S4 - HOPE random forest-V2

December 6, 2020

1 Import data from DB.

[1]:
```
import pandas as pd
import numpy as np
```

[2]:
```
dfOrg = pd.read_csv('hope_dataset_cleaned.csv')

print(dfOrg.shape[0])
```

```
1243
```

[3]:
```
dfOrg.head(10)
```

[3]:
```
   pedido.data.attributes.age pedido.data.attributes.diagnostic_main  \
0                        75.0                     FISTULA PERITONEAL
1                        75.0                     FISTULA PERITONEAL
2                        75.0                     FISTULA PERITONEAL
3                        75.0                     FISTULA PERITONEAL
4                        75.0                     FISTULA PERITONEAL
5                        75.0                     FISTULA PERITONEAL
6                        75.0                     FISTULA PERITONEAL
7                        75.0                     FISTULA PERITONEAL
8                        75.0                     FISTULA PERITONEAL
9                        75.0                     FISTULA PERITONEAL

  pedido.data.attributes.gender  articulo  respuesta.articlesRevisedYear  \
0                          male  27395425                           2018
1                          male  28560554                           2018
2                          male  28641726                           2017
3                          male  26245344                           2016
4                          male  28942543                           2018
5                          male  24782153                           2014
6                          male  28002229                           2018
7                          male  27505109                           2017
8                          male  24850546                           2015
9                          male  29371050                           2019
```

```
   respuesta.articlesRevisedMonth  \
0                               1
1                               4
2                              12
3                              12
4                               6
5                               6
6                               9
7                               4
8                               1
9                               4

                                 respuesta.pubmed_keys  utilidad
0  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       1.0
1  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
2  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
3  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
4  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
5  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
6  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
7  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
8  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
9  Abdomen,Adenocarcinoma,Antiemetics,Blood Cultu…       NaN
```

Expand pubmed_keys attribute

[4]:
```
dfOrg['respuesta.pubmed_keys'] = dfOrg['respuesta.pubmed_keys'].apply(lambda x :
 ↪ str(x).split(','))

dfOrg = dfOrg.explode('respuesta.pubmed_keys').reset_index(drop=True)

dfOrg.head(10)
```

[4]:
```
   pedido.data.attributes.age pedido.data.attributes.diagnostic_main  \
0                        75.0                      FISTULA PERITONEAL
1                        75.0                      FISTULA PERITONEAL
2                        75.0                      FISTULA PERITONEAL
3                        75.0                      FISTULA PERITONEAL
4                        75.0                      FISTULA PERITONEAL
5                        75.0                      FISTULA PERITONEAL
6                        75.0                      FISTULA PERITONEAL
7                        75.0                      FISTULA PERITONEAL
8                        75.0                      FISTULA PERITONEAL
9                        75.0                      FISTULA PERITONEAL

  pedido.data.attributes.gender  articulo  respuesta.articlesRevisedYear  \
0                          male  27395425                           2018
```

```
1                          male  27395425                           2018
2                          male  27395425                           2018
3                          male  27395425                           2018
4                          male  27395425                           2018
5                          male  27395425                           2018
6                          male  27395425                           2018
7                          male  27395425                           2018
8                          male  27395425                           2018
9                          male  27395425                           2018

   respuesta.articlesRevisedMonth respuesta.pubmed_keys  utilidad
0                               1               Abdomen       1.0
1                               1         Adenocarcinoma       1.0
2                               1           Antiemetics       1.0
3                               1         Blood Culture       1.0
4                               1             Catharsis       1.0
5                               1             Diuresis       1.0
6                               1               Fistula       1.0
7                               1           Gastrectomy       1.0
8                               1     Incisional Hernia       1.0
9                               1            Intestines       1.0
```

2 Transform (factorice) from Categories to continuous atributes

Transform 'pedido.data.attributes.diagnostic_main' atribute

[5]:
```
dataDiagnosticMain, categoriesDiagnosticMain = pd.factorize(dfOrg['pedido.data.
 ↪attributes.diagnostic_main'])

dfOrg['pedido.data.attributes.diagnostic_main'] = dataDiagnosticMain
```

Transform 'gender' atribute

[6]:
```
dataGender, categoriesGender = pd.factorize(dfOrg['pedido.data.attributes.
 ↪gender'])

dfOrg['pedido.data.attributes.gender'] = dataGender
```

Transform 'respuesta.pubmed_keys' atribute

[7]:
```
categoriesORGPubMedKeys = dfOrg['respuesta.pubmed_keys'].value_counts()

print("total: " + str(categoriesORGPubMedKeys.size))
```

```
total: 353
```

```
[8]: dataPubMedKeys, categoriesPubMedKeys = pd.factorize(dfOrg['respuesta.
      ↪pubmed_keys'])

     dfOrg['respuesta.pubmed_keys'] = dataPubMedKeys
```

```
[9]: dfOrg.head(10)
```

```
[9]:    pedido.data.attributes.age  pedido.data.attributes.diagnostic_main  \
     0                        75.0                                       0
     1                        75.0                                       0
     2                        75.0                                       0
     3                        75.0                                       0
     4                        75.0                                       0
     5                        75.0                                       0
     6                        75.0                                       0
     7                        75.0                                       0
     8                        75.0                                       0
     9                        75.0                                       0

        pedido.data.attributes.gender  articulo  respuesta.articlesRevisedYear  \
     0                              0  27395425                           2018
     1                              0  27395425                           2018
     2                              0  27395425                           2018
     3                              0  27395425                           2018
     4                              0  27395425                           2018
     5                              0  27395425                           2018
     6                              0  27395425                           2018
     7                              0  27395425                           2018
     8                              0  27395425                           2018
     9                              0  27395425                           2018

        respuesta.articlesRevisedMonth  respuesta.pubmed_keys  utilidad
     0                               1                      0       1.0
     1                               1                      1       1.0
     2                               1                      2       1.0
     3                               1                      3       1.0
     4                               1                      4       1.0
     5                               1                      5       1.0
     6                               1                      6       1.0
     7                               1                      7       1.0
     8                               1                      8       1.0
     9                               1                      9       1.0
```

```
[10]: print("age NaN => " + str(dfOrg[pd.isnull(dfOrg['pedido.data.attributes.age'])].
       ↪shape[0]))
      print("diagnostic_main NaN => " + str(dfOrg[pd.isnull(dfOrg['pedido.data.
       ↪attributes.diagnostic_main'])].shape[0]))
```

```
print("gender NaN => " + str(dfOrg[pd.isnull(dfOrg['pedido.data.attributes.
 ↪gender'])].shape[0]))
print("articulo NaN => " + str(dfOrg[pd.isnull(dfOrg['articulo'])].shape[0]))
print("articlesRevisedYear NaN => " + str(dfOrg[pd.isnull(dfOrg['respuesta.
 ↪articlesRevisedYear'])].shape[0]))
print("articlesRevisedMonth NaN => " + str(dfOrg[pd.isnull(dfOrg['respuesta.
 ↪articlesRevisedMonth'])].shape[0]))
print("pubmed_keys NaN => " + str(dfOrg[pd.isnull(dfOrg['respuesta.
 ↪pubmed_keys'])].shape[0]))
print("utilidad NaN => " + str(dfOrg[pd.isnull(dfOrg['utilidad'])].shape[0]))
```

```
age NaN => 10
diagnostic_main NaN => 0
gender NaN => 0
articulo NaN => 0
articlesRevisedYear NaN => 0
articlesRevisedMonth NaN => 0
pubmed_keys NaN => 0
utilidad NaN => 14758
```

Remove row with age eq NaN

[11]:
```
dfOrg = dfOrg[pd.notnull(dfOrg['pedido.data.attributes.age'])]
```

3 Standardize the Data

Choosed “age”, “diagnostic_main”, “month” and “pubmed_keys” attributes (based on PCA_V3 study)

[12]:
```
from sklearn.preprocessing import StandardScaler

features = ["pedido.data.attributes.age",
    "pedido.data.attributes.diagnostic_main",
    "respuesta.articlesRevisedMonth",
    "respuesta.pubmed_keys",
    "utilidad"
]

# Separating out the features
x = dfOrg.loc[:, features].values

featuresTransformed = StandardScaler().fit_transform(x)

dfStandarized = pd.DataFrame(featuresTransformed, index=dfOrg.index,␣
 ↪columns=features)
dfStandarized['utilidad'] = dfOrg['utilidad']
```

```
dfStandarized
```

```
[12]:        pedido.data.attributes.age  pedido.data.attributes.diagnostic_main  \
      0                        1.285887                               -1.503163
      1                        1.285887                               -1.503163
      2                        1.285887                               -1.503163
      3                        1.285887                               -1.503163
      4                        1.285887                               -1.503163
      …                             …                                     …
      15583                   -0.607930                               -0.586347
      15584                   -0.607930                               -0.586347
      15585                   -0.607930                               -0.586347
      15586                   -0.607930                               -0.586347
      15587                   -0.607930                               -0.586347

             respuesta.articlesRevisedMonth  respuesta.pubmed_keys  utilidad
      0                           -1.463658              -1.089722       1.0
      1                           -1.463658              -1.080463       1.0
      2                           -1.463658              -1.071203       1.0
      3                           -1.463658              -1.061944       1.0
      4                           -1.463658              -1.052684       1.0
      …                                …                      …      …
      15583                       -1.178433              -0.330441       NaN
      15584                       -1.178433              -0.978608       NaN
      15585                       -1.178433               0.891817       NaN
      15586                       -1.178433              -0.876753       NaN
      15587                       -1.178433               0.901077       NaN

      [15578 rows x 5 columns]
```

4 Separe data by utilidad is defined

```
[13]: dfDataSetComplete = dfStandarized[pd.notnull(dfStandarized['utilidad'])]

      print(dfDataSetComplete.shape[0])

      dfDataSetToPredict = dfStandarized[pd.isnull(dfStandarized['utilidad'])]

      print(dfDataSetToPredict.shape[0])
```

```
830
14748
```

5 Random Forest

We check the number of results

[14]:
```
dfDataSetComplete.groupby('utilidad').size()
```

[14]:
```
utilidad
0.0    346
1.0    484
dtype: int64
```

Separe “utilidad” atribute from dataToTrain

[15]:
```
X = np.array(dfDataSetComplete.drop(['utilidad'],1))
y = np.array(dfDataSetComplete['utilidad'])
X.shape
```

[15]:
```
(830, 4)
```

[16]:
```
from sklearn.model_selection import train_test_split

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

6 Exploring number of estimators

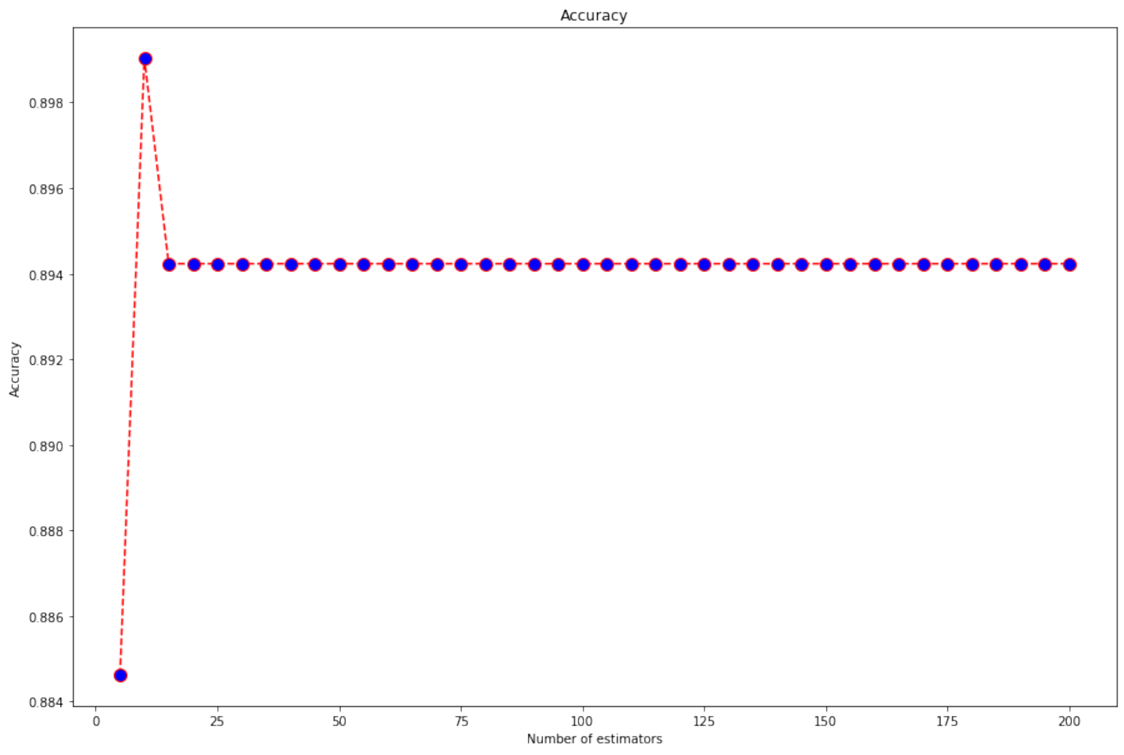
Via the sample size n of the bootstrap sample, we control the bias-variance tradeoff of the random forest. By choosing a larger value for n, we decrease the randomness and thus the forest is more likely to overfit. On the other hand, we can reduce the degree of overfitting by choosing smaller values for n at the expense of the model performance. In most implementations, including the RandomForestClassifier implementation in scikit-learn, the sample size of the bootstrap sample is chosen to be equal to the number of samples in the original training set, which usually provides a good bias-variance tradeoff.

https://towardsdatascience.com/gini-index-vs-information-entropy-7a7e4fed3fcb

[17]:
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix,␣
 ↪accuracy_score

k_range = range(5, 205, 5)
accuracy = []

for k in k_range:
    forest_test = RandomForestClassifier(
        criterion='entropy',
        n_estimators=k,
        random_state=0
    )
    forest_test.fit(X_train, y_train)
    y_pred_test = forest_test.predict(X_test)
    accuracy.append(accuracy_score(y_test, y_pred_test))
```

[18]:
```
import matplotlib.pyplot as plt

fig, axs = plt.subplots(figsize=(15, 10))
axs.plot(k_range, accuracy, color='red', linestyle='dashed', marker='o',
         markerfacecolor='blue', markersize=10)
axs.set_title('Accuracy')
axs.set_xlabel('Number of estimators')
axs.set_ylabel('Accuracy')
```

[18]:
```
Text(0, 0.5, 'Accuracy')
```



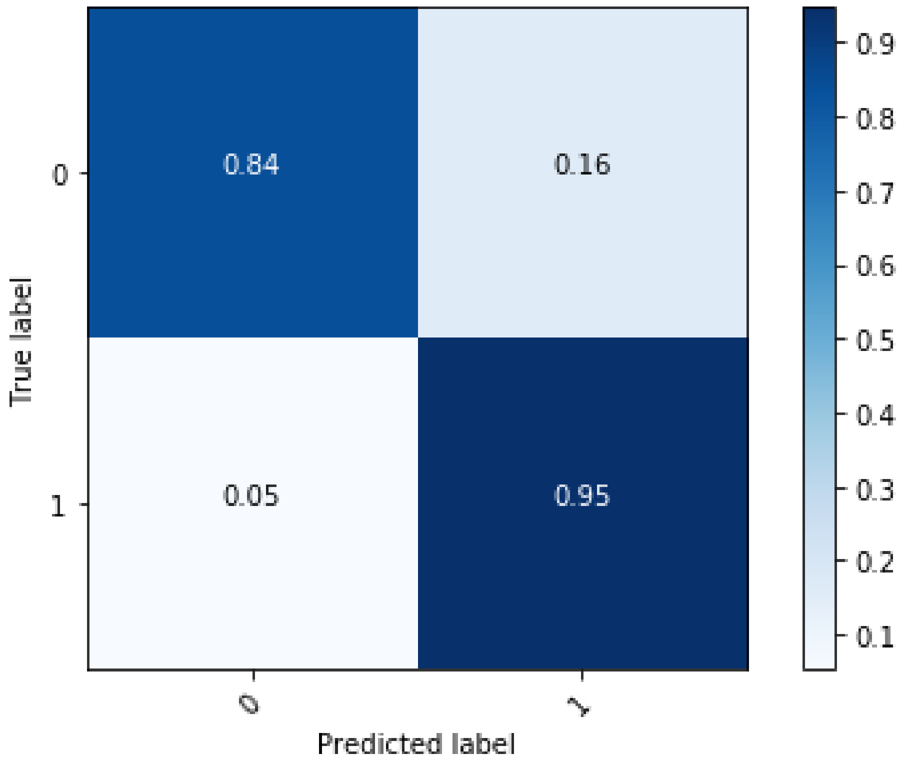
6.1 Evaluating the Algorithm

[19]:
```
forest = RandomForestClassifier(
    criterion='entropy',
    n_estimators=10,
    random_state=0
)

forest.fit(X_train, y_train)
```

```
y_pred = forest.predict(X_test)

print(classification_report(y_test,y_pred))
print(accuracy_score(y_test, y_pred))
```

```
              precision    recall  f1-score   support

         0.0       0.93      0.84      0.88        95
         1.0       0.88      0.95      0.91       113

    accuracy                           0.90       208
   macro avg       0.90      0.89      0.90       208
weighted avg       0.90      0.90      0.90       208

0.8990384615384616
```

[20]:
```
import itertools



cnf_matrix = confusion_matrix(y_test, y_pred)

def plot_confusion_matrix(cm, classes):
    cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]

    cmap=plt.cm.Blues

    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], ".2f"),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')

n_classes=["0","1"]
plot_confusion_matrix(cnf_matrix, classes=n_classes)
```



7 Run Prediction

```
[21]: result = forest.predict(dfDataSetToPredict[["pedido.data.attributes.age",
          "pedido.data.attributes.diagnostic_main",
          "respuesta.articlesRevisedMonth",
          "respuesta.pubmed_keys"
      ]])

      result
```

```
[21]: array([1., 1., 1., …, 0., 0., 0.])
```