Churn_AdaBoost

April 23, 2024

[18]:
```
# Libraries

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sb
from sklearn.model_selection import train_test_split
from sklearn import metrics
from sklearn.preprocessing import MinMaxScaler
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay,␣
↪accuracy_score, f1_score
from sklearn.model_selection import GridSearchCV
from sklearn.feature_selection import RFE
from sklearn.ensemble import AdaBoostClassifier

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

[7]:
```
# Reading in the data
churn = pd.read_csv('/Users/gregory/Desktop/data_mining_2/Projects/Project_4/
↪Data/telco_churn_data_clean.csv')

churn.head()
```

[7]:
```
   Unnamed: 0  Referred_a_Friend  Number_of_Referrals  Tenure_in_Months  \
0           3                  1                    1                25
1           4                  1                    1                37
2           5                  0                    0                27
3           6                  1                    1                 1
4           7                  1                    6                58

   Offer  Phone_Service  Avg_Monthly_Long_Distance_Charges  Multiple_Lines  \
0    3.0              1                              19.76               0
1    3.0              1                               6.33               1
2    3.0              1                               3.33               1
3    5.0              1                              15.28               0
```

```
4   2.0             0                              0.00             0

   Internet_Service  Internet_Type  …  Married  Number_of_Dependents  \
0                 1            1.0  …        1                     1
1                 1            2.0  …        1                     1
2                 1            1.0  …        0                     1
3                 1            2.0  …        1                     2
4                 1            2.0  …        1                     0

   Zip_Code  Population  Churn_Value  CLTV  Churn_Category  \
0     90303       27778            1  5337             2.0
1     90602       26265            1  2793             3.0
2     90660       63288            1  4638             1.0
3     90720       21343            1  3964             5.0
4     91024       10558            1  5444             2.0

   Total_Customer_Svc_Requests  Product/Service_Issues_Reported  \
0                            1                                1
1                            1                                0
2                            0                                0
3                            7                                0
4                            2                                1

   Customer_Satisfaction
0                    2.0
1                    2.0
2                    2.0
3                    1.0
4                    1.0

[5 rows x 39 columns]
```

[8]:

```python
# Drop the unnamed column

churn2 = churn.drop('Unnamed: 0', axis = 1)

churn2.head()
```

[8]:

```
   Referred_a_Friend  Number_of_Referrals  Tenure_in_Months  Offer  \
0                  1                    1                25    3.0
1                  1                    1                37    3.0
2                  0                    0                27    3.0
3                  1                    1                 1    5.0
4                  1                    6                58    2.0

   Phone_Service  Avg_Monthly_Long_Distance_Charges  Multiple_Lines  \
0              1                              19.76               0
```

```
1              1                               6.33                 1
2              1                               3.33                 1
3              1                              15.28                 0
4              0                               0.00                 0

   Internet_Service  Internet_Type  Avg_Monthly_GB_Download  …  Married  \
0                 1            1.0                       13  …        1
1                 1            2.0                       15  …        1
2                 1            1.0                       20  …        0
3                 1            2.0                       33  …        1
4                 1            2.0                       26  …        1

   Number_of_Dependents  Zip_Code  Population  Churn_Value  CLTV  \
0                     1     90303       27778            1  5337
1                     1     90602       26265            1  2793
2                     1     90660       63288            1  4638
3                     2     90720       21343            1  3964
4                     0     91024       10558            1  5444

   Churn_Category  Total_Customer_Svc_Requests  \
0             2.0                            1
1             3.0                            1
2             1.0                            0
3             5.0                            7
4             2.0                            2

   Product/Service_Issues_Reported  Customer_Satisfaction
0                                1                    2.0
1                                0                    2.0
2                                0                    2.0
3                                0                    1.0
4                                1                    1.0

[5 rows x 38 columns]
```

[9]:

```
# Moving target for ease of access

churn_val = churn2.pop('Churn_Value')
churn2.insert(37, "Churn_Value", churn_val)

churn2.head()
```

[9]:

```
   Referred_a_Friend  Number_of_Referrals  Tenure_in_Months  Offer  \
0                  1                    1                25    3.0
1                  1                    1                37    3.0
2                  0                    0                27    3.0
3                  1                    1                 1    5.0
```

```
4                 1                    6                58    2.0

   Phone_Service  Avg_Monthly_Long_Distance_Charges  Multiple_Lines  \
0              1                              19.76               0
1              1                               6.33               1
2              1                               3.33               1
3              1                              15.28               0
4              0                               0.00               0

   Internet_Service  Internet_Type  Avg_Monthly_GB_Download  …  Married  \
0                 1            1.0                       13  …        1
1                 1            2.0                       15  …        1
2                 1            1.0                       20  …        0
3                 1            2.0                       33  …        1
4                 1            2.0                       26  …        1

   Number_of_Dependents  Zip_Code  Population  CLTV  Churn_Category  \
0                     1     90303       27778  5337             2.0
1                     1     90602       26265  2793             3.0
2                     1     90660       63288  4638             1.0
3                     2     90720       21343  3964             5.0
4                     0     91024       10558  5444             2.0

   Total_Customer_Svc_Requests  Product/Service_Issues_Reported  \
0                            1                                1
1                            1                                0
2                            0                                0
3                            7                                0
4                            2                                1

   Customer_Satisfaction  Churn_Value
0                    2.0            1
1                    2.0            1
2                    2.0            1
3                    1.0            1
4                    1.0            1

[5 rows x 38 columns]
```

[13]:
```
churn2
```

[13]:
```
      Referred_a_Friend  Number_of_Referrals  Tenure_in_Months  Offer  \
0                     1                    1                25    3.0
1                     1                    1                37    3.0
2                     0                    0                27    3.0
3                     1                    1                 1    5.0
4                     1                    6                58    2.0
```

```
…                    …                    …                 …    …
7035                 0                    0                   72    3.4
7036                 1                    1                   24    3.0
7037                 1                    4                   72    3.0
7038                 1                    1                   11    3.0
7039                 0                    0                   66    3.0

      Phone_Service  Avg_Monthly_Long_Distance_Charges  Multiple_Lines  \
0                 1                              19.76               0
1                 1                               6.33               1
2                 1                               3.33               1
3                 1                              15.28               0
4                 0                               0.00               0
…               …                                  …              …
7035              1                              22.77               0
7036              1                              36.05               1
7037              1                              29.66               1
7038              0                               0.00               0
7039              1                              30.96               0

      Internet_Service  Internet_Type  Avg_Monthly_GB_Download  …  Married  \
0                    1            1.0                       13  …        1
1                    1            2.0                       15  …        1
2                    1            1.0                       20  …        0
3                    1            2.0                       33  …        1
4                    1            2.0                       26  …        1
…                  …            …                        …   …       …
7035                 0            2.0                        0  …        0
7036                 1            3.0                       24  …        1
7037                 1            2.0                       59  …        1
7038                 1            3.0                       17  …        1
7039                 1            1.0                       11  …        0

      Number_of_Dependents  Zip_Code  Population  CLTV  Churn_Category  \
0                        1     90303       27778  5337             2.0
1                        1     90602       26265  2793             3.0
2                        1     90660       63288  4638             1.0
3                        2     90720       21343  3964             5.0
4                        0     91024       10558  5444             2.0
…                      …       …         …    …              …
7035                     0     92285        2182  5306             1.0
7036                     2     92301       18980  2140             1.0
7037                     2     92304          42  5560             1.0
7038                     2     92305         301  2793             1.0
7039                     0     92308       28819  5097             1.0

      Total_Customer_Svc_Requests  Product/Service_Issues_Reported  \
```

```
0                                1                                 1
1                                1                                 0
2                                0                                 0
3                                7                                 0
4                                2                                 1
…                             …                               …
7035                             0                                 0
7036                             2                                 0
7037                             2                                 0
7038                             0                                 0
7039                             1                                 2

      Customer_Satisfaction  Churn_Value
0                       2.0            1
1                       2.0            1
2                       2.0            1
3                       1.0            1
4                       1.0            1
…                    …           …
7035                    4.0            0
7036                    4.0            0
7037                    4.0            0
7038                    4.0            0
7039                    4.0            0

[7040 rows x 38 columns]
```

[15]:

```
# Split data

X = churn2.iloc[:, 0:37]
y = churn2.iloc[:, 37]

# Min-Max

mms = MinMaxScaler()
X_minmax = mms.fit_transform(X)

# Train/Test split

X_train, X_test, y_train, y_test = train_test_split(X_minmax, y, train_size=0.
↪8, stratify=y, random_state=0)
```

[17]:

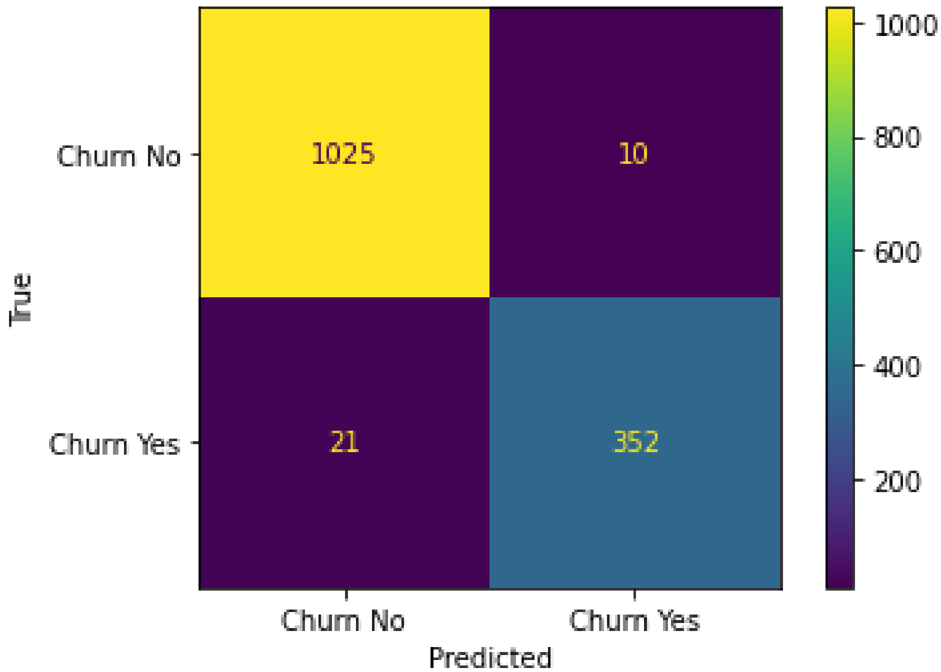
```
# GridSearchCV

parameters = {
    'n_estimators': [10, 50, 100],
    'learning_rate': [0.01, 0.1, 0.5, 1, 2]
```

```
}

ada = AdaBoostClassifier()
clf = GridSearchCV(ada, parameters)
clf.fit(X_train, y_train)
print(clf.best_estimator_)
```

```
AdaBoostClassifier(learning_rate=1, n_estimators=100)
```

[35]:
```
# RFE

ada = AdaBoostClassifier(learning_rate=1, n_estimators=100)
selector = RFE(ada)
selector.fit(X_train,y_train)

X_train_rfe = selector.transform(X_train)
X_test_rfe = selector.transform(X_test)

ada.fit(X_train_rfe, y_train)
y_pred = ada.predict(X_test_rfe)

cf_matrix = confusion_matrix(y_test,y_pred)
cmd = ConfusionMatrixDisplay(cf_matrix, display_labels=['Churn No', 'Churn␣
↪Yes'])
cmd.plot()
cmd.ax_.set(xlabel='Predicted', ylabel='True')

f1_score(y_test,y_pred) # 95.78%
```

[35]: 0.9578231292517007



[37]:

```
# Feature Names
X_train_df = pd.DataFrame(data=X_train)
features = selector.fit_transform(X_train,y_train)
feature_idx = selector.get_support(indices=True)
feature_names = X_train_df.columns[feature_idx]
features = pd.DataFrame(features, columns=feature_names)
features.head()

# Selected Predictors:

# 1: Number_of_Referrals
# 2: Tenure_in_Months
# 3: Offer
# 5: Avg_Monthly_Long_Distance_Charges
# 8: Internet_Type
# 9: Avg_Monthly_GB_Download
# 20: Payment_Method
# 21: Monthly_Charge
# 22: Total_Regular_Charges
# 24: Total_Extra_Data_Charges
# 25: Total_Long_Distance_Charges
# 29: Number_of_Dependents
# 30: Zip_Code
# 31: Population
# 32: CLTV
```

```
# 34: Total_Customer_Svc_Requests
# 35: Product/Service_Issues_Reported
# 36: Customer_Satisfaction
```

[37]:

```
          1         2     3         5     8         9   20        21  \
0  0.000000  0.253521  0.75  0.343469  0.20  0.000000  0.5  0.005246
1  0.454545  1.000000  0.00  0.427485  1.00  0.138298  0.0  0.932903
2  0.272727  0.619718  0.25  0.616123  1.00  0.031915  0.5  0.630521
3  0.000000  0.014085  1.00  0.879376  0.50  0.159574  0.0  0.605166
4  0.000000  0.154930  0.75  0.779356  0.25  0.000000  0.5  0.017170

         22        24        25   29        30        31        32        34  \
0  0.030048  0.000000  0.091516  0.0  0.213043  0.335448  0.203024  0.222222
1  0.967701  0.000000  0.431630  0.0  0.383477  0.069466  0.533911  0.333333
2  0.443024  0.000000  0.388810  0.0  0.915921  0.023985  0.311319  0.000000
3  0.015088  0.003397  0.024664  0.0  0.498455  0.028070  0.711586  0.000000
4  0.028462  0.000000  0.131152  0.0  0.419743  0.042223  0.665555  0.000000

         35    36
0  0.000000  0.75
1  0.166667  0.50
2  0.000000  0.50
3  0.000000  0.25
4  0.000000  1.00
```

[ ]: