Notebook Predictive analytics

January 24, 2023

[99]:
```
import numpy as np
import pandas as pd
import matplotlib as plt
from sklearn.pipeline import Pipeline
from sklearn.model_selection import GridSearchCV, train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.multiclass import OneVsRestClassifier
from sklearn.metrics import precision_recall_curve, roc_curve, accuracy_score,␣
 ↪precision_score, recall_score
from sklearn import datasets, neighbors
from mlxtend.plotting import plot_decision_regions
from sklearn.tree import DecisionTreeClassifier
from sklearn.naive_bayes import MultinomialNB
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import RandomizedSearchCV
from sklearn.naive_bayes import GaussianNB
```

[100]:
```
df_userdata = pd.read_csv('final_userdata_min_40.csv')
df_userdata = df_userdata.drop(df_userdata.columns[0:11],axis =1 )
df_userdata = df_userdata.drop('liked_recipes',axis =1 )
df_userdata.kitchen.unique()
```

[100]:
```
array(['frans', 'aziatisch', 'hollands', 'mexicaans', 'italiaans',
       'mediterraan', 'amerikaans'], dtype=object)
```

[101]:
```
for keuken in range(len(df_userdata)):

    if df_userdata['kitchen'].iloc[keuken] == 'aziatisch':
        df_userdata['kitchen'].iloc[keuken] = 0
    elif df_userdata['kitchen'].iloc[keuken] == 'frans':
        df_userdata['kitchen'].iloc[keuken] = 1
    elif df_userdata['kitchen'].iloc[keuken] == 'hollands':
        df_userdata['kitchen'].iloc[keuken] = 2
    elif df_userdata['kitchen'].iloc[keuken] == 'italiaans':
        df_userdata['kitchen'].iloc[keuken] = 3
    elif df_userdata['kitchen'].iloc[keuken] == 'mexicaans':
        df_userdata['kitchen'].iloc[keuken] = 4
```

```
    elif df_userdata['kitchen'].iloc[keuken] == 'mediterraan':
        df_userdata['kitchen'].iloc[keuken] = 5
    elif df_userdata['kitchen'].iloc[keuken] == 'amerikaans':
        df_userdata['kitchen'].iloc[keuken] = 6

df_userdata
```

```
/tmp/ipykernel_43015/3680158733.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 1
/tmp/ipykernel_43015/3680158733.py:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 0
/tmp/ipykernel_43015/3680158733.py:8: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 2
/tmp/ipykernel_43015/3680158733.py:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 4
/tmp/ipykernel_43015/3680158733.py:10: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 3
/tmp/ipykernel_43015/3680158733.py:14: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 5
/tmp/ipykernel_43015/3680158733.py:16: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-
```

```
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_userdata['kitchen'].iloc[keuken] = 6
```

[101]:

	chilivlokken	gemalen kaneel	sjalot	knoflook	rode peper	zout	\
0	0	0	0	1	0	0	
1	0	0	1	1	0	1	
2	0	0	1	1	0	0	
3	0	0	1	1	0	0	
4	0	0	1	1	0	0	
…	…	…	…	…	…	…	
1400	1	1	1	1	0	1	
1401	0	0	1	1	0	0	
1402	0	0	0	1	0	1	
1403	0	0	1	1	1	0	
1404	0	0	0	0	1	0	

	vastkokende aardappel	zoete aardappel	vissaus	middelgrote ui	…	\
0	0	0	0	0	…	
1	1	0	0	0	…	
2	0	0	0	1	…	
3	0	1	0	0	…	
4	1	0	0	1	…	
…	…	…	…	…	…	
1400	0	0	0	0	…	
1401	0	1	0	0	…	
1402	1	0	0	0	…	
1403	0	0	0	0	…	
1404	1	0	0	0	…	

	(arachide)olie	tomatenblokjes	zoete puntpaprika	(olijf)olie	\
0	0	0	0	0	
1	0	0	0	0	
2	0	0	0	0	
3	0	1	0	0	
4	0	0	0	0	
…	…	…	…	…	
1400	0	0	0	0	
1401	0	0	1	1	
1402	1	1	0	0	
1403	0	0	0	0	
1404	0	0	0	0	

	kruimige aardappelen	magere gerookte spekreepjes	takje rozemarijn	\
0	1	0	0	
1	0	0	0	
2	0	0	1	
3	0	0	1	

```
4                        0                            0                 0
…                    …                          …                …
1400                     0                            0                 0
1401                     1                            0                 0
1402                     0                            0                 0
1403                     0                            0                 1
1404                     0                            0                 0

      boter  aardappelen  kitchen
0         0            1        1
1         1            0        1
2         1            0        1
3         0            0        1
4         0            0        1
…       …            …        …
1400      0            0        1
1401      0            0        2
1402      0            0        1
1403      0            0        0
1404      0            0        0

[1405 rows x 172 columns]
```

[102]:

```python
y= df_userdata['kitchen']
X = df_userdata.drop('kitchen', axis = 1)

y=y.astype('int')

X_main, X_test, y_main, y_test = train_test_split(X, y, test_size = 0.2,␣
↪random_state=42, stratify=y)
X_train, X_val, y_train, y_val = train_test_split(X_main, y_main, test_size = 0.
↪25, random_state=42, stratify=y_main)
X_test
```

[102]:

```
      chilivlokken  gemalen kaneel  sjalot  knoflook  rode peper  zout  \
1346             0               0       0         1           1     0
1281             0               0       1         1           0     0
1324             0               0       0         1           1     1
853              0               0       0         1           0     0
981              0               0       1         1           1     0
…              …               …     …       …         …   …
602              0               0       0         1           0     0
1140             0               0       0         1           0     1
1266             0               0       0         1           0     0
418              0               0       1         1           0     0
901              0               0       0         1           1     1
```

```
      vastkokende aardappel  zoete aardappel  vissaus  middelgrote ui  …  \
1346                      0                1        0               0  …
1281                      0                0        0               0  …
1324                      0                0        0               1  …
853                       0                0        0               0  …
981                       0                0        0               0  …
…                       …                …        …             …  …
602                       0                0        0               0  …
1140                      0                0        0               0  …
1266                      0                0        0               0  …
418                       0                1        0               1  …
901                       0                0        0               1  …

      kippenbouillon van tablet  (arachide)olie  tomatenblokjes  \
1346                          0                0               0
1281                          0                0               0
1324                          0                0               0
853                           1                0               0
981                           0                0               0
…                           …              …             …
602                           0                1               1
1140                          0                0               1
1266                          0                0               0
418                           0                0               0
901                           0                0               1

      zoete puntpaprika  (olijf)olie  kruimige aardappelen  \
1346                  0            0                     0
1281                  0            0                     0
1324                  0            0                     0
853                   0            0                     0
981                   0            0                     0
…                   …          …                     …
602                   0            0                     0
1140                  0            0                     0
1266                  0            0                     0
418                   0            0                     1
901                   0            1                     0

      magere gerookte spekreepjes  takje rozemarijn  boter  aardappelen
1346                            0                 0      0            0
1281                            0                 0      0            0
1324                            0                 0      0            0
853                             0                 0      0            0
981                             1                 0      0            0
…                             …               …    …          …
602                             0                 0      0            0
```

1140	0	1	0	0
1266	0	0	0	0
418	0	0	0	0
901	1	0	0	0

[281 rows x 171 columns]

[278]:
```
model = RandomForestClassifier()
model.fit(X_train,y_train)
y_proba = model.predict(X_val)
```

[279]:
```
print('Acc_score',accuracy_score(y_proba,y_val))
print('prec_score',precision_score(y_proba,y_val, average ='macro'))
print('rec_score',recall_score(y_proba,y_val, average ='macro'))
```

```
Acc_score 0.9644128113879004
prec_score 0.9644599303135888
rec_score 0.9649198332491933
```

[280]:
```
#params = { 'criterion' : ['gini', 'entropy', 'log_loss'],
#            'max_depth' : [3,5,8,10,15,20,25,30,40,50,60,70,80,90,100],
#            'min_samples_split' : [5,6,7,8,9,10,20,30,40,50,60]
#                                    }
```

[281]:
```
#params = { 'leaf_size' : [1,2,3,4,5,6,7,8,9,10,20,30,40,50,60,70,80,90],
#            'n_neighbors' : [1,2,3,4,5,6,7,8,9,10],
#            'weights' : ['uniform', 'distance'],
#            'algorithm' : ['auto', 'ball_tree', 'kd_tree', 'brute']
#                                    }
```

[286]:
```
params = { 'n_estimators' : [10,20,30,40,50,80,100,130,150,200,250,300,350,400],
           'criterion' : ['gini', 'entropy', 'log_loss'],
           'max_depth' : [3,5,8,10,15,20,25,30,40,50,60,70,80,90,100],
           'min_samples_split' : [5,6,7,8,9,10,20,30,40,50,60]
                                    }
```

[287]:
```
randomsearch = RandomizedSearchCV(estimator= model ,param_distributions=␣
↪params, n_iter=30, cv=20, random_state=42)
```

[288]:
```
search = randomsearch.fit(X_train,y_train)
search.best_estimator_
```

[288]:
```
RandomForestClassifier(criterion='entropy', max_depth=20, min_samples_split=5,
                       n_estimators=350)
```

[289]:
```
model.score(X_val,y_val)
```

[289]:
```
0.9644128113879004
```

[293]:
```
#model = KNeighborsClassifier(algorithm='brute', leaf_size=1, n_neighbors=8,␣
 ↪weights='distance')
#model = DecisionTreeClassifier(max_depth=25, min_samples_split=20)
#model = MultinomialNB()
RandomForestClassifier(criterion='entropy', max_depth=20, min_samples_split=5,␣
 ↪n_estimators=350)
```

[293]:
```
RandomForestClassifier(criterion='entropy', max_depth=20, min_samples_split=5,
                       n_estimators=350)
```

[294]:
```
model.fit(X_train,y_train)
y_proba = model.predict(X_test)
```

[295]:
```
print('Acc_score',accuracy_score(y_proba,y_test))
print('prec_score',precision_score(y_proba,y_test, average ='macro'))
print('rec_score',recall_score(y_proba,y_test, average ='macro'))
```

```
Acc_score 0.9786476868327402
prec_score 0.9785714285714285
rec_score 0.9791568754557977
```

[296]:
```
from sklearn.metrics import confusion_matrix, classification_report

print(confusion_matrix(y_test, y_proba))
print(classification_report(y_test, y_proba))
```

```
[[41  0  0  0  0  0  0]
 [ 1 39  0  0  0  0  0]
 [ 1  1 38  0  0  0  0]
 [ 0  0  0 39  0  1  0]
 [ 0  0  0  0 40  0  0]
 [ 0  0  0  1  0 39  0]
 [ 0  0  0  0  1  0 39]]
              precision    recall  f1-score   support

           0       0.95      1.00      0.98        41
           1       0.97      0.97      0.97        40
           2       1.00      0.95      0.97        40
           3       0.97      0.97      0.97        40
           4       0.98      1.00      0.99        40
           5       0.97      0.97      0.97        40
           6       1.00      0.97      0.99        40

    accuracy                           0.98       281
   macro avg       0.98      0.98      0.98       281
```

```
weighted avg       0.98      0.98      0.98       281
```

[271]:
```
model.score(X_test,y_test)
```

[271]:
```
0.8540925266903915
```

[272]:
```
from sklearn.utils.multiclass import unique_labels
unique_labels(y_test)
```

[272]:
```
array([0, 1, 2, 3, 4, 5, 6])
```

[273]:
```
def plot(Y_test, y_proba):
    labels= unique_labels(y_test)
    columns=[f"Predicted {label}" for label in labels]
    index=[f"Actual {label}" for label in labels]
    table= pd.DataFrame(confusion_matrix(y_test, y_proba), columns=columns,␣
 ↪index=index)
    return table
```

[274]:
```
plot(y_test, y_proba)
```

[274]:

	Predicted 0	Predicted 1	Predicted 2	Predicted 3	Predicted 4	Predicted 5	Predicted 6
Actual 0	39	2	0	0	0	0	0
Actual 1	0	36	0	4	0	0	0
Actual 2	2	4	33	1	0	0	0
Actual 3	0	1	0	34	0	5	0
Actual 4	0	0	0	0	39	0	1
Actual 5	0	0	1	4	4	28	3
Actual 6	1	1	0	0	6	1	31

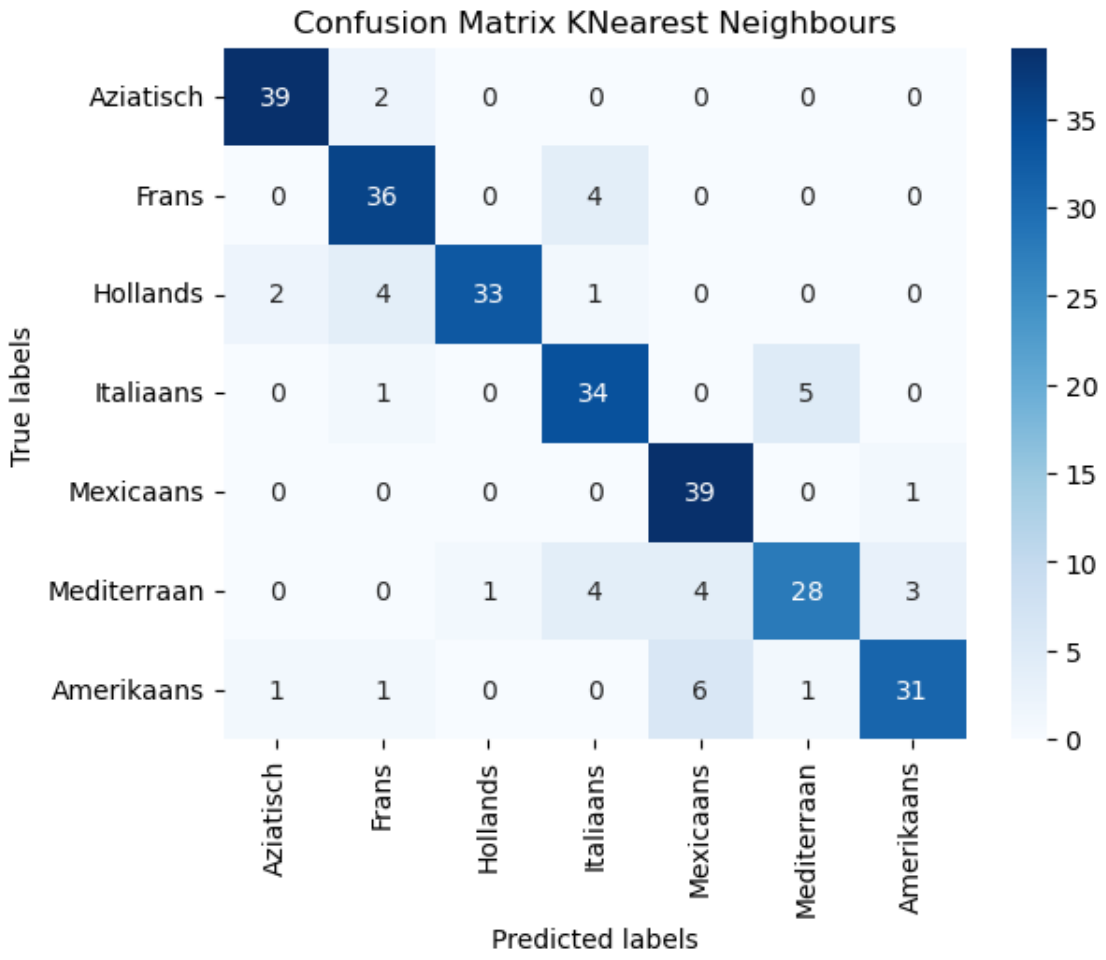
[275]:
```
import seaborn as sns
```

[276]:
```
def plot2(Y_test, y_proba):
    labels= unique_labels(y_test)
    columns=[f"Predicted {label}" for label in labels]
    index=[f"Actual {label}" for label in labels]
```

```
    table= pd.DataFrame(confusion_matrix(y_test, y_proba), columns=columns,␣
↪index=index)
    heatmap=sns.heatmap(table, annot=True, fmt="d", cmap= "Blues")
    heatmap.set_xlabel('Predicted labels');
    heatmap.set_ylabel('True labels');
    heatmap.set_title('Confusion Matrix KNearest Neighbours');
    heatmap.xaxis.set_ticklabels(["Aziatisch",  "Frans", "Hollands",␣
↪"Italiaans", "Mexicaans", "Mediterraan", "Amerikaans"]);
    heatmap.yaxis.set_ticklabels(["Aziatisch",  "Frans", "Hollands",␣
↪"Italiaans", "Mexicaans", "Mediterraan", "Amerikaans"], rotation=0);
    return heatmap
```

[277]:
```
plot2(y_test, y_proba)
```

[277]:
```
<AxesSubplot:title={'center':'Confusion Matrix KNearest Neighbours'},
xlabel='Predicted labels', ylabel='True labels'>
```



[340]:
```
    if df_userdata['kitchen'].iloc[keuken] == 'aziatisch':
        df_userdata['kitchen'].iloc[keuken] = 0
    elif df_userdata['kitchen'].iloc[keuken] == 'frans':
        df_userdata['kitchen'].iloc[keuken] = 1
    elif df_userdata['kitchen'].iloc[keuken] == 'hollands':
        df_userdata['kitchen'].iloc[keuken] = 2
    elif df_userdata['kitchen'].iloc[keuken] == 'italiaans':
        df_userdata['kitchen'].iloc[keuken] = 3
    elif df_userdata['kitchen'].iloc[keuken] == 'mexicaans':
        df_userdata['kitchen'].iloc[keuken] = 4
    elif df_userdata['kitchen'].iloc[keuken] == 'mediterraan':
        df_userdata['kitchen'].iloc[keuken] = 5
```