Evaluation done at random point.
Time taken: 1.1550
Function value obtained: -0.9600
Current minimum: -0.9600
Iteration No: 4 started. Evaluating function at random point.
Iteration No: 4 ended. Evaluation done at random point.
Time taken: 1.4277
Function value obtained: -0.8333
Current minimum: -0.9600
Iteration No: 5 started. Evaluating function at random point.
Iteration No: 5 ended. Evaluation done at random point.
Time taken: 1.8770
Function value obtained: -0.8600
Current minimum: -0.9600
Iteration No: 6 started. Evaluating function at random point.
Iteration No: 6 ended. Evaluation done at random point.
Time taken: 1.4114
Function value obtained: -0.9600
Current minimum: -0.9600
Iteration No: 7 started. Evaluating function at random point.
Iteration No: 7 ended. Evaluation done at random point.
Time taken: 0.4433
Function value obtained: -0.9600
Current minimum: -0.9600
Iteration No: 8 started. Evaluating function at random point.
Iteration No: 8 ended. Evaluation done at random point.
Time taken: 0.4880
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 9 started. Evaluating function at random point.
Iteration No: 9 ended. Evaluation done at random point.
Time taken: 0.5554
Function value obtained: -0.9600
Current minimum: -0.9667
```

```
Iteration No: 10 started. Evaluating function at random point.
Iteration No: 10 ended. Evaluation done at random point.
Time taken: 2.1526
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 11 started. Searching for the next optimal point.
Iteration No: 11 ended. Search finished for the next optimal point.
Time taken: 1.6117
Function value obtained: -0.9533
Current minimum: -0.9667
Iteration No: 12 started. Searching for the next optimal point.
Iteration No: 12 ended. Search finished for the next optimal point.
Time taken: 0.8020
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 13 started. Searching for the next optimal point.
Iteration No: 13 ended. Search finished for the next optimal point.
Time taken: 1.2455
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 14 started. Searching for the next optimal point.
Iteration No: 14 ended. Search finished for the next optimal point.
Time taken: 0.7749
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 15 started. Searching for the next optimal point.
Iteration No: 15 ended. Search finished for the next optimal point.
Time taken: 0.7048
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 16 started. Searching for the next optimal point.
Iteration No: 16 ended. Search finished for the next optimal point.
Time taken: 0.8774
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 17 started. Searching for the next optimal point.
Iteration No: 17 ended. Search finished for the next optimal point.
Time taken: 2.6222
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 18 started. Searching for the next optimal point.
Iteration No: 18 ended. Search finished for the next optimal point.
Time taken: 0.6504
Function value obtained: -0.9667
Current minimum: -0.9667
```

```
Iteration No: 19 started. Searching for the next optimal point.
Iteration No: 19 ended. Search finished for the next optimal point.
Time taken: 2.2540
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 20 started. Searching for the next optimal point.
Iteration No: 20 ended. Search finished for the next optimal point.
Time taken: 2.2905
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 21 started. Searching for the next optimal point.
Iteration No: 21 ended. Search finished for the next optimal point.
Time taken: 2.3293
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 22 started. Searching for the next optimal point.
Iteration No: 22 ended. Search finished for the next optimal point.
Time taken: 2.3326
Function value obtained: -0.9533
Current minimum: -0.9667
Iteration No: 23 started. Searching for the next optimal point.
Iteration No: 23 ended. Search finished for the next optimal point.
Time taken: 0.6713
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 24 started. Searching for the next optimal point.
Iteration No: 24 ended. Search finished for the next optimal point.
Time taken: 2.3003
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 25 started. Searching for the next optimal point.
Iteration No: 25 ended. Search finished for the next optimal point.
Time taken: 2.4709
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 26 started. Searching for the next optimal point.
Iteration No: 26 ended. Search finished for the next optimal point.
Time taken: 2.3129
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 27 started. Searching for the next optimal point.
Iteration No: 27 ended. Search finished for the next optimal point.
Time taken: 0.6546
Function value obtained: -0.9600
Current minimum: -0.9667
```

```
Iteration No: 28 started. Searching for the next optimal point.
Iteration No: 28 ended. Search finished for the next optimal point.
Time taken: 1.8235
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 29 started. Searching for the next optimal point.
Iteration No: 29 ended. Search finished for the next optimal point.
Time taken: 2.2986
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 30 started. Searching for the next optimal point.
Iteration No: 30 ended. Search finished for the next optimal point.
Time taken: 0.6267
Function value obtained: -0.9533
Current minimum: -0.9667
Best Accuracy: 0.9666666666666668
Best Parameters: [237, 9, 'gini']
```

In [164...
```python
from skopt import gp_minimize                                    #meta-learning
from skopt.space import Real, Integer, Categorical
from skopt.utils import use_named_args
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import cross_val_score, train_test_split
from sklearn.datasets import load_iris
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import make_pipeline
from sklearn.metrics import accuracy_score
from sklearn.linear_model import LinearRegression
import numpy as np

iris = load_iris()
X = iris.data
y = iris.target

search_space = [
    Integer(100, 1000, name='n_estimators'),
    Integer(1, 20, name='max_depth'),  # Increased max_depth range
    Categorical(['gini', 'entropy'], name='criterion')
]

@use_named_args(search_space)
def objective_function(*args, **kwargs):
    clf = RandomForestClassifier(*args, **kwargs)
    score = cross_val_score(clf, X, y, scoring='accuracy', cv=5).mean()
    return -score
```

```python
result = gp_minimize(objective_function, search_space, n_calls=50, random_state=42, verbose=True)

best_accuracy = -result.fun
best_parameters = result.x

print("Best Accuracy:", best_accuracy)
print("Best Parameters:", best_parameters)

# Extracting meta-features and meta-targets
meta_features = []
meta_targets = []
for params in result.x_iters:
    meta_features.append(params)
    meta_targets.append(-objective_function(*params))  # Calling the objective function directly

# Training a meta-learner
scaler = StandardScaler()
meta_features_scaled = scaler.fit_transform(meta_features)
meta_learner = LinearRegression()
meta_learner.fit(meta_features_scaled, meta_targets)

# Generating new data for meta-learning
new_data = np.array([[400, 30, 0], [300, 20, 1]])
new_data_scaled = scaler.transform(new_data)

# Predicting meta-targets using the meta-learner
predicted_meta_targets = meta_learner.predict(new_data_scaled)

print("Predicted Meta-Targets:", predicted_meta_targets)
```

```
Iteration No: 1 started. Evaluating function at random point.
Iteration No: 1 ended. Evaluation done at random point.
Time taken: 1.7584
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 2 started. Evaluating function at random point.
Iteration No: 2 ended. Evaluation done at random point.
Time taken: 1.3450
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 3 started. Evaluating function at random point.
Iteration No: 3 ended. Evaluation done at random point.
Time taken: 1.0452
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 4 started. Evaluating function at random point.
Iteration No: 4 ended. Evaluation done at random point.
Time taken: 1.3721
Function value obtained: -0.9467
Current minimum: -0.9667
Iteration No: 5 started. Evaluating function at random point.
Iteration No: 5 ended. Evaluation done at random point.
Time taken: 1.8703
Function value obtained: -0.8267
Current minimum: -0.9667
Iteration No: 6 started. Evaluating function at random point.
Iteration No: 6 ended. Evaluation done at random point.
Time taken: 1.3413
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 7 started. Evaluating function at random point.
Iteration No: 7 ended. Evaluation done at random point.
Time taken: 0.2493
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 8 started. Evaluating function at random point.
Iteration No: 8 ended. Evaluation done at random point.
Time taken: 0.2951
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 9 started. Evaluating function at random point.
Iteration No: 9 ended. Evaluation done at random point.
Time taken: 0.3719
Function value obtained: -0.9600
Current minimum: -0.9667
```

```
Iteration No: 10 started. Evaluating function at random point.
Iteration No: 10 ended. Evaluation done at random point.
Time taken: 2.1849
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 11 started. Searching for the next optimal point.
Iteration No: 11 ended. Search finished for the next optimal point.
Time taken: 1.5085
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 12 started. Searching for the next optimal point.
Iteration No: 12 ended. Search finished for the next optimal point.
Time taken: 1.7354
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 13 started. Searching for the next optimal point.
Iteration No: 13 ended. Search finished for the next optimal point.
Time taken: 0.4413
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 14 started. Searching for the next optimal point.
Iteration No: 14 ended. Search finished for the next optimal point.
Time taken: 1.0157
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 15 started. Searching for the next optimal point.
Iteration No: 15 ended. Search finished for the next optimal point.
Time taken: 2.3423
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 16 started. Searching for the next optimal point.
Iteration No: 16 ended. Search finished for the next optimal point.
Time taken: 0.4395
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 17 started. Searching for the next optimal point.
Iteration No: 17 ended. Search finished for the next optimal point.
Time taken: 2.2621
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 18 started. Searching for the next optimal point.
Iteration No: 18 ended. Search finished for the next optimal point.
Time taken: 0.4494
Function value obtained: -0.9667
Current minimum: -0.9667
```

```
Iteration No: 19 started. Searching for the next optimal point.
Iteration No: 19 ended. Search finished for the next optimal point.
Time taken: 2.3372
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 20 started. Searching for the next optimal point.
Iteration No: 20 ended. Search finished for the next optimal point.
Time taken: 2.3330
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 21 started. Searching for the next optimal point.
Iteration No: 21 ended. Search finished for the next optimal point.
Time taken: 1.9790
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 22 started. Searching for the next optimal point.
Iteration No: 22 ended. Search finished for the next optimal point.
Time taken: 2.3393
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 23 started. Searching for the next optimal point.
Iteration No: 23 ended. Search finished for the next optimal point.
Time taken: 2.2938
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 24 started. Searching for the next optimal point.
Iteration No: 24 ended. Search finished for the next optimal point.
Time taken: 1.1932
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 25 started. Searching for the next optimal point.
Iteration No: 25 ended. Search finished for the next optimal point.
Time taken: 2.3535
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 26 started. Searching for the next optimal point.
Iteration No: 26 ended. Search finished for the next optimal point.
Time taken: 0.4517
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 27 started. Searching for the next optimal point.
Iteration No: 27 ended. Search finished for the next optimal point.
Time taken: 0.4394
Function value obtained: -0.9533
Current minimum: -0.9667
```

```
Iteration No: 28 started. Searching for the next optimal point.
Iteration No: 28 ended. Search finished for the next optimal point.
Time taken: 2.2764
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 29 started. Searching for the next optimal point.
Iteration No: 29 ended. Search finished for the next optimal point.
Time taken: 2.4935
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 30 started. Searching for the next optimal point.
Iteration No: 30 ended. Search finished for the next optimal point.
Time taken: 0.5229
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 31 started. Searching for the next optimal point.
Iteration No: 31 ended. Search finished for the next optimal point.
Time taken: 0.4956
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 32 started. Searching for the next optimal point.
Iteration No: 32 ended. Search finished for the next optimal point.
Time taken: 2.4976
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 33 started. Searching for the next optimal point.
Iteration No: 33 ended. Search finished for the next optimal point.
Time taken: 0.5457
Function value obtained: -0.9467
Current minimum: -0.9667
Iteration No: 34 started. Searching for the next optimal point.
Iteration No: 34 ended. Search finished for the next optimal point.
Time taken: 2.5901
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 35 started. Searching for the next optimal point.
Iteration No: 35 ended. Search finished for the next optimal point.
Time taken: 2.5431
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 36 started. Searching for the next optimal point.
Iteration No: 36 ended. Search finished for the next optimal point.
Time taken: 0.8971
Function value obtained: -0.9600
Current minimum: -0.9667
```

```
Iteration No: 37 started. Searching for the next optimal point.
Iteration No: 37 ended. Search finished for the next optimal point.
Time taken: 2.4068
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 38 started. Searching for the next optimal point.
Iteration No: 38 ended. Search finished for the next optimal point.
Time taken: 2.5704
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 39 started. Searching for the next optimal point.
Iteration No: 39 ended. Search finished for the next optimal point.
Time taken: 2.4699
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 40 started. Searching for the next optimal point.
Iteration No: 40 ended. Search finished for the next optimal point.
Time taken: 2.5238
Function value obtained: -0.9533
Current minimum: -0.9667
Iteration No: 41 started. Searching for the next optimal point.
Iteration No: 41 ended. Search finished for the next optimal point.
Time taken: 0.6683
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 42 started. Searching for the next optimal point.
Iteration No: 42 ended. Search finished for the next optimal point.
Time taken: 1.4053
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 43 started. Searching for the next optimal point.
Iteration No: 43 ended. Search finished for the next optimal point.
Time taken: 2.5370
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 44 started. Searching for the next optimal point.
Iteration No: 44 ended. Search finished for the next optimal point.
Time taken: 2.4164
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 45 started. Searching for the next optimal point.
Iteration No: 45 ended. Search finished for the next optimal point.
Time taken: 1.0735
Function value obtained: -0.9667
Current minimum: -0.9667
```

```
Iteration No: 46 started. Searching for the next optimal point.
Iteration No: 46 ended. Search finished for the next optimal point.
Time taken: 2.5187
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 47 started. Searching for the next optimal point.
Iteration No: 47 ended. Search finished for the next optimal point.
Time taken: 2.4523
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 48 started. Searching for the next optimal point.
Iteration No: 48 ended. Search finished for the next optimal point.
Time taken: 0.6296
Function value obtained: -0.9667
Current minimum: -0.9667
Iteration No: 49 started. Searching for the next optimal point.
Iteration No: 49 ended. Search finished for the next optimal point.
Time taken: 0.5887
Function value obtained: -0.9600
Current minimum: -0.9667
Iteration No: 50 started. Searching for the next optimal point.
Iteration No: 50 ended. Search finished for the next optimal point.
Time taken: 2.6241
Function value obtained: -0.9667
Current minimum: -0.9667
Best Accuracy: 0.9666666666666668
Best Parameters: [817, 4, 'entropy']
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
Cell In[164], line 42
     40 for params in result.x_iters:
     41     meta_features.append(params)
---> 42     meta_targets.append(-objective_function(*params))  # Calling the objective function directly
     44 # Training a meta-learner
     45 scaler = StandardScaler()

TypeError: objective_function() takes 1 positional argument but 3 were given
```

```
In [ ]:  print("Best Accuracy:", best_accuracy)
         print("Best Parameters:", best_parameters)
```

```
[CV 6/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.900 total time=    0.2s
[CV 10/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.895 total time=    0.2s
[CV 8/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.890 total time=    0.3s
[CV 6/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.905 total time=    0.6s
[CV 4/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.865 total time=    0.9s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.840 total time=    0.1s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.865 total time=    0.1s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.865 total time=    0.1s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.845 total time=    0.3s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.830 total time=    0.3s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.875 total time=    0.5s
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.910 total time=    0.8s
[CV 2/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.865 total time=    0.1s
[CV 6/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.895 total time=    0.2s
[CV 1/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.870 total time=    0.3s
[CV 9/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.830 total time=    0.3s
[CV 7/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.880 total time=    0.6s
[CV 5/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.905 total time=    0.9s
[CV 2/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.870 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.885 total time=    0.2s
[CV 10/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.880 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.900 total time=    0.3s
[CV 4/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.885 total time=    0.6s
[CV 2/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.870 total time=    0.9s
[CV 9/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.860 total time=    0.8s
[CV 7/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.870 total time=    0.4s
[CV 5/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.925 total time=    0.7s
[CV 3/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.920 total time=    1.1s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.880 total time=    0.2s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.910 total time=    0.2s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.855 total time=    0.2s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.885 total time=    0.3s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.840 total time=    0.3s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.860 total time=    0.6s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.915 total time=    1.1s
[CV 3/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.870 total time=    0.2s
[CV 6/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.900 total time=    0.2s
[CV 10/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.890 total time=    0.2s
[CV 6/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.915 total time=    0.4s
[CV 4/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.870 total time=    0.7s
[CV 2/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.880 total time=    1.1s
[CV 9/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.870 total time=    1.1s
[CV 10/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.875 total time=    0.3s
[CV 5/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.900 total time=    0.7s
[CV 3/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.925 total time=    1.3s
```

```
[CV 7/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.880 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.905 total time=    0.3s
[CV 4/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.855 total time=    0.6s
[CV 1/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.885 total time=    0.9s
[CV 10/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.880 total time=    0.8s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.880 total time=    0.5s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.865 total time=    0.8s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.885 total time=    0.8s
[CV 7/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.900 total time=    0.3s
[CV 6/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.920 total time=    0.6s
[CV 4/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.860 total time=    0.9s
[CV 3/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.870 total time=    0.2s
[CV 7/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.860 total time=    0.2s
[CV 1/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.890 total time=    0.3s
[CV 7/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.875 total time=    0.3s
[CV 5/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.900 total time=    0.6s
[CV 3/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.900 total time=    0.9s
[CV 2/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.855 total time=    0.2s
[CV 5/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.925 total time=    0.2s
[CV 2/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.875 total time=    0.3s
[CV 9/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.850 total time=    0.4s
[CV 8/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.860 total time=    0.7s
[CV 5/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.910 total time=    1.1s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.885 total time=    0.2s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.855 total time=    0.2s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.870 total time=    0.3s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.875 total time=    0.3s
[CV 5/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.935 total time=    0.7s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.905 total time=    1.0s
[CV 1/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.885 total time=    0.3s
[CV 5/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.895 total time=    0.2s
[CV 9/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.820 total time=    0.2s
[CV 5/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.915 total time=    0.4s
[CV 2/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.860 total time=    0.8s
[CV 10/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.880 total time=    0.8s
[CV 7/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.875 total time=    1.1s
[CV 2/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.875 total time=    0.4s
[CV 8/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.845 total time=    0.4s
[CV 8/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.870 total time=    0.8s
[CV 4/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.885 total time=    1.3s
[CV 3/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.885 total time=    0.2s
[CV 4/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.870 total time=    0.3s
[CV 2/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.850 total time=    0.6s
[CV 9/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.865 total time=    0.6s
[CV 7/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.880 total time=    0.9s
```

```
[CV 5/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.870 total time=    0.3s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.885 total time=    0.5s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.845 total time=    0.5s
[CV 7/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.875 total time=    0.8s
[CV 9/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.830 total time=    0.2s
[CV 6/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.920 total time=    0.3s
[CV 3/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.905 total time=    0.6s
[CV 1/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.905 total time=    0.8s
[CV 9/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.855 total time=    0.9s
[CV 10/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.900 total time=    0.4s
[CV 8/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.885 total time=    0.6s
[CV 6/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.930 total time=    0.9s
[CV 4/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.875 total time=    0.2s
[CV 8/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.875 total time=    0.2s
[CV 4/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.860 total time=    0.4s
[CV 2/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.870 total time=    0.7s
[CV 10/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.875 total time=    0.7s
[CV 8/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.875 total time=    1.1s
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.900 total time=    0.3s
[CV 2/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.895 total time=    0.6s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.860 total time=    0.7s
[CV 7/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.880 total time=    1.2s
[CV 2/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.885 total time=    0.4s
[CV 9/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.860 total time=    0.4s
[CV 7/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.885 total time=    0.7s
[CV 5/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.910 total time=    1.2s
[CV 3/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.885 total time=    0.2s
[CV 7/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.890 total time=    0.2s
[CV 1/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.895 total time=    0.4s
[CV 7/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.880 total time=    0.4s
[CV 6/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.905 total time=    0.8s
[CV 5/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.915 total time=    1.3s
[CV 1/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.900 total time=    0.2s
[CV 9/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.845 total time=    0.2s
[CV 7/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.870 total time=    0.3s
[CV 5/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.900 total time=    0.6s
[CV 3/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.890 total time=    0.9s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.870 total time=    0.1s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.890 total time=    0.1s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.845 total time=    0.1s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.895 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.860 total time=    0.3s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.910 total time=    0.5s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.875 total time=    0.8s
[CV 3/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.880 total time=    0.1s
```

```
[CV 7/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.885 total time=    0.2s
[CV 2/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.885 total time=    0.3s
[CV 10/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.900 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.880 total time=    0.6s
[CV 6/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.905 total time=    0.9s
[CV 4/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.860 total time=    0.2s
[CV 8/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.870 total time=    0.2s
[CV 3/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.910 total time=    0.3s
[CV 1/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.895 total time=    0.6s
[CV 9/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.845 total time=    0.6s
[CV 7/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.880 total time=    0.9s
[CV 9/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.855 total time=    0.2s
[CV 5/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.895 total time=    0.3s
[CV 3/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.915 total time=    0.7s
[CV 1/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.890 total time=    1.1s
[CV 9/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.875 total time=    1.1s
[CV 3/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.900 total time=    0.7s
[CV 1/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.910 total time=    1.1s
[CV 9/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.860 total time=    1.2s
[CV 1/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.900 total time=    0.8s
[CV 1/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.895 total time=    1.2s
[CV 10/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.900 total time=    1.0s
[CV 9/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.880 total time=    0.4s
[CV 7/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.885 total time=    0.8s
[CV 6/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.905 total time=    1.3s
[CV 5/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.910 total time=    0.2s
[CV 2/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.890 total time=    0.3s
[CV 10/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.890 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.885 total time=    0.6s
[CV 6/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.915 total time=    0.9s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.890 total time=    0.1s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.855 total time=    0.1s
[CV 4/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.860 total time=    0.3s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.860 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.865 total time=    0.5s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.905 total time=    0.8s
[CV 4/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.850 total time=    0.2s
[CV 8/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.880 total time=    0.2s
[CV 3/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.900 total time=    0.4s
[CV 2/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.870 total time=    0.6s
[CV 10/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.885 total time=    0.6s
[CV 8/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.875 total time=    0.9s
[CV 2/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.875 total time=    0.3s
[CV 8/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.860 total time=    0.4s
[CV 7/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.890 total time=    0.6s
```

```
[CV 5/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.910 total time=   0.9s
[CV 3/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.885 total time=   0.2s
[CV 7/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.895 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.925 total time=   0.4s
[CV 1/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.910 total time=   0.7s
[CV 9/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.850 total time=   0.8s
[CV 7/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.865 total time=   1.0s
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.890 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.875 total time=   0.3s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.850 total time=   0.7s
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.915 total time=   1.2s
[CV 4/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.875 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.855 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.885 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.900 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.855 total time=   0.7s
[CV 6/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.915 total time=   1.2s
[CV 4/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.880 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.850 total time=   0.2s
[CV 4/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.880 total time=   0.4s
[CV 2/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.870 total time=   0.7s
[CV 9/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.850 total time=   0.8s
[CV 7/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.870 total time=   1.2s
[CV 8/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.870 total time=   0.2s
[CV 5/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.895 total time=   0.3s
[CV 3/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.885 total time=   0.6s
[CV 2/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.880 total time=   0.9s
[CV 9/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.835 total time=   0.9s
[CV 3/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.905 total time=   0.5s
[CV 1/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.880 total time=   0.8s
[CV 9/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.850 total time=   0.9s
[CV 8/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.880 total time=   0.3s
[CV 5/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.895 total time=   0.6s
[CV 3/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.900 total time=   0.9s
[CV 1/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.875 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.910 total time=   0.1s
[CV 9/10] END criterion=gini, max_depth=30, n_estimators=50;, score=0.865 total time=   0.1s
[CV 5/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.885 total time=   0.3s
[CV 2/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.875 total time=   0.6s
[CV 10/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.885 total time=   0.6s
[CV 8/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.865 total time=   0.9s
[CV 10/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.875 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.895 total time=   0.4s
[CV 4/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.880 total time=   0.8s
[CV 2/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.875 total time=   1.1s
```

```
[CV 10/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.880 total time=   1.1s
[CV  4/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.870 total time=   0.7s
[CV  2/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.870 total time=   1.0s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.885 total time=   1.2s
[CV  3/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.915 total time=   0.7s
[CV  9/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.860 total time=   0.8s
[CV  8/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.870 total time=   1.1s
[CV  3/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.915 total time=   0.4s
[CV  1/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.900 total time=   0.8s
[CV 10/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.890 total time=   0.8s
[CV  8/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.865 total time=   1.2s
[CV  2/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.855 total time=   0.1s
[CV  1/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.900 total time=   0.3s
[CV  9/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.860 total time=   0.3s
[CV  7/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.880 total time=   0.6s
[CV  5/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.905 total time=   0.9s
[CV  5/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.875 total time=   0.1s
[CV  7/10] END criterion=gini, max_depth=10, n_estimators=50;, score=0.880 total time=   0.1s
[CV  1/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.895 total time=   0.3s
[CV  7/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.890 total time=   0.3s
[CV  5/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.910 total time=   0.5s
[CV  3/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.885 total time=   0.8s
[CV  1/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.845 total time=   0.1s
[CV  5/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.900 total time=   0.2s
[CV 10/10] END criterion=gini, max_depth=20, n_estimators=50;, score=0.875 total time=   0.2s
[CV  5/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.885 total time=   0.3s
[CV  4/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.880 total time=   0.6s
[CV  2/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.870 total time=   0.9s
[CV 10/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.890 total time=   0.9s
[CV  3/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.895 total time=   0.6s
[CV  1/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.890 total time=   0.9s
[CV 10/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.880 total time=   0.9s
[CV  8/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.875 total time=   0.4s
[CV  6/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.910 total time=   0.7s
[CV  4/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.890 total time=   1.1s
[CV  2/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.855 total time=   0.2s
[CV  6/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.895 total time=   0.2s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.875 total time=   0.2s
[CV  5/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.925 total time=   0.3s
[CV  1/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.900 total time=   0.7s
[CV 10/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.875 total time=   0.7s
[CV  8/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.855 total time=   1.1s
[CV  1/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.915 total time=   0.4s
[CV  7/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.885 total time=   0.4s
[CV  5/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.925 total time=   0.7s
```

```
[CV 3/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.915 total time=   1.2s
[CV 1/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.875 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.900 total time=   0.2s
[CV 9/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.845 total time=   0.2s
[CV 5/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.905 total time=   0.4s
[CV 3/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.905 total time=   0.8s
[CV 1/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.915 total time=   1.2s
[CV 9/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.870 total time=   1.0s
[CV 4/10] END criterion=gini, max_depth=None, n_estimators=50;, score=0.850 total time=   0.2s
[CV 3/10] END criterion=gini, max_depth=None, n_estimators=100;, score=0.875 total time=   0.3s
[CV 1/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.875 total time=   0.6s
[CV 10/10] END criterion=gini, max_depth=None, n_estimators=200;, score=0.865 total time=   0.6s
[CV 8/10] END criterion=gini, max_depth=None, n_estimators=300;, score=0.865 total time=   0.9s
[CV 6/10] END criterion=gini, max_depth=10, n_estimators=100;, score=0.910 total time=   0.3s
[CV 2/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.870 total time=   0.5s
[CV 10/10] END criterion=gini, max_depth=10, n_estimators=200;, score=0.880 total time=   0.5s
[CV 8/10] END criterion=gini, max_depth=10, n_estimators=300;, score=0.860 total time=   0.8s
[CV 4/10] END criterion=gini, max_depth=20, n_estimators=100;, score=0.880 total time=   0.3s
[CV 1/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.915 total time=   0.6s
[CV 9/10] END criterion=gini, max_depth=20, n_estimators=200;, score=0.850 total time=   0.6s
[CV 7/10] END criterion=gini, max_depth=20, n_estimators=300;, score=0.895 total time=   0.9s
[CV 4/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.880 total time=   0.3s
[CV 9/10] END criterion=gini, max_depth=30, n_estimators=100;, score=0.860 total time=   0.3s
[CV 6/10] END criterion=gini, max_depth=30, n_estimators=200;, score=0.920 total time=   0.6s
[CV 4/10] END criterion=gini, max_depth=30, n_estimators=300;, score=0.885 total time=   0.9s
[CV 1/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.890 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=None, n_estimators=50;, score=0.905 total time=   0.2s
[CV 1/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.870 total time=   0.4s
[CV 10/10] END criterion=entropy, max_depth=None, n_estimators=100;, score=0.900 total time=   0.4s
[CV 7/10] END criterion=entropy, max_depth=None, n_estimators=200;, score=0.895 total time=   0.8s
[CV 6/10] END criterion=entropy, max_depth=None, n_estimators=300;, score=0.910 total time=   1.1s
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.865 total time=   0.2s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=50;, score=0.865 total time=   0.2s
[CV 2/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.870 total time=   0.3s
[CV 8/10] END criterion=entropy, max_depth=10, n_estimators=100;, score=0.865 total time=   0.3s
[CV 6/10] END criterion=entropy, max_depth=10, n_estimators=200;, score=0.910 total time=   0.7s
[CV 4/10] END criterion=entropy, max_depth=10, n_estimators=300;, score=0.880 total time=   1.0s
[CV 2/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.865 total time=   0.3s
[CV 7/10] END criterion=entropy, max_depth=20, n_estimators=50;, score=0.870 total time=   0.2s
[CV 3/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.920 total time=   0.4s
[CV 8/10] END criterion=entropy, max_depth=20, n_estimators=100;, score=0.875 total time=   0.4s
[CV 6/10] END criterion=entropy, max_depth=20, n_estimators=200;, score=0.910 total time=   0.7s
[CV 4/10] END criterion=entropy, max_depth=20, n_estimators=300;, score=0.885 total time=   1.2s
[CV 2/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.870 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.880 total time=   0.2s
```

```
[CV 10/10] END criterion=entropy, max_depth=30, n_estimators=50;, score=0.910 total time=   0.2s
[CV 6/10] END criterion=entropy, max_depth=30, n_estimators=100;, score=0.900 total time=   0.4s
[CV 4/10] END criterion=entropy, max_depth=30, n_estimators=200;, score=0.880 total time=   0.8s
[CV 2/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.875 total time=   1.3s
[CV 10/10] END criterion=entropy, max_depth=30, n_estimators=300;, score=0.895 total time=   1.0s
```

In [ ]: