Random Forest - TF-IDF

May 11, 2024

1 Initialization

Connect to Google Drive:

```
[ ]: # from google.colab import drive
     # drive.mount('/content/drive')

     # %cd '/content/drive/MyDrive/GitHub/emotion-dectection-from-text'
```

Preparing necessary packages:

```
[ ]: import numpy as np
     import pandas as pd
     import seaborn as sns

     from sklearn.ensemble import RandomForestClassifier
     from sklearn.model_selection import GridSearchCV, cross_val_score
     from sklearn.metrics import accuracy_score
     from joblib import dump

     from preset_function import evaluate_model, draw_learning_curve,␣
      ↪load_processed_data

     X_train_bow, X_test_bow, X_train_tfidf, X_test_tfidf, \
         X_train_bow_L1, X_test_bow_L1, X_train_tfidf_L1, X_test_tfidf_L1=␣
      ↪load_processed_data('input')

     y_train, y_test = load_processed_data('output')

     %matplotlib inline
```

1.1 Select dataset

At first, we choose the dataset to be used for training and testing the model.

```
[ ]: X_train = X_train_tfidf
     X_test = X_test_tfidf
```

2 Basic training

We define the model with the default parameters and train it.

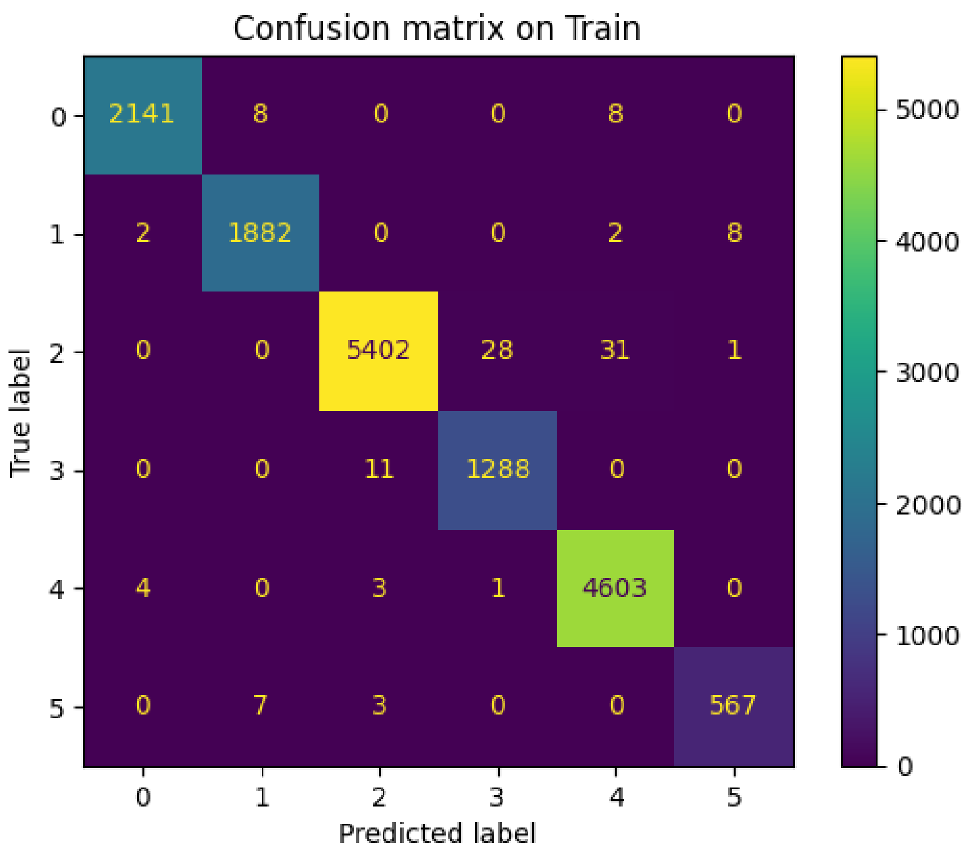
[ ]:
```
RF = RandomForestClassifier()
RF.fit(X_train , y_train)
```

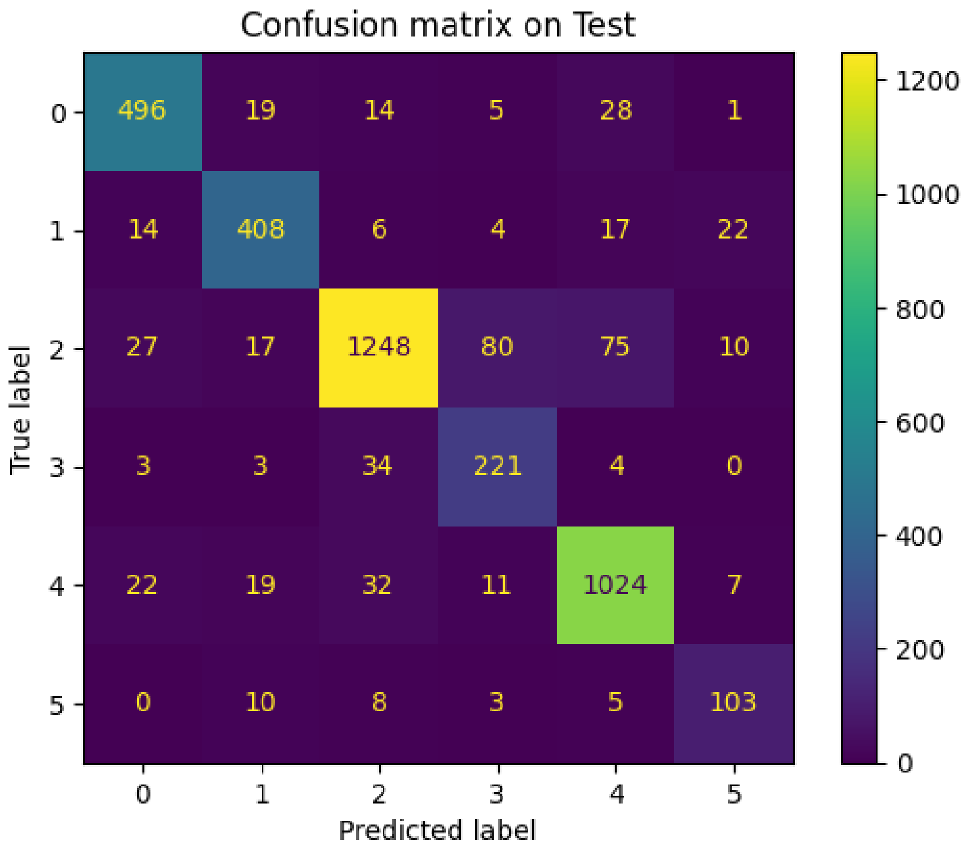
[ ]:
```
RandomForestClassifier()
```

Evaluate this model using a preset function:

[ ]:
```
evaluate_model(RF, X_train, X_test, y_train, y_test, include_training=True)
```

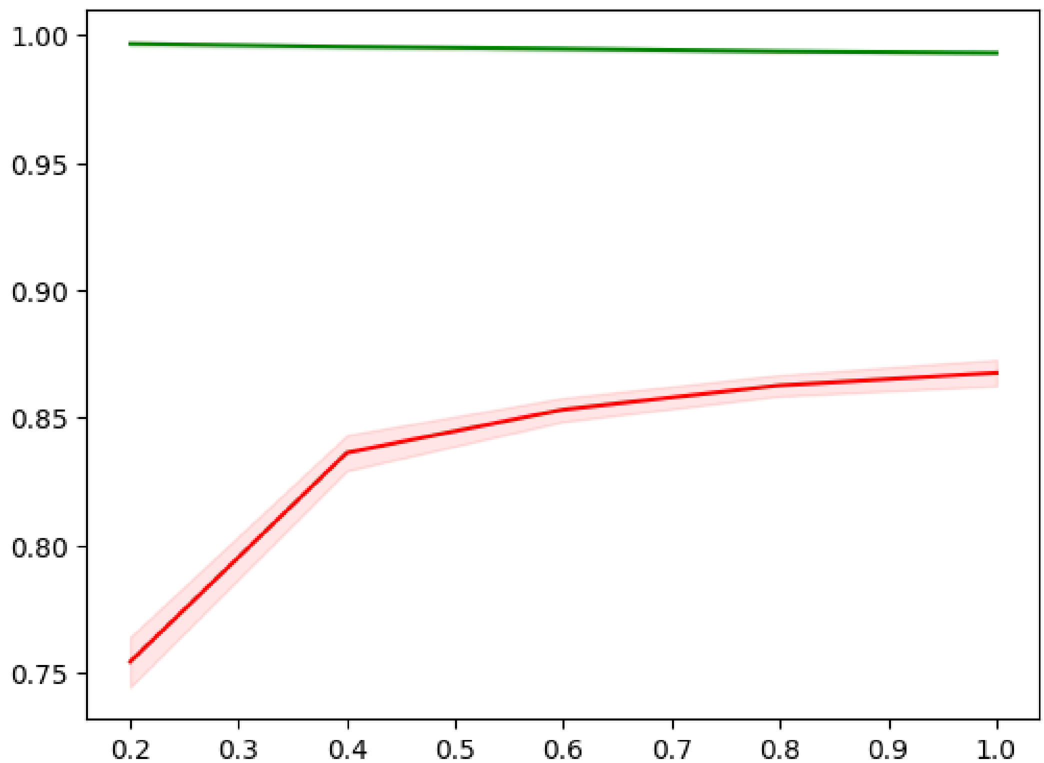
```
Score of on train are:
        - Accuracy score: 0.9927
        - Micro F1 score: 0.9927
        - Macro F1 score: 0.9906
Score of on test are:
        - Accuracy score: 0.8750
        - Micro F1 score: 0.8750
        - Macro F1 score: 0.8410
```





Draw learning curve using a preset function:

[ ]:
```
draw_learning_curve(RF, X_train, y_train)
```



3 Single tuning

This section examines the best range for each parameters by plotting the performance of the model with a range of value for each parameters.

3.1 N_estimator

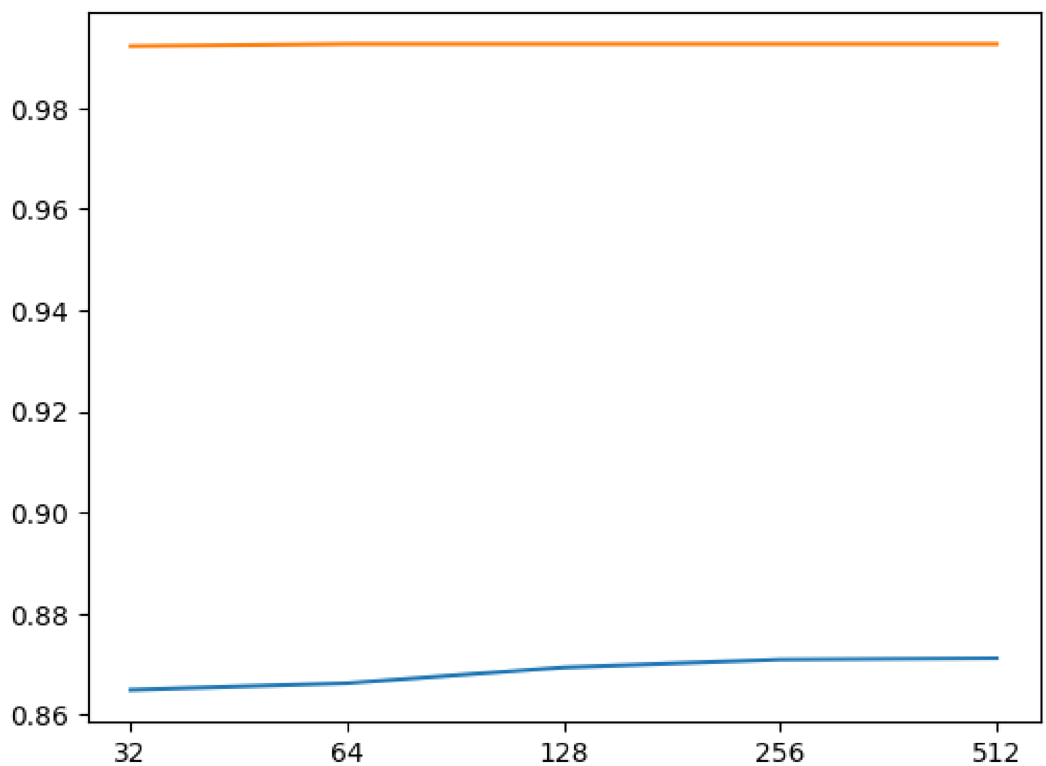
The number of trees in the forest.

[ ]:
```
# Setting the possible value for n_estimators
n_estimators_list = [32, 64, 128, 256, 512]

trs_list = list()
cvs_list = list()

for n_estimators in n_estimators_list:
    # Define model for each n_estimators
    rf_model = RandomForestClassifier(n_estimators=n_estimators)
    rf_model.fit(X_train, y_train)

    # Calculate the cross validation score
    train_score = accuracy_score(y_train, rf_model.predict(X_train))
```

```
    cvs_score = np.mean(cross_val_score(rf_model, X_train, y_train, cv=5,␣
↪n_jobs=5))

    trs_list.append(train_score)
    cvs_list.append(cvs_score)
```

[ ]:
```
# Draw the plot for n_estimators
fig = sns.lineplot(x=list(range(len(n_estimators_list))), y=cvs_list)
fig = sns.lineplot(x=list(range(len(n_estimators_list))), y=trs_list)
fig.set_xticks(range(len(n_estimators_list)))
fig.set_xticklabels(n_estimators_list)
```

[ ]:
```
[Text(0, 0, '32'),
 Text(1, 0, '64'),
 Text(2, 0, '128'),
 Text(3, 0, '256'),
 Text(4, 0, '512')]
```



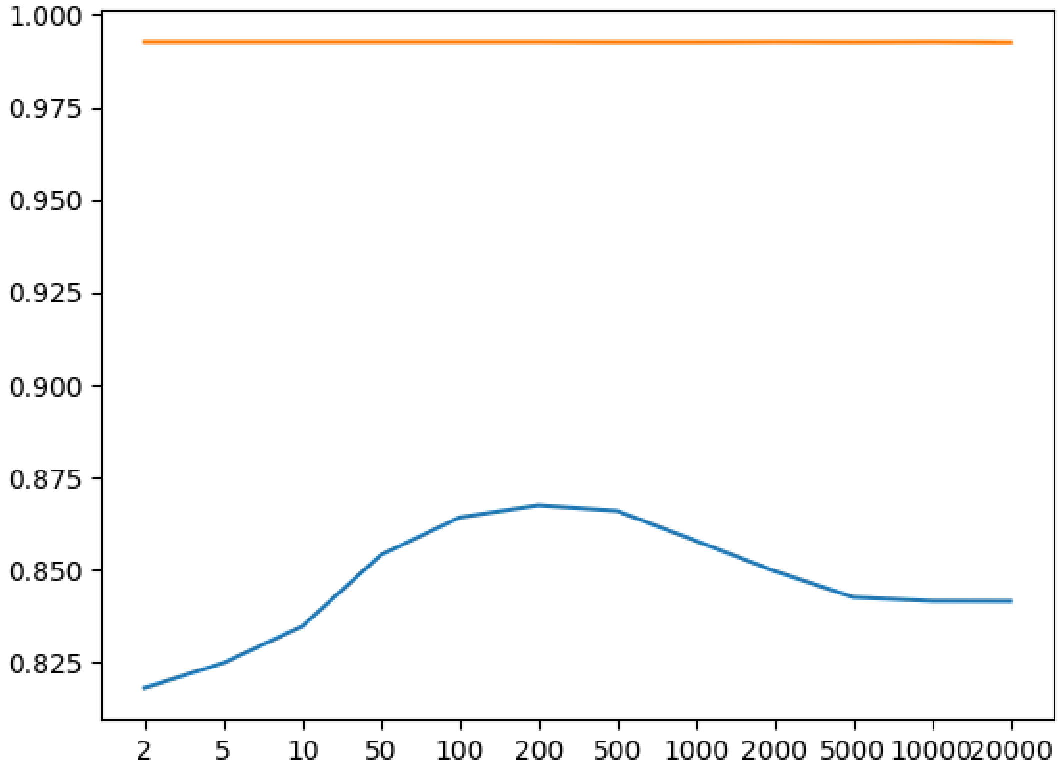
3.2 Max_features

The number of features to consider when looking for the best split.

[ ]:
```python
# Setting the max_features range
max_features_list = [2, 5, 10, 50, 100, 200, 500, 1000, 2000, 5000, 10000,␣
↪20000]
trs_list = list()
cvs_list = list()

for max_features in max_features_list:
  # Define model for each max_features
  rf_model = RandomForestClassifier(max_features=max_features)
  rf_model.fit(X_train, y_train)

  # Calculate the cross validation score
  train_score = accuracy_score(y_train, rf_model.predict(X_train))
  cv_score = np.mean(cross_val_score(rf_model, X_train, y_train, cv=5,␣
↪n_jobs=4))

  trs_list.append(train_score)
  cvs_list.append(cv_score)
```

[ ]:
```python
# Draw the plot for max_features
fig = sns.lineplot(x=list(range(len(max_features_list))), y=cvs_list)
fig = sns.lineplot(x=list(range(len(max_features_list))), y=trs_list)
fig.set_xticks(range(len(max_features_list)))
fig.set_xticklabels(max_features_list)
```

[ ]:
```
[Text(0, 0, '2'),
 Text(1, 0, '5'),
 Text(2, 0, '10'),
 Text(3, 0, '50'),
 Text(4, 0, '100'),
 Text(5, 0, '200'),
 Text(6, 0, '500'),
 Text(7, 0, '1000'),
 Text(8, 0, '2000'),
 Text(9, 0, '5000'),
 Text(10, 0, '10000'),
 Text(11, 0, '20000')]
```



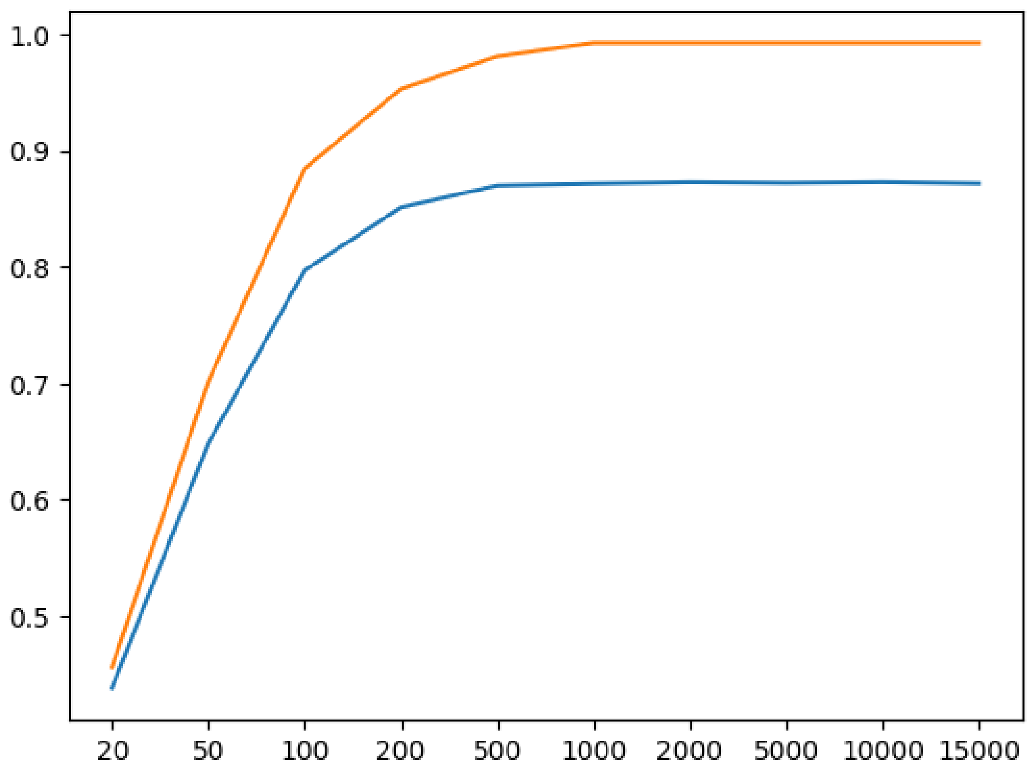
3.3 Max_depth

max_depth is the maximum depth of the tree.

[ ]:
```
# Setting the possible value for max depth
max_depth_list = [20, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 15000]

trs_list = list()
cvs_list = list()

for max_depth in max_depth_list:
    # Define model for each max_depth
    rf_model = RandomForestClassifier(max_depth=max_depth)
    rf_model.fit(X_train, y_train)

    # Calculate the cross validation score
    train_score = accuracy_score(y_train, rf_model.predict(X_train))
    cvs_score = np.mean(cross_val_score(rf_model, X_train, y_train, cv=5,␣
 ↪n_jobs=5))

    trs_list.append(train_score)
    cvs_list.append(cvs_score)
```

```
[ ]: # Draw the plot for max depth
fig = sns.lineplot(x=list(range(len(max_depth_list))), y=cvs_list)
fig = sns.lineplot(x=list(range(len(max_depth_list))), y=trs_list)
fig.set_xticks(range(len(max_depth_list)))
fig.set_xticklabels(max_depth_list)
```

```
[ ]: [Text(0, 0, '20'),
 Text(1, 0, '50'),
 Text(2, 0, '100'),
 Text(3, 0, '200'),
 Text(4, 0, '500'),
 Text(5, 0, '1000'),
 Text(6, 0, '2000'),
 Text(7, 0, '5000'),
 Text(8, 0, '10000'),
 Text(9, 0, '15000')]
```



3.4 Min_samples_split

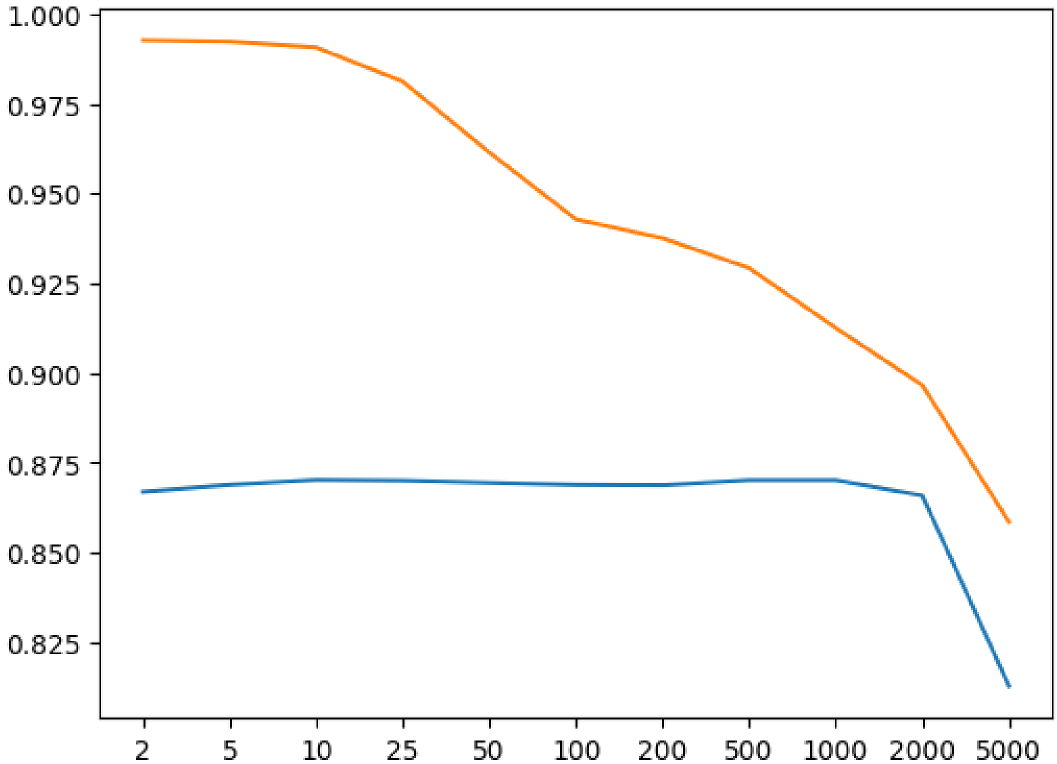
min_samples_split is the minimum number of samples required to split an internal node.

[ ]:
```python
# Setting the possible value for min_samples_split
min_samples_split_list = [2, 5, 10, 25, 50, 100, 200, 500, 1000, 2000, 5000]

trs_list = list()
cvs_list = list()

for min_samples_split in min_samples_split_list:
    # Define model for each min_samples_split
    rf_model = RandomForestClassifier(min_samples_split=min_samples_split)
    rf_model.fit(X_train, y_train)

    # Calculate the cross validation score
    train_score = accuracy_score(y_train, rf_model.predict(X_train))
    cvs_score = np.mean(cross_val_score(rf_model, X_train, y_train, cv=5,␣
 ↪n_jobs=5))

    trs_list.append(train_score)
    cvs_list.append(cvs_score)
```

```
c:\Users\DELL\AppData\Local\Programs\Python\Python311\Lib\site-
packages\joblib\externals\loky\process_executor.py:752: UserWarning: A worker
stopped while some jobs were given to the executor. This can be caused by a too
short worker timeout or by a memory leak.
  warnings.warn(
```

[ ]:
```python
# Draw the plot for min_samples_split
fig = sns.lineplot(x=list(range(len(min_samples_split_list))), y=cvs_list)
fig = sns.lineplot(x=list(range(len(min_samples_split_list))), y=trs_list)
fig.set_xticks(range(len(min_samples_split_list)))
fig.set_xticklabels(min_samples_split_list)
```

[ ]:
```
[Text(0, 0, '2'),
 Text(1, 0, '5'),
 Text(2, 0, '10'),
 Text(3, 0, '25'),
 Text(4, 0, '50'),
 Text(5, 0, '100'),
 Text(6, 0, '200'),
 Text(7, 0, '500'),
 Text(8, 0, '1000'),
 Text(9, 0, '2000'),
 Text(10, 0, '5000')]
```



3.5 Min_samples_leaf

min_samples_leaf is the minimum number of samples required to be at a leaf node. A split point at any depth will only be considered if it leaves at least ***min_samples_leaf*** training samples in each of the left and right branches.

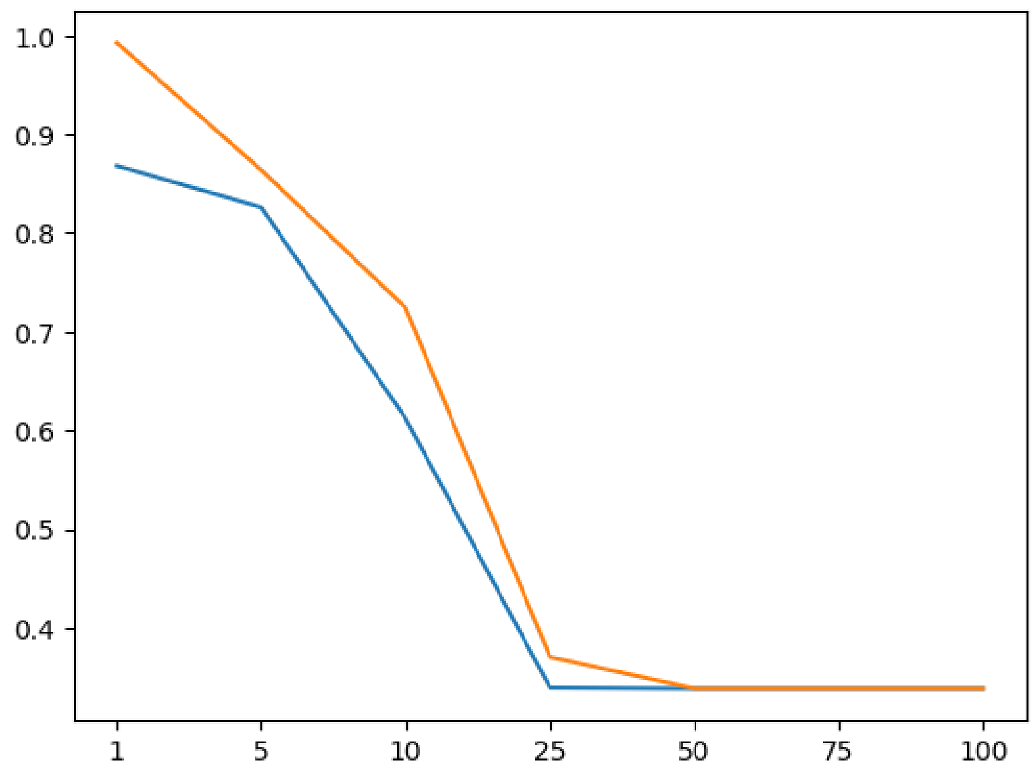
[ ]:
```
# Setting the min_samples_leaf range
min_samples_leaf_list = [1, 5, 10, 25, 50, 75, 100]
trs_list = list()
cvs_list = list()

for min_samples_leaf in min_samples_leaf_list:
  # Define model for each min_samples_leaf
  rf_model = RandomForestClassifier(min_samples_leaf=min_samples_leaf)
  rf_model.fit(X_train, y_train)

  # Calculate the cross validation score
  train_score = accuracy_score(y_train, rf_model.predict(X_train))
  cv_score = np.mean(cross_val_score(rf_model, X_train, y_train, cv=5,␣
↪n_jobs=4))

  trs_list.append(train_score)
```

```
    cvs_list.append(cv_score)
```

```
c:\Users\DELL\AppData\Local\Programs\Python\Python311\Lib\site-
packages\joblib\externals\loky\process_executor.py:752: UserWarning: A worker
stopped while some jobs were given to the executor. This can be caused by a too
short worker timeout or by a memory leak.
  warnings.warn(
```

[ ]:
```
# Draw the plot for min_samples_leaf
fig = sns.lineplot(x=list(range(len(min_samples_leaf_list))), y=cvs_list)
fig = sns.lineplot(x=list(range(len(min_samples_leaf_list))), y=trs_list)
fig.set_xticks(range(len(min_samples_leaf_list)))
fig.set_xticklabels(min_samples_leaf_list)
```

[ ]:
```
[Text(0, 0, '1'),
 Text(1, 0, '5'),
 Text(2, 0, '10'),
 Text(3, 0, '25'),
 Text(4, 0, '50'),
 Text(5, 0, '75'),
 Text(6, 0, '100')]
```



From the plot, we can see that the higher this parameter is, the lower the accuracy for both training and testing are.

4 Multiple tuning

First, we use grid search to help tuning this model.

```
[ ]: dict_param = {
         'max_depth' : np.asarray([500, 1000, 2000]),
         'min_samples_split': np.asarray([10, 25, 50]),
         'min_samples_leaf': np.asarray([1, 2, 5]),
         'max_features': np.asarray([100, 200, 500]),
     }

     grid_search = GridSearchCV(RandomForestClassifier(n_estimators=256),␣
      ↪dict_param, cv = 5, n_jobs=5)
     grid_search.fit(X_train, y_train)
```

```
[ ]: GridSearchCV(cv=5, estimator=RandomForestClassifier(n_estimators=256), n_jobs=5,
                  param_grid={'max_depth': array([ 500, 1000, 2000]),
                              'max_features': array([100, 200, 500]),
                              'min_samples_leaf': array([1, 2, 5]),
                              'min_samples_split': array([10, 25, 50])})
```

We elminate all parameters that appear in models with the validation accuracy < 0.85

```
[ ]: df = pd.DataFrame(
       dict(
         max_depth = [val['max_depth'] for val in grid_search.cv_results_['params']],
         min_samples_split = [val['min_samples_split'] for val in grid_search.
      ↪cv_results_['params']],
         min_samples_leaf = [val['min_samples_leaf'] for val in grid_search.
      ↪cv_results_['params']],
         max_features = [val['max_features'] for val in grid_search.
      ↪cv_results_['params']],
         score = grid_search.cv_results_['mean_test_score']
       )
     )
     df = df[df['score'] <= 0.871]

     for param in dict_param:
       for value in dict_param[param]:
         if len(df[df[param] == value]) == 81 // len(dict_param[param]) :
           print(param, value)
```

```
max_depth 500
min_samples_split 50
min_samples_leaf 2
min_samples_leaf 5
```

```
max_features 100
max_features 500
```

We repeat this process again, this time with the domain narrowed down.

```
[ ]: dict_param = {
         'max_depth' : np.asarray([1000, 2000, 5000]),
         'min_samples_split': np.asarray([10, 25, 1000]),
         'max_features': np.asarray([200, 250, 300])
     }

     grid_search = GridSearchCV(RandomForestClassifier(n_estimators = 256),␣
      ↪dict_param, cv = 5, n_jobs=5)
     grid_search.fit(X_train, y_train)
```

```
[ ]: GridSearchCV(cv=5, estimator=RandomForestClassifier(n_estimators=256), n_jobs=5,
                  param_grid={'max_depth': array([1000, 2000, 5000]),
                              'max_features': array([200, 250, 300]),
                              'min_samples_split': array([  10,   25, 1000])})
```

```
[ ]: df = pd.DataFrame(
       dict(
         max_depth = [val['max_depth'] for val in grid_search.cv_results_['params']],
         min_samples_split = [val['min_samples_split'] for val in grid_search.
      ↪cv_results_['params']],
         max_features = [val['max_features'] for val in grid_search.
      ↪cv_results_['params']],
         score = grid_search.cv_results_['mean_test_score']
       )
     )

     df = df[df['score'] <= 0.871]

     for param in dict_param:
       for value in dict_param[param]:
         if len(df[df[param] == value]) == 27 // len(dict_param[param]) :
           print(param, value)
```

Find the best combination of parameters for the model:

```
[ ]: print(grid_search.best_estimator_, grid_search.best_score_)
```

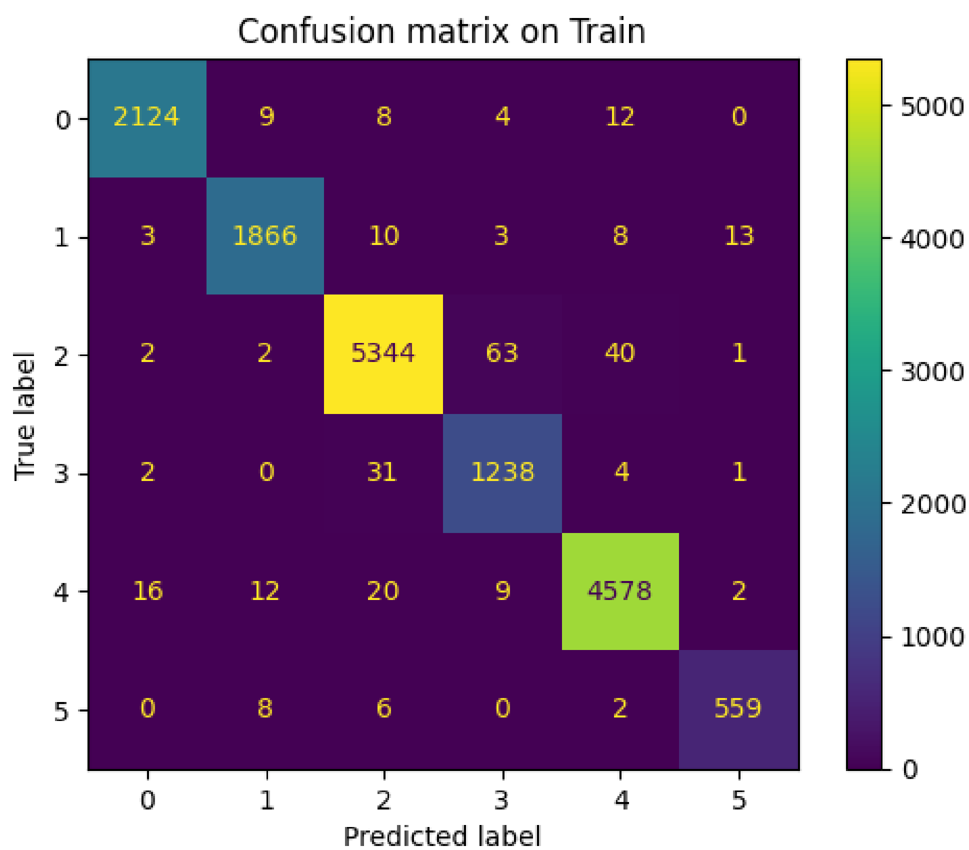
```
RandomForestClassifier(max_depth=5000, max_features=300, min_samples_split=25,
                       n_estimators=256) 0.8721874999999999
```

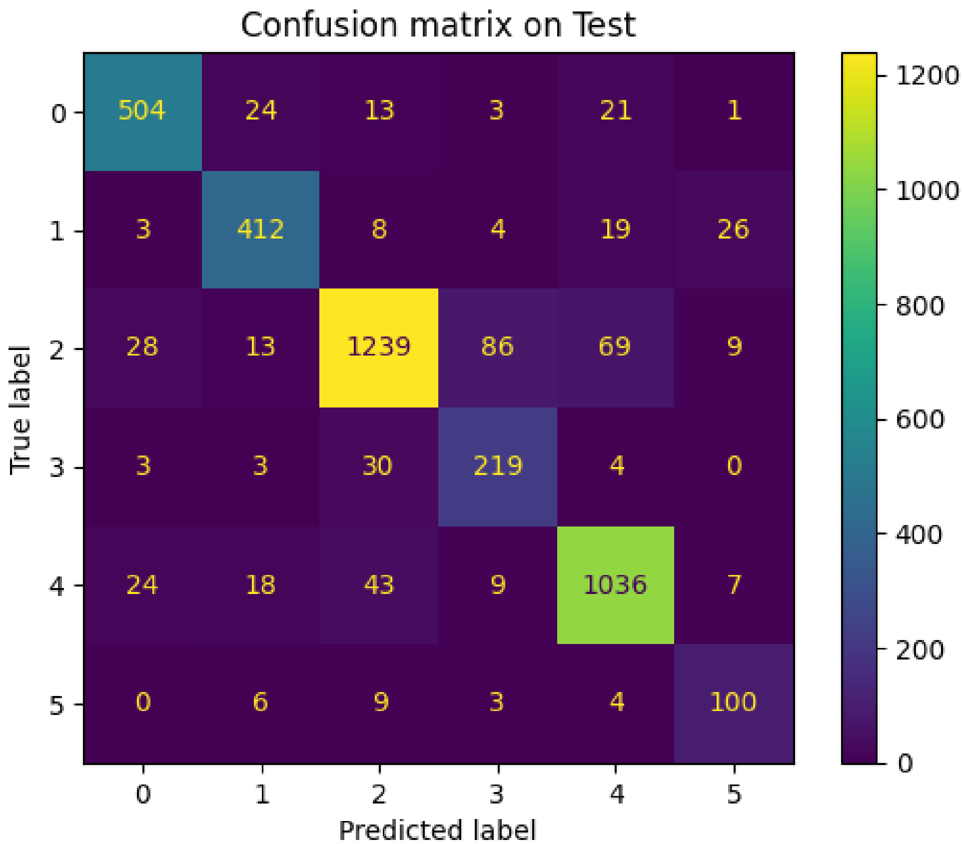
5 Conclusion

We use all the parameters from the last section to define the best model and then evaluate it using the preset functions.

```
[ ]: best_rf_model = RandomForestClassifier(max_depth=5000, max_features=300,␣
      ↪min_samples_split=25,
                                          n_estimators=256)
     best_rf_model.fit(X_train, y_train)

     evaluate_model(best_rf_model, X_train, X_test, y_train, y_test,␣
      ↪include_training=True)
```

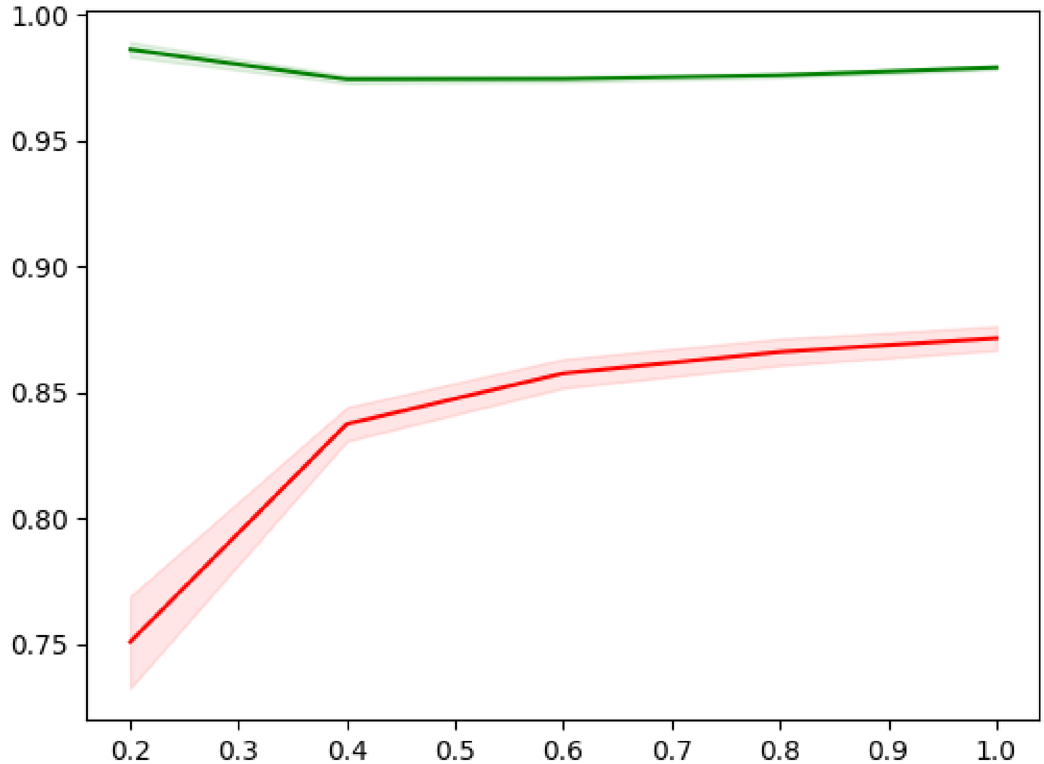
```
Score of on train are:
        - Accuracy score: 0.9818
        - Micro F1 score: 0.9818
        - Macro F1 score: 0.9775
Score of on test are:
        - Accuracy score: 0.8775
        - Micro F1 score: 0.8775
        - Macro F1 score: 0.8438
```





After that, we draw the learning curve of this Decision Tree model.

[ ]:
```
draw_learning_curve(best_rf_model, X_train, y_train)
```



Finally, we export the model.

[ ]:
```
directory = "data/models/"

dump(best_rf_model, directory + "best_rf_model_tfidf.joblib")
```

[ ]: ['data/models/best_rf_model_tfidf.joblib']