Avaliacao_ensemble

November 4, 2019

[1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
from datetime import datetime
import matplotlib.pyplot as plt
%matplotlib inline
from sklearn.model_selection import StratifiedKFold, GridSearchCV
from sklearn.ensemble import RandomForestClassifier,␣
↪GradientBoostingClassifier, AdaBoostClassifier, VotingClassifier
from sklearn.metrics import roc_auc_score, roc_curve, auc,␣
↪precision_recall_curve
from sklearn.metrics import classification_report, confusion_matrix
from xgboost import XGBClassifier
from mlxtend.plotting import plot_learning_curves
from yellowbrick.model_selection import LearningCurve
import matplotlib.gridspec as gridspec
import itertools
from sklearn.model_selection import cross_val_score, train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score
from sklearn.linear_model import LogisticRegression
from sklearn import tree
from sklearn.naive_bayes import MultinomialNB
from sklearn.utils import shuffle
from sklearn.preprocessing import LabelEncoder, OrdinalEncoder
```

[2]:
```
def timer(start_time=None):
    if not start_time:
        start_time = datetime.now()
        return start_time
    elif start_time:
        tmin, tsec = divmod((datetime.now() - start_time).total_seconds(), 60)
        print('\n Tempo Necessário: %i minutos and %s segundos.' % (tmin,␣
↪round(tsec, 2)))
```

[3]:
```
train = pd.read_csv('trainRF.csv')
train = shuffle(train)
```

```
X_train = train.iloc[:,1:68]
Y_train = train.loc[:, train.columns == 'Y']
test = pd.read_csv('testRF.csv')
test = shuffle(test)
X_test = test.iloc[:,1:68]
Y_test = test.loc[:, test.columns == 'Y']
```

[4]:
```
print(X_train.shape)
```

```
(109992, 67)
```

[5]:
```
print(X_test.shape)
```

```
(65995, 67)
```

[6]:
```
X_train.head()
```

[6]:

	v1	v3	v6	v7	v8	v9	v10	v16	v17	v18	…	v687	v689	v690	\
8046	0	0	0	0	0	0	0	0	0	0	…	90.98	-1.00	0.0	
3263	0	0	0	0	0	0	0	0	0	0	…	100.00	-1.00	0.0	
102787	0	0	0	0	0	0	0	0	0	0	…	95.24	76.28	0.0	
60232	0	0	0	0	0	0	0	0	0	0	…	99.82	0.21	0.0	
35416	0	0	0	1	1	1	1	1	1	1	…	-1.00	-1.00	0.0	

	v691	v694	v56	v64	v72	v74	v78
8046	0.0	0	0.0	0.0	0.0	0.0	0.0
3263	0.0	1	0.0	0.0	1316.0	0.0	0.0
102787	0.0	1	0.0	0.0	0.0	0.0	0.0
60232	0.0	1	0.0	0.0	565.0	0.0	1750.0
35416	1.0	1	0.0	0.0	0.0	0.0	0.0

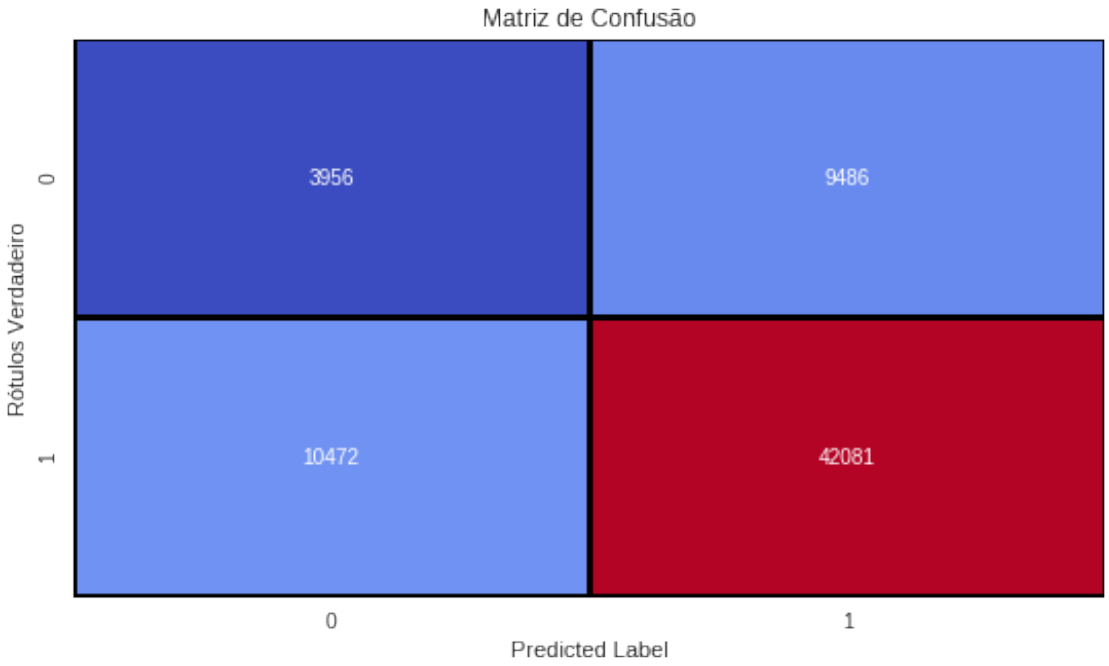
[5 rows x 67 columns]

[7]:
```
# Fit a Decision Tree model as comparison
starttime = timer(None)
start_time = timer(None)
clf_DecisionTreeClassifier = DecisionTreeClassifier()
clf_DecisionTreeClassifier.fit(X_train, Y_train.values.ravel())
DecisionTreeClassifier_pred = clf_DecisionTreeClassifier.predict(X_test)
timer(start_time)
accuracy_score(Y_test, DecisionTreeClassifier_pred)
false_positive_rate, true_positive_rate, thresholds = roc_curve(Y_test␣
 ↪,DecisionTreeClassifier_pred)
roc_auc = auc(false_positive_rate, true_positive_rate)

plt.figure(1)
```

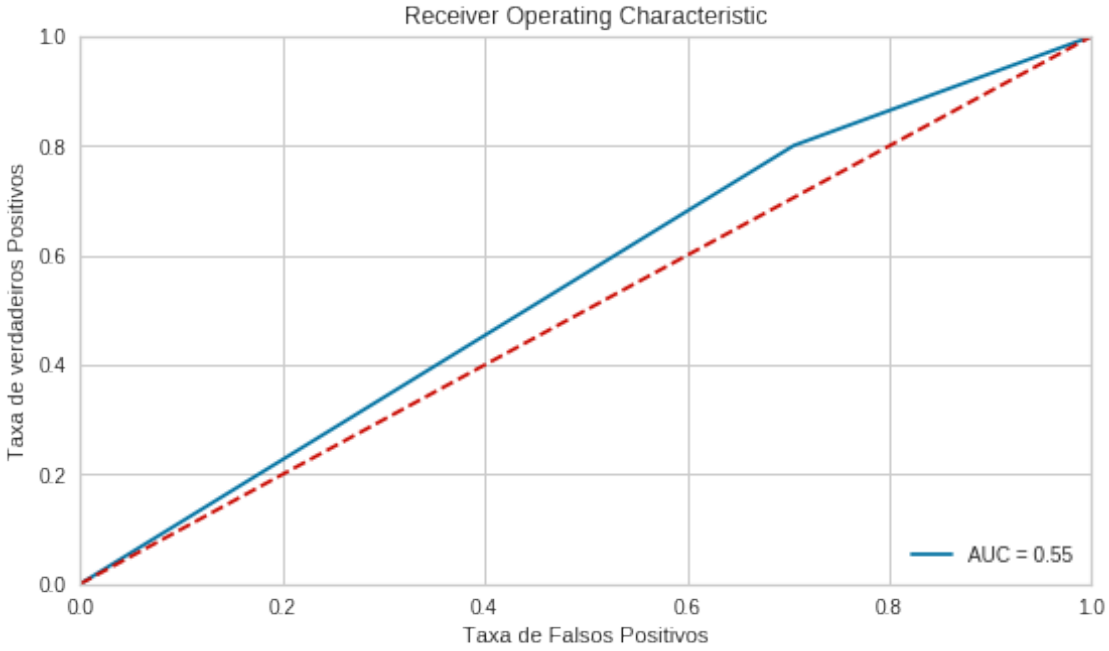
```
matrix_DecisionTreeClassifier = confusion_matrix(Y_test,␣
 ↪DecisionTreeClassifier_pred)
plt.figure(figsize=(9,5))
DecisionTreeClassifier = sns.heatmap(matrix_DecisionTreeClassifier, annot=True,␣
 ↪cbar=False, fmt="d", cmap ='coolwarm', linecolor ='black', linewidths = 2)
bottom, top = DecisionTreeClassifier.get_ylim()
DecisionTreeClassifier.set_ylim(bottom + 0.5, top - 0.5)
plt.ylabel('Rótulos Verdadeiro')
plt.xlabel('Predicted Label')
plt.title('Matriz de Confusão')
plt.show()



plt.figure(2)
plt.figure(figsize=(9,5))
plt.title('Receiver Operating Characteristic')
plt.plot(false_positive_rate, true_positive_rate, 'b',
label='AUC = %0.2f'% roc_auc)
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([-0.0,1.0])
plt.ylim([-0.0,1.0])
plt.ylabel('Taxa de verdadeiros Positivos')
plt.xlabel('Taxa de Falsos Positivos')
plt.show()



print("Relatório de Classificação")
print(classification_report(Y_test, DecisionTreeClassifier_pred))

print("Acurácia do Modelo")
accuracy_score(Y_test, DecisionTreeClassifier_pred)
```

```
 Tempo Necessário: 0 minutos and 3.64 segundos.
```

```
<Figure size 432x288 with 0 Axes>
```



<Figure size 432x288 with 0 Axes>



Relatório de Classificação

```
              precision    recall  f1-score   support

           0       0.27      0.29      0.28     13442
           1       0.82      0.80      0.81     52553

    accuracy                           0.70     65995
   macro avg       0.55      0.55      0.55     65995
weighted avg       0.71      0.70      0.70     65995

Acurácia do Modelo
```

[7]:
```
0.6975831502386545
```

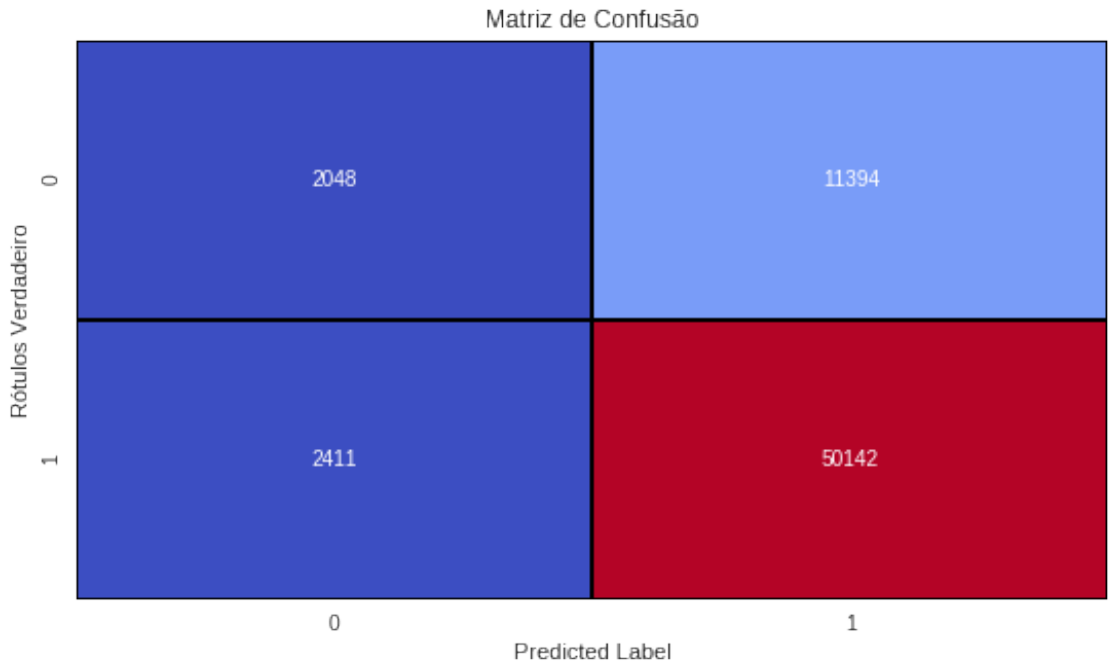
Fit a Simple Random Forest model

[8]:
```
starttime = timer(None)
start_time = timer(None)
clf = RandomForestClassifier(n_estimators=100,␣
 ↪max_features="auto",random_state=0)
clf.fit(X_train, Y_train.values.ravel())
RandomForestClassifier_pred = clf.predict(X_test)
timer(start_time)
accuracy_score(Y_test, RandomForestClassifier_pred)
false_positive_rate, true_positive_rate, thresholds = roc_curve(Y_test,␣
 ↪RandomForestClassifier_pred)
roc_auc = auc(false_positive_rate, true_positive_rate)


plt.figure(1)
matrix_RandomForestClassifier = confusion_matrix(Y_test,␣
 ↪RandomForestClassifier_pred)
plt.figure(figsize=(9,5))
map_RandomForestClassifier = sns.heatmap(matrix_RandomForestClassifier,␣
 ↪annot=True, cbar=False, fmt="d", cmap ='coolwarm', linecolor ='black',␣
 ↪linewidths = 1)
bottom, top = map_RandomForestClassifier.get_ylim()
map_RandomForestClassifier.set_ylim(bottom + 0.5, top - 0.5)
plt.ylabel('Rótulos Verdadeiro')
plt.xlabel('Predicted Label')
plt.title('Matriz de Confusão')
plt.show()

plt.figure(2)
plt.figure(figsize=(9,5))
plt.title('Receiver Operating Characteristic')
plt.plot(false_positive_rate, true_positive_rate, 'b',
label='AUC = %0.2f'% roc_auc)
```

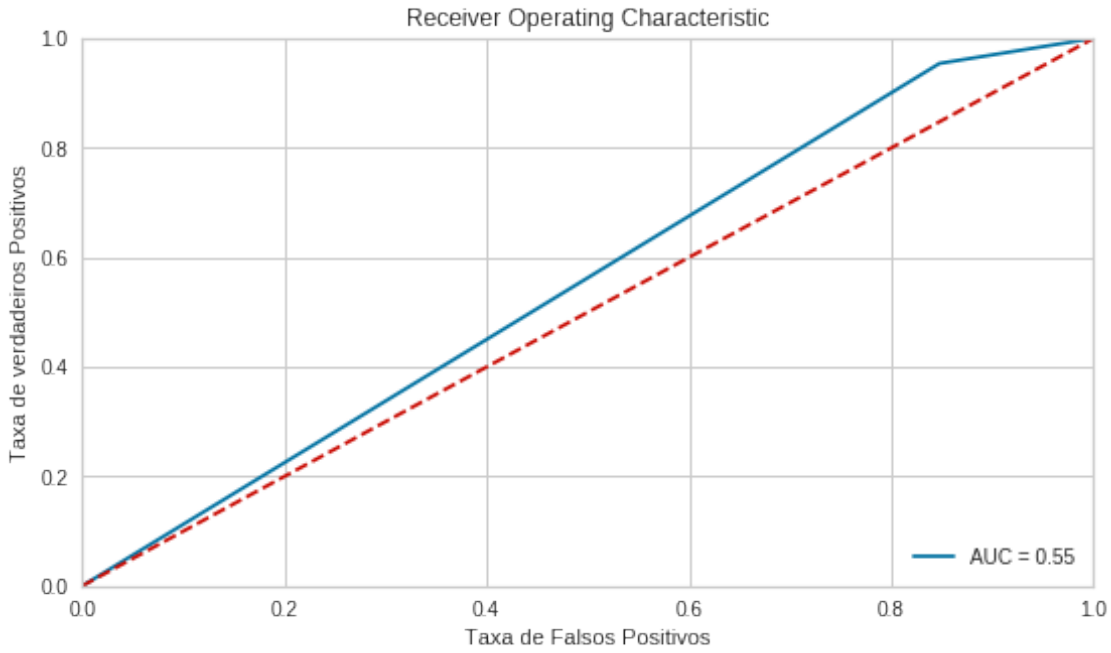
```
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([-0.0,1.0])
plt.ylim([-0.0,1.0])
plt.ylabel('Taxa de verdadeiros Positivos')
plt.xlabel('Taxa de Falsos Positivos')
plt.show()



print("Relatório de Classificação")
print(classification_report(Y_test, RandomForestClassifier_pred))

print("Acurácia do Modelo")
accuracy_score(Y_test, RandomForestClassifier_pred)
```

```
 Tempo Necessário: 0 minutos and 32.88 segundos.
```

```
<Figure size 432x288 with 0 Axes>
```




```
<Figure size 432x288 with 0 Axes>
```




```
Relatório de Classificação
              precision    recall  f1-score   support

           0       0.46      0.15      0.23     13442
           1       0.81      0.95      0.88     52553

    accuracy                           0.79     65995
   macro avg       0.64      0.55      0.55     65995
weighted avg       0.74      0.79      0.75     65995

Acurácia do Modelo
```

[8]:
```
0.7908174861731949
```

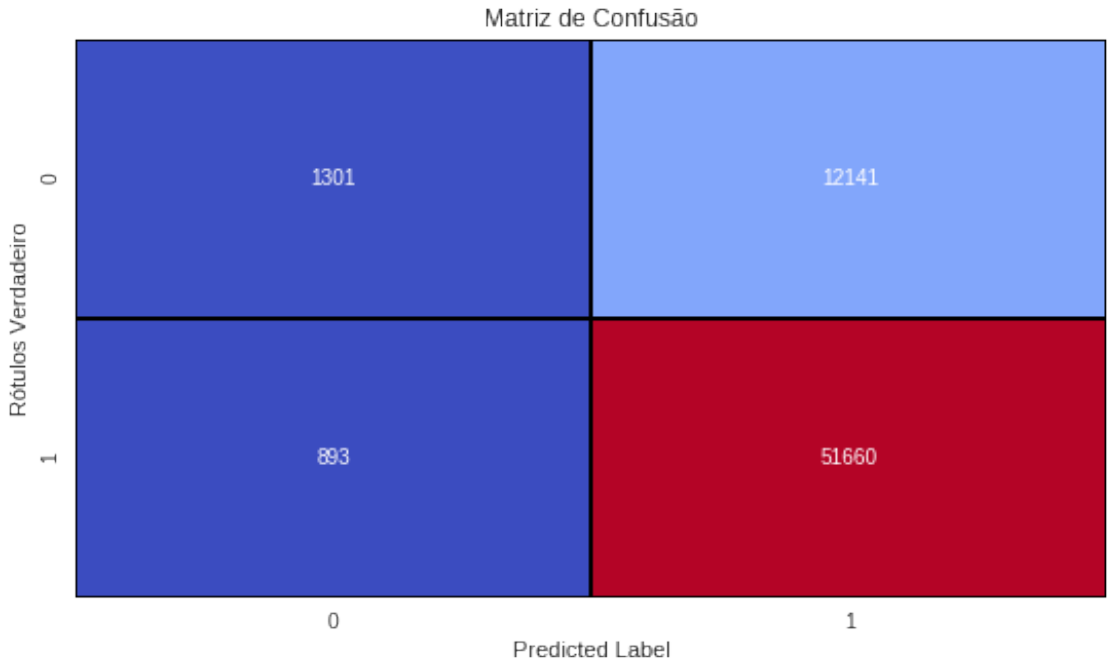
Fit a AdaBoost model

[9]:
```
starttime = timer(None)
start_time = timer(None)
clf = AdaBoostClassifier(n_estimators=100)
clf.fit(X_train, Y_train.values.ravel())
AdaBoostClassifier_pred = clf.predict(X_test)
timer(start_time)
accuracy_score(Y_test, AdaBoostClassifier_pred)
false_positive_rate, true_positive_rate, thresholds = roc_curve(Y_test,␣
 ↪AdaBoostClassifier_pred)
roc_auc = auc(false_positive_rate, true_positive_rate)
```

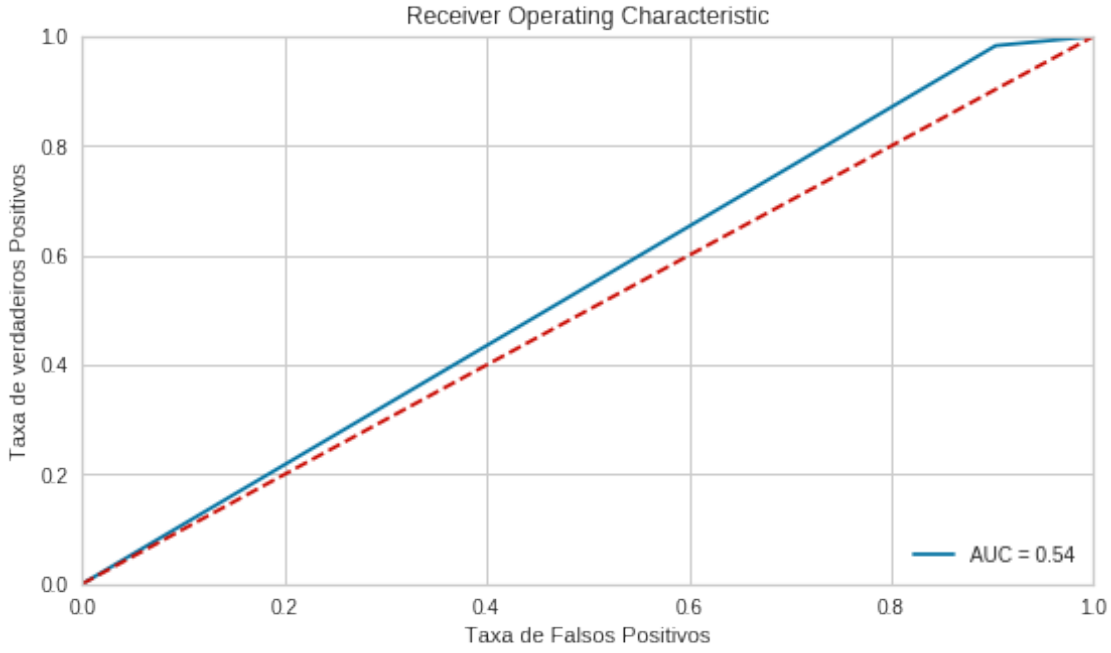
```
plt.figure(1)
matrix_AdaBoostClassifier = confusion_matrix(Y_test, AdaBoostClassifier_pred)
plt.figure(figsize=(9,5))
map_matrix_AdaBoostClassifier = sns.heatmap(matrix_AdaBoostClassifier,␣
↪annot=True, cbar=False, fmt="d", cmap ='coolwarm', linecolor ='black',␣
↪linewidths = 1)
bottom, top = map_matrix_AdaBoostClassifier.get_ylim()
map_matrix_AdaBoostClassifier.set_ylim(bottom + 0.5, top - 0.5)
plt.ylabel('Rótulos Verdadeiro')
plt.xlabel('Predicted Label')
plt.title('Matriz de Confusão')
plt.show()

plt.figure(2)
plt.figure(figsize=(9,5))
plt.title('Receiver Operating Characteristic')
plt.plot(false_positive_rate, true_positive_rate, 'b',
label='AUC = %0.2f'% roc_auc)
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([-0.0,1.0])
plt.ylim([-0.0,1.0])
plt.ylabel('Taxa de verdadeiros Positivos')
plt.xlabel('Taxa de Falsos Positivos')
plt.show()


print("Relatório de Classificação")
print(classification_report(Y_test, AdaBoostClassifier_pred))

print("Acurácia do Modelo")
accuracy_score(Y_test, AdaBoostClassifier_pred)
```

```
 Tempo Necessário: 0 minutos and 19.74 segundos.
```

```
<Figure size 432x288 with 0 Axes>
```



<Figure size 432x288 with 0 Axes>



Relatório de Classificação

```
              precision    recall  f1-score   support

           0       0.59      0.10      0.17     13442
           1       0.81      0.98      0.89     52553

    accuracy                           0.80     65995
   macro avg       0.70      0.54      0.53     65995
weighted avg       0.77      0.80      0.74     65995
```

Acurácia do Modelo

[9]: 0.8025001894082885

Fit a Gradient Boosting model

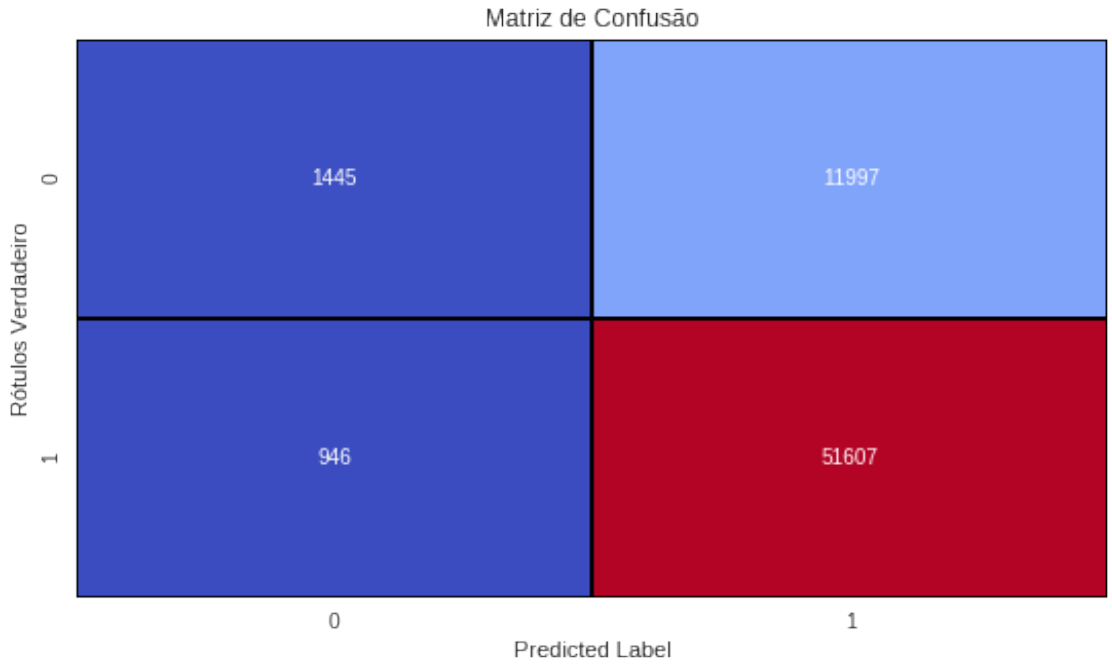
[10]:
```
lr_list = [0.05, 0.075, 0.1, 0.25, 0.5, 0.75, 1]
for learning_rate in lr_list:
    gb_clf = GradientBoostingClassifier(n_estimators=100,␣
 ↪learning_rate=learning_rate, max_features=2, max_depth=2, random_state=0)
    gb_clf.fit(X_train, Y_train.values.ravel())

    print("Learning rate: ", learning_rate)
    print("Accuracy score (training): {0:.3f}".format(gb_clf.score(X_train,␣
 ↪Y_train)))
    print("Accuracy score (validation): {0:.3f}".format(gb_clf.score(X_test,␣
 ↪Y_test)))
```

```
Learning rate:  0.05
Accuracy score (training): 0.798
Accuracy score (validation): 0.801
Learning rate:  0.075
Accuracy score (training): 0.799
Accuracy score (validation): 0.802
Learning rate:  0.1
Accuracy score (training): 0.800
Accuracy score (validation): 0.803
Learning rate:  0.25
Accuracy score (training): 0.801
Accuracy score (validation): 0.803
Learning rate:  0.5
Accuracy score (training): 0.802
Accuracy score (validation): 0.803
Learning rate:  0.75
Accuracy score (training): 0.801
Accuracy score (validation): 0.802
Learning rate:  1
Accuracy score (training): 0.801
Accuracy score (validation): 0.801
```

[11]:
```
gb_clf2 = GradientBoostingClassifier(n_estimators=200, learning_rate=0.5,␣
 ↪max_features=2, max_depth=2, random_state=1)
gb_clf2.fit(X_train, Y_train.values.ravel())
GradientBoostingClassifier_predictions = gb_clf2.predict(X_test)

matrix_GradientBoostingClassifier2 = confusion_matrix(Y_test,␣
 ↪GradientBoostingClassifier_predictions)
plt.figure(figsize=(9,5))
map_matrix_GradientBoostingClassifier2 = sns.
 ↪heatmap(matrix_GradientBoostingClassifier2, annot=True, cbar=False, fmt="d",␣
 ↪cmap ='coolwarm', linecolor ='black', linewidths = 1)
bottom, top = map_matrix_GradientBoostingClassifier2.get_ylim()
map_matrix_GradientBoostingClassifier2.set_ylim(bottom + 0.5, top - 0.5)
plt.ylabel('Rótulos Verdadeiro')
plt.xlabel('Predicted Label')
plt.title('Matriz de Confusão')



print("Relatório de Classificação")
print(classification_report(Y_test, GradientBoostingClassifier_predictions))

print("Acurácia do Modelo")
accuracy_score(Y_test, GradientBoostingClassifier_predictions)
```

```
Relatório de Classificação
              precision    recall  f1-score   support

           0       0.60      0.11      0.18     13442
           1       0.81      0.98      0.89     52553

    accuracy                           0.80     65995
   macro avg       0.71      0.54      0.54     65995
weighted avg       0.77      0.80      0.74     65995

Acurácia do Modelo
```

[11]:
```
0.8038790817486173
```



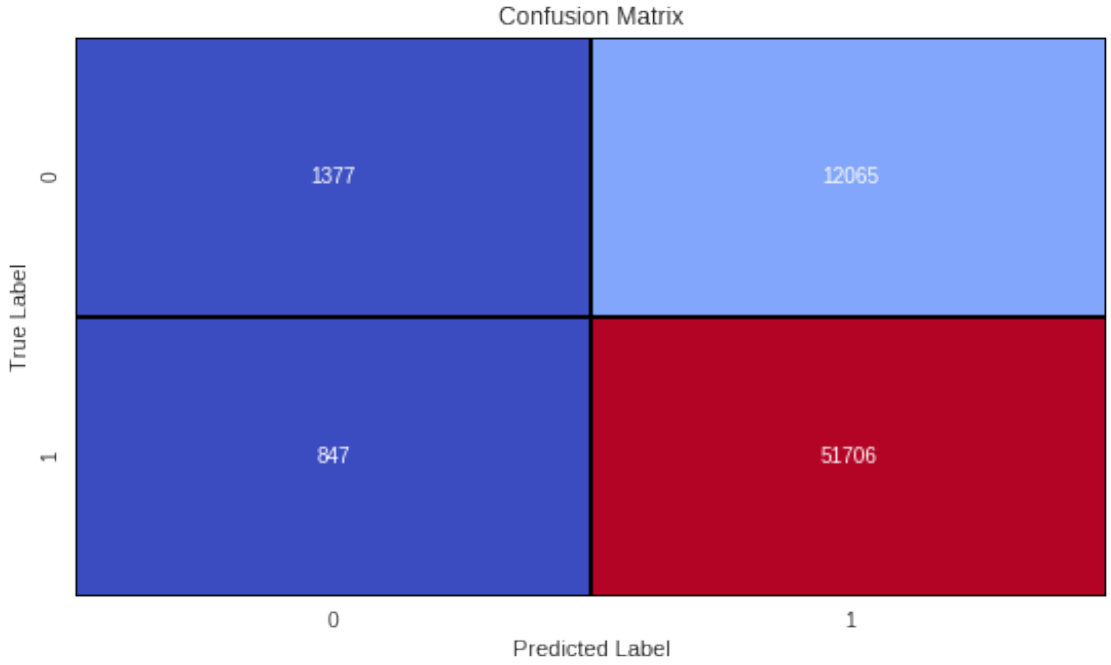
XGboost Classifier

[12]:
```
starttime = timer(None)
start_time = timer(None)
xgb_clf = XGBClassifier(base_score=0.2, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=0.1, colsample_bytree=1, gamma=1,
              learning_rate=0.1, max_delta_step=1, max_depth=3,
              min_child_weight=1, missing=None, n_estimators=300, n_jobs=4,
              nthread=None, objective='reg:squarederror', random_state=1,
              reg_alpha=0, reg_lambda=10, scale_pos_weight=1, seed=None,
              silent=None, subsample=1, verbosity=1)
xgb_clf.fit(X_train, Y_train.values.ravel())
predictions_xgb = xgb_clf.predict(X_test)
scores = cross_val_score(xgb_clf, X_train, Y_train.values.ravel(), cv=5)
timer(start_time)

false_positive_rate, true_positive_rate, thresholds = roc_curve(Y_test,␣
 ↪predictions_xgb)
roc_auc = auc(false_positive_rate, true_positive_rate)
matrix_xgb_clf = confusion_matrix(Y_test, predictions_xgb)



plt.figure(1)
plt.figure(figsize=(9,5))
```

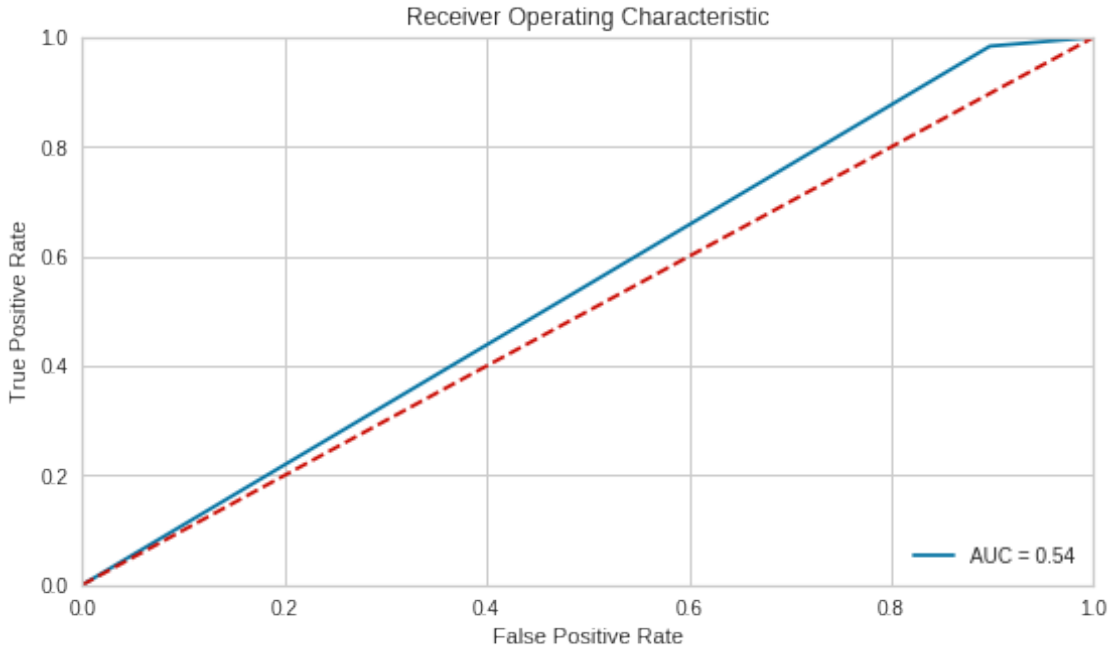
```
xgb_clf_heatmap = sns.heatmap(matrix_xgb_clf,annot=True, cbar=False, fmt="d",␣
 ↪cmap ='coolwarm', linecolor ='black', linewidths = 1)
bottom, top = xgb_clf_heatmap.get_ylim()
xgb_clf_heatmap.set_ylim(bottom + 0.5, top - 0.5)
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Confusion Matrix')
plt.show()

plt.figure(2)
plt.figure(figsize=(9,5))
plt.title('Receiver Operating Characteristic')
plt.plot(false_positive_rate, true_positive_rate, 'b',
label='AUC = %0.2f'% roc_auc)
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([-0.0,1.0])
plt.ylim([-0.0,1.0])
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()

plt.figure(3)
precision, recall, thresholds = precision_recall_curve(Y_test, predictions_xgb)
plt.figure(figsize = (9,5))
plt.plot(recall, precision)
plt.plot([0, 1], [0.5, 0.5], linestyle = '--')
plt.xlabel('Recall', fontsize = 16)
plt.ylabel('Precision', fontsize = 16)
plt.xticks(size = 18)
plt.yticks(size = 18)
plt.title('Precision-Recall', fontsize = 28)
plt.show();


print("Classification Report")
print(classification_report(Y_test, predictions_xgb))

print("Acurácia do Modelo")
accuracy_score(Y_test, predictions_xgb)

print("Acurácia do Modelo Cross Validation")
print(scores.mean())
```

```
 Tempo Necessário: 0 minutos and 25.58 segundos.
```

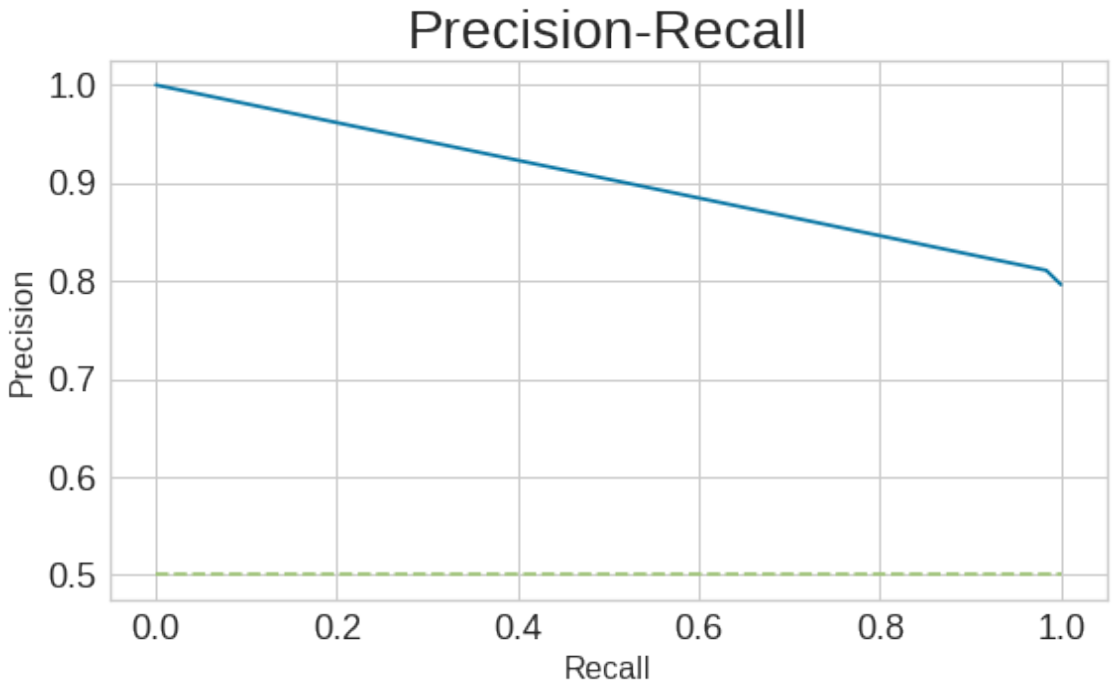
```
<Figure size 432x288 with 0 Axes>
```



<Figure size 432x288 with 0 Axes>

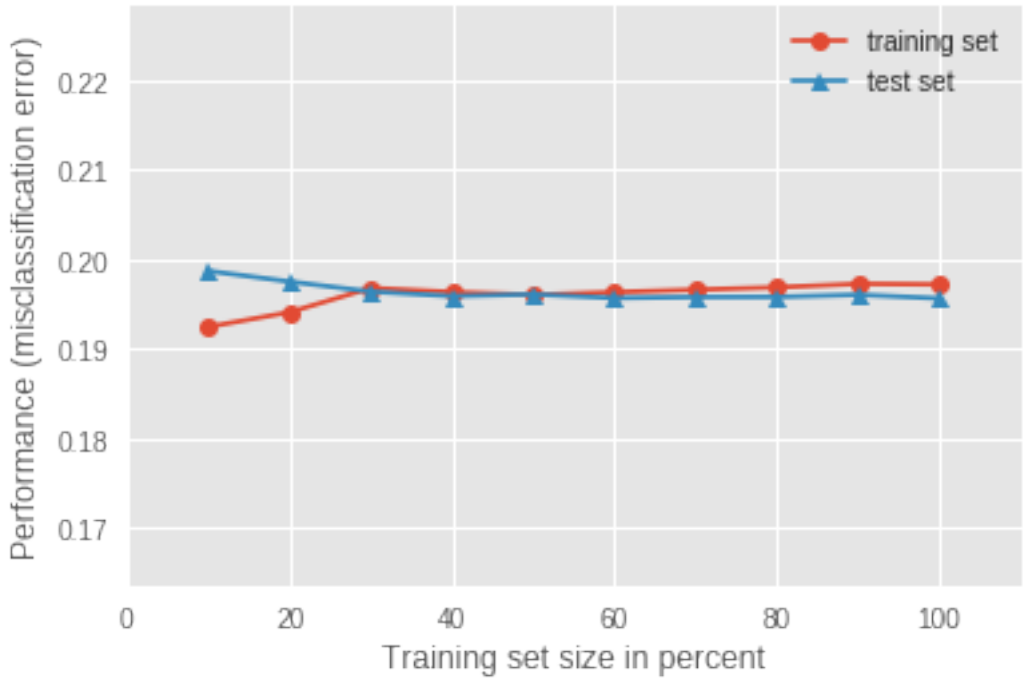


```
<Figure size 432x288 with 0 Axes>
```




```
Classification Report
              precision    recall  f1-score   support

           0       0.62      0.10      0.18     13442
           1       0.81      0.98      0.89     52553

    accuracy                           0.80     65995
   macro avg       0.71      0.54      0.53     65995
weighted avg       0.77      0.80      0.74     65995

Acurácia do Modelo
Acurácia do Modelo Cross Validation
0.8008764474456356
```

[13]:
```
plt.figure()
plot_learning_curves(X_train, Y_train.values.ravel(), X_test, Y_test.values.
 ↪ravel(), xgb_clf, print_model=False, style='ggplot')
plt.show()
```



Voting Ensemble

[ ]:
```
from sklearn.ensemble import VotingClassifier
starttime = timer(None)
start_time = timer(None)
model1 = RandomForestClassifier(n_estimators=50, max_depth=2, criterion='gini',␣
↪random_state=0)
model2 = AdaBoostClassifier(n_estimators=50, random_state=1, learning_rate=1)
model3 = XGBClassifier(base_score=0.2, booster='gbtree', colsample_bylevel=1,
              colsample_bynode=0.1, colsample_bytree=1, gamma=1,
              learning_rate=0.1, max_delta_step=1, max_depth=3,
              min_child_weight=1, missing=None, n_estimators=300, n_jobs=4,
              nthread=None, objective='reg:squarederror', random_state=1,
              reg_alpha=0, reg_lambda=10, scale_pos_weight=1, seed=None,
              silent=None, subsample=1, verbosity=1)
model = VotingClassifier(estimators=[('rf', model1), ('dtc', model2), ('xgb',␣
↪model3)], voting='soft')
model.fit(X_train,Y_train.values.ravel())
model.score(X_test,Y_test.values.ravel())
predictions_model = model.predict(X_test)
scores = cross_val_score(model, X_train, Y_train.values.ravel(), cv=3)
timer(start_time)

false_positive_rate, true_positive_rate, thresholds = roc_curve(Y_test,␣
↪predictions_model)
```

```
roc_auc = auc(false_positive_rate, true_positive_rate)
matrix_model = confusion_matrix(Y_test, predictions_model)



plt.figure(1)
plt.figure(figsize=(9,5))
model_heatmap = sns.heatmap(matrix_model,annot=True, cbar=False, fmt="d", cmap␣
↪='coolwarm', linecolor ='black', linewidths = 1)
bottom, top = model_heatmap.get_ylim()
model_heatmap.set_ylim(bottom + 0.5, top - 0.5)
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Confusion Matrix')
plt.show()

plt.figure(2)
plt.figure(figsize=(9,5))
plt.title('Receiver Operating Characteristic')
plt.plot(false_positive_rate, true_positive_rate, 'b',
label='AUC = %0.2f'% roc_auc)
plt.legend(loc='lower right')
plt.plot([0,1],[0,1],'r--')
plt.xlim([-0.0,1.0])
plt.ylim([-0.0,1.0])
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()

plt.figure(3)
precision, recall, thresholds = precision_recall_curve(Y_test,␣
↪predictions_model)
plt.figure(figsize = (9,5))
plt.plot(recall, precision)
plt.plot([0, 1], [0.5, 0.5], linestyle = '--')
plt.xlabel('Recall', fontsize = 16)
plt.ylabel('Precision', fontsize = 16)
plt.xticks(size = 18)
plt.yticks(size = 18)
plt.title('Precision-Recall', fontsize = 28)
plt.show();



print("Classification Report")
print(classification_report(Y_test, predictions_model))

print("Acurácia do Modelo")
```

```
accuracy_score(Y_test, predictions_model)

print("Acurácia do Modelo Cross Validation")
print(scores.mean())
```

[ ]:
```
plt.figure()
plot_learning_curves(X_train, Y_train.values.ravel(), X_test, Y_test.values.
 ↪ravel(), model, print_model=False, style='ggplot')
plt.show()
```

[ ]:
```
from sklearn.ensemble import BaggingClassifier
from sklearn import tree
model = BaggingClassifier(tree.DecisionTreeClassifier(random_state=1))
model.fit(X_train, Y_train.values.ravel())
model.score(X_test,Y_test.values.ravel())
```

[ ]:
```

```