HR_Analytics_SMOTE

May 19, 2021

1 HR Analytics - Capstone Project

HR Analysis is predictive analysis to identifying the employees most likely to get promoted.

HR Process: First identify a set of employees based on recommendations/ past performance. Selected employees go through the separate training and evaluation program for each vertical. These programs are based on the required skill of each vertical. At the end of the program, based on various factors such as training performance, KPI completion (only employees with KPIs completed greater than 60% are considered) etc., employee gets promotion

For above mentioned process, the final promotions are only announced after the evaluation and this leads to delay in transition to their new roles. Hence, company needs help to identifying the eligible candidates at a particular checkpoint so that they can expedite the entire promotion cycle.

They have provided multiple attributes around Employee's past and current performance along with demographics. Now, The task is to predict whether a potential promotee at checkpoint in the test set will be promoted or not after the evaluation process.

This dataset contains 'employee_id', 'department', 'region', 'education', 'gender', 'recruitment_channel', 'no_of_trainings', 'age', 'previous_year_rating', 'length_of_service', 'KPIs_met >80%', 'awards_won?', 'avg_training_score', 'is_promoted'

The dataset has 14 features, 54808 observations.

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

[2]:
```
train = pd.read_csv("train_LZdllcl.csv")
test = pd.read_csv("test_2umaH9m.csv")
```

[3]:
```
train.head(3)
```

[3]:
```
   employee_id         department     region         education gender  \
0        65438  Sales & Marketing   region_7  Master's & above      f
1        65141         Operations  region_22        Bachelor's      m
2         7513  Sales & Marketing  region_19        Bachelor's      m

  recruitment_channel  no_of_trainings  age  previous_year_rating  \
0            sourcing                1   35                   5.0
```

```
1               other                1   30                   5.0
2            sourcing                1   34                   3.0

   length_of_service  KPIs_met >80%  awards_won?  avg_training_score  \
0                  8              1            0                  49
1                  4              0            0                  60
2                  7              0            0                  50

   is_promoted
0            0
1            0
2            0
```

[4]:

```
test.head(3)
```

[4]:

```
   employee_id         department     region   education gender  \
0         8724         Technology  region_26  Bachelor's      m
1        74430                 HR   region_4  Bachelor's      f
2        72255  Sales & Marketing  region_13  Bachelor's      m

  recruitment_channel  no_of_trainings  age  previous_year_rating  \
0            sourcing                1   24                   NaN
1               other                1   31                   3.0
2               other                1   31                   1.0

   length_of_service  KPIs_met >80%  awards_won?  avg_training_score
0                  1              1            0                  77
1                  5              0            0                  51
2                  4              0            0                  47
```

[5]:

```
train.shape
```

[5]:

```
(54808, 14)
```

[6]:

```
test.shape
```

[6]:

```
(23490, 13)
```

[7]:

```
train.describe()
```

[7]:

```
        employee_id  no_of_trainings           age  previous_year_rating  \
count  54808.000000     54808.000000  54808.000000          50684.000000
mean   39195.830627         1.253011     34.803915              3.329256
std    22586.581449         0.609264      7.660169              1.259993
min        1.000000         1.000000     20.000000              1.000000
25%    19669.750000         1.000000     29.000000              3.000000
50%    39225.500000         1.000000     33.000000              3.000000
```

```
75%    58730.500000         1.000000     39.000000              4.000000
max    78298.000000        10.000000     60.000000              5.000000

       length_of_service  KPIs_met >80%   awards_won?  avg_training_score  \
count       54808.000000   54808.000000  54808.000000        54808.000000
mean            5.865512       0.351974      0.023172           63.386750
std             4.265094       0.477590      0.150450           13.371559
min             1.000000       0.000000      0.000000           39.000000
25%             3.000000       0.000000      0.000000           51.000000
50%             5.000000       0.000000      0.000000           60.000000
75%             7.000000       1.000000      0.000000           76.000000
max            37.000000       1.000000      1.000000           99.000000

        is_promoted
count  54808.000000
mean       0.085170
std        0.279137
min        0.000000
25%        0.000000
50%        0.000000
75%        0.000000
max        1.000000
```

[8]:
```
test.describe()
```

[8]:
```
        employee_id  no_of_trainings           age  previous_year_rating  \
count  23490.000000     23490.000000  23490.000000          21678.000000
mean   39041.399149         1.254236     34.782929              3.339146
std    22640.809201         0.600910      7.679492              1.263294
min        3.000000         1.000000     20.000000              1.000000
25%    19370.250000         1.000000     29.000000              3.000000
50%    38963.500000         1.000000     33.000000              3.000000
75%    58690.000000         1.000000     39.000000              4.000000
max    78295.000000         9.000000     60.000000              5.000000

       length_of_service  KPIs_met >80%   awards_won?  avg_training_score
count       23490.000000   23490.000000  23490.000000        23490.000000
mean            5.810387       0.358834      0.022776           63.263133
std             4.207917       0.479668      0.149191           13.411750
min             1.000000       0.000000      0.000000           39.000000
25%             3.000000       0.000000      0.000000           51.000000
50%             5.000000       0.000000      0.000000           60.000000
75%             7.000000       1.000000      0.000000           76.000000
max            34.000000       1.000000      1.000000           99.000000
```

[9]:
```
train.isnull().sum()
```

[9]:
```
employee_id                0
department                 0
region                     0
education               2409
gender                     0
recruitment_channel        0
no_of_trainings            0
age                        0
previous_year_rating    4124
length_of_service          0
KPIs_met >80%              0
awards_won?                0
avg_training_score         0
is_promoted                0
dtype: int64
```

[10]:
```
test.isnull().sum()
```

[10]:
```
employee_id                0
department                 0
region                     0
education               1034
gender                     0
recruitment_channel        0
no_of_trainings            0
age                        0
previous_year_rating    1812
length_of_service          0
KPIs_met >80%              0
awards_won?                0
avg_training_score         0
dtype: int64
```

[11]:
```
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 54808 entries, 0 to 54807
Data columns (total 14 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   employee_id           54808 non-null  int64
 1   department            54808 non-null  object
 2   region                54808 non-null  object
 3   education             52399 non-null  object
 4   gender                54808 non-null  object
 5   recruitment_channel   54808 non-null  object
 6   no_of_trainings       54808 non-null  int64
 7   age                   54808 non-null  int64
 8   previous_year_rating  50684 non-null  float64
 9   length_of_service     54808 non-null  int64
 10  KPIs_met >80%         54808 non-null  int64
 11  awards_won?           54808 non-null  int64
 12  avg_training_score    54808 non-null  int64
 13  is_promoted           54808 non-null  int64
dtypes: float64(1), int64(8), object(5)
memory usage: 5.9+ MB
```

[12]:
```
train.education.value_counts()
```

[12]:
```
Bachelor's          36669
Master's & above    14925
Below Secondary       805
Name: education, dtype: int64
```

[14]:
```
train['education'].fillna("Bachelor's", inplace=True)
test['education'].fillna("Bachelor's", inplace=True)
```

[15]:
```
train['previous_year_rating'].skew()
```

[15]:
```
-0.3106378431385327
```

[16]:
```
train['previous_year_rating'].value_counts()
```

[16]:
```
3.0    18618
5.0    11741
4.0     9877
1.0     6223
2.0     4225
Name: previous_year_rating, dtype: int64
```

[17]:
```
train['previous_year_rating'].fillna(train['previous_year_rating'].median(),␣
 ↪inplace=True)
test['previous_year_rating'].fillna(test['previous_year_rating'].median(),␣
 ↪inplace=True)
```

[18]:
```
train.isnull().sum()
```

[18]:
```
employee_id             0
department              0
region                  0
education               0
gender                  0
recruitment_channel     0
no_of_trainings         0
```

```
age                    0
previous_year_rating   0
length_of_service      0
KPIs_met >80%          0
awards_won?            0
avg_training_score     0
is_promoted            0
dtype: int64
```

[19]:

```
test.isnull().sum()
```

[19]:

```
employee_id            0
department             0
region                 0
education              0
gender                 0
recruitment_channel    0
no_of_trainings        0
age                    0
previous_year_rating   0
length_of_service      0
KPIs_met >80%          0
awards_won?            0
avg_training_score     0
dtype: int64
```

[20]:

```
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 54808 entries, 0 to 54807
Data columns (total 14 columns):
 #   Column                Non-Null Count  Dtype
---  ------                --------------  -----
 0   employee_id           54808 non-null  int64
 1   department            54808 non-null  object
 2   region                54808 non-null  object
 3   education             54808 non-null  object
 4   gender                54808 non-null  object
 5   recruitment_channel   54808 non-null  object
 6   no_of_trainings       54808 non-null  int64
 7   age                   54808 non-null  int64
 8   previous_year_rating  54808 non-null  float64
 9   length_of_service     54808 non-null  int64
 10  KPIs_met >80%         54808 non-null  int64
 11  awards_won?           54808 non-null  int64
 12  avg_training_score    54808 non-null  int64
 13  is_promoted           54808 non-null  int64
```

```
dtypes: float64(1), int64(8), object(5)
memory usage: 5.9+ MB
```

```
[21]: from sklearn import preprocessing
      le = preprocessing.LabelEncoder()
```

```
[22]: train['department'] = le.fit_transform(train['department'])
      test['department'] = le.fit_transform(test['department'])
      train['gender'] = le.fit_transform(train['gender'])
      test['gender'] = le.fit_transform(test['gender'])
      train['education'] = le.fit_transform(train['education'])
      test['education'] = le.fit_transform(test['education'])
      train['recruitment_channel'] = le.fit_transform(train['recruitment_channel'])
      test['recruitment_channel'] = le.fit_transform(test['recruitment_channel'])
```

```
[23]: train.drop(labels='employee_id',axis=1,inplace=True)
      train.drop(labels='region',axis=1,inplace=True)
      test.drop(labels='region',axis=1,inplace=True)
```

```
[24]: train.head(3)
```

```
[24]:    department  education  gender  recruitment_channel  no_of_trainings  age  \
      0           7          2       0                    2                1   35
      1           4          0       1                    0                1   30
      2           7          0       1                    2                1   34

         previous_year_rating  length_of_service  KPIs_met >80%  awards_won?  \
      0                   5.0                  8              1            0
      1                   5.0                  4              0            0
      2                   3.0                  7              0            0

         avg_training_score  is_promoted
      0                  49            0
      1                  60            0
      2                  50            0
```

```
[25]: train.columns
```

```
[25]: Index(['department', 'education', 'gender', 'recruitment_channel',
             'no_of_trainings', 'age', 'previous_year_rating', 'length_of_service',
             'KPIs_met >80%', 'awards_won?', 'avg_training_score', 'is_promoted'],
            dtype='object')
```

```
[26]: rel_feat =['department', 'education', 'gender', 'recruitment_channel',
             'no_of_trainings', 'age', 'previous_year_rating', 'length_of_service',
             'KPIs_met >80%', 'awards_won?', 'avg_training_score']
```

[27]:

```
rel_feat_corr = train.corr()['is_promoted'][['department', 'education',␣
 ↪'gender', 'recruitment_channel',
       'no_of_trainings', 'age', 'previous_year_rating', 'length_of_service',
       'KPIs_met >80%', 'awards_won?', 'avg_training_score']]
```

[28]:

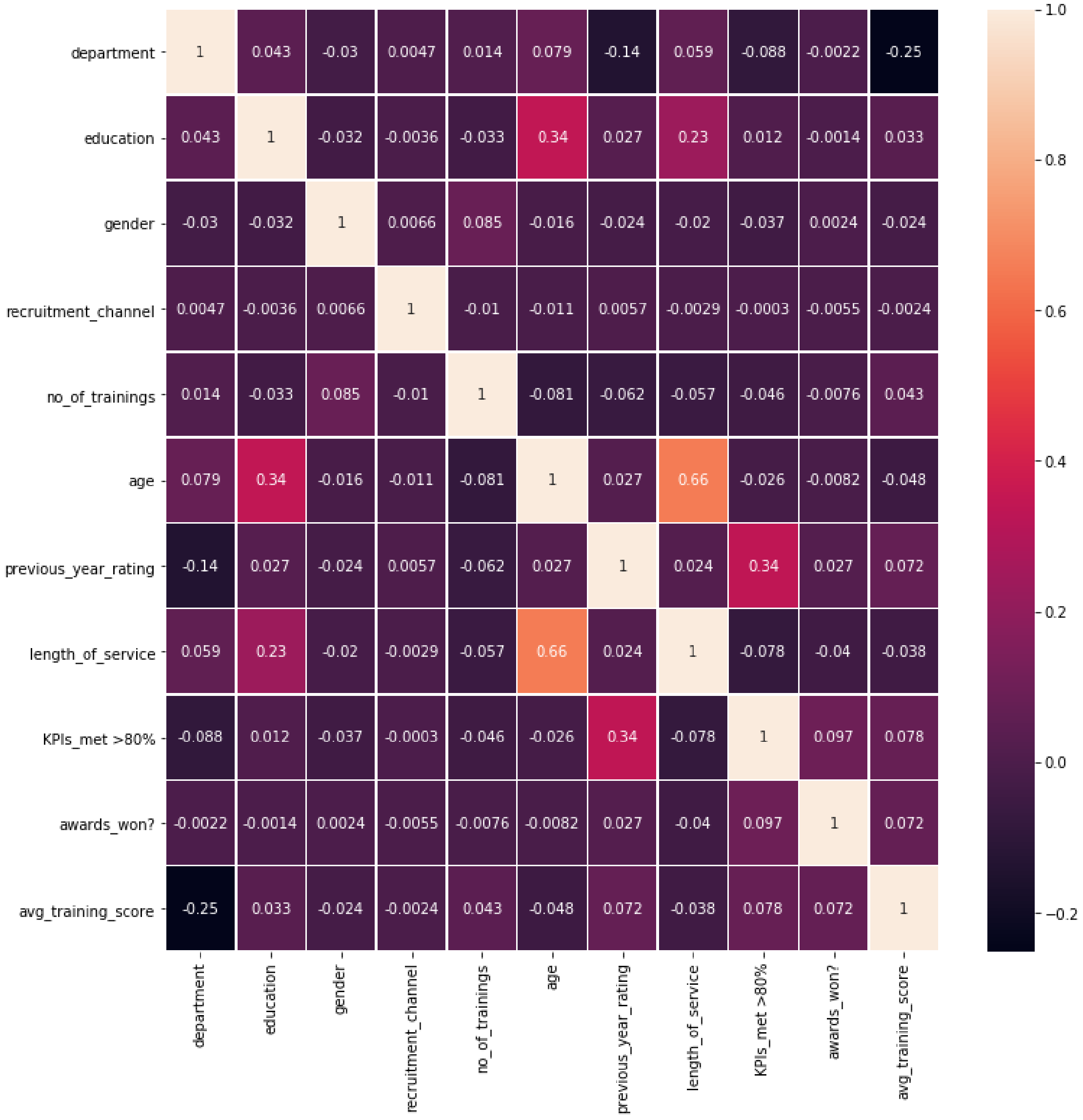
```
rel_feat_corr
```

[28]:

```
department              0.000130
education               0.029257
gender                 -0.011109
recruitment_channel     0.002229
no_of_trainings        -0.024896
age                    -0.017166
previous_year_rating    0.153230
length_of_service      -0.010670
KPIs_met >80%           0.221582
awards_won?             0.195871
avg_training_score      0.181147
Name: is_promoted, dtype: float64
```

[30]:

```
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
plt.figure(figsize = (12,12))
sns.heatmap(train[rel_feat].corr(),annot = True, linewidths = 0.5);
```



[31]:
```
X= train[rel_feat]
y= train['is_promoted']
```

[32]:
```
from imblearn.over_sampling import SMOTE
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 1,␣
 ↪stratify=y)
```

[33]:
```
y_train.value_counts()
```

[33]:
```
0    37605
1     3501
```

```
Name: is_promoted, dtype: int64
```

[34]:

```
smt = SMOTE()
X_train, y_train = smt.fit_sample(X_train, y_train)
np.bincount(y_train)
```

[34]:

```
array([37605, 37605], dtype=int64)
```

2 Random Forest

[35]:

```
#Import Random Forest Model
from sklearn.ensemble import RandomForestClassifier
from sklearn.feature_selection import SelectFromModel

parameters = {'bootstrap': False,
              'min_samples_leaf': 3,
              'n_estimators':500,
              'min_samples_split': 10,
              'max_features': 'sqrt',
              'max_depth': 10,
             }

#Create a random forest classifier, 100 trees
clf_rf=RandomForestClassifier(**parameters)

#Train the model using the training sets
clf_rf.fit(X_train,y_train)

rf_pred=clf_rf.predict(X_test).astype(int)
```

[36]:

```
from sklearn.metrics import classification_report, confusion_matrix,␣
 ↪accuracy_score,recall_score

print(confusion_matrix(y_test,rf_pred))
print(classification_report(y_test,rf_pred))
print("Accuracy:",accuracy_score(y_test, rf_pred))
```

```
[[9990 2545]
 [ 360  807]]
              precision    recall  f1-score   support

           0       0.97      0.80      0.87     12535
           1       0.24      0.69      0.36      1167

    accuracy                           0.79     13702
   macro avg       0.60      0.74      0.62     13702
```

```
weighted avg       0.90      0.79      0.83     13702

Accuracy: 0.7879871551598306
```

[37]:
```
recall_score(y_test, rf_pred)
```

[37]:
```
0.6915167095115681
```

[38]:
```
rf_pred = clf_rf.predict(test[rel_feat]).astype(int)
sub = pd.DataFrame()
sub['employee_id'] = test['employee_id']
sub['is_promoted'] = rf_pred
sub[['employee_id','is_promoted']].to_csv('submission_rf.csv',index=False)
```

[39]:
```
sub.head()
```

[39]:
```
   employee_id  is_promoted
0         8724            1
1        74430            0
2        72255            0
3        38562            0
4        64486            0
```

[40]:
```
sub.shape
```

[40]:
```
(23490, 2)
```

[41]:
```
sub.is_promoted.value_counts()
```

[41]:
```
0    17774
1     5716
Name: is_promoted, dtype: int64
```

3 XGBoost

[42]:
```
from xgboost import plot_importance
```

[43]:
```
# XGB Classifier
from xgboost import XGBClassifier

clf_xgb = XGBClassifier(n_estimators=200,
 max_depth=10,
 min_child_weight=5,
 gamma=0,
 subsample=0.5,
 #colsample_bytree=0.3,
 objective= 'binary:logistic',
 nthread=5,
 scale_pos_weight=13,
 reg_lambda=5,
 alpha=5,
 base_score=0.15,
 #seed=1029,
 random_state=45)

clf_xgb.fit(X_train, y_train)
```

```
[43]: XGBClassifier(alpha=5, base_score=0.15, booster='gbtree', colsample_bylevel=1,
                    colsample_bynode=1, colsample_bytree=1, gamma=0,
                    learning_rate=0.1, max_delta_step=0, max_depth=10,
                    min_child_weight=5, missing=None, n_estimators=200, n_jobs=1,
                    nthread=5, objective='binary:logistic', random_state=45,
                    reg_alpha=0, reg_lambda=5, scale_pos_weight=13, seed=None,
                    silent=None, subsample=0.5, verbosity=1)
```

```
[44]: # Predicting the Test set results
      xg_pred = clf_xgb.predict(X_test).astype(int)
```

```
[45]: # evaluate predictions
      print(confusion_matrix(y_test,xg_pred))
      print(classification_report(y_test,xg_pred))
      print("Accuracy:",accuracy_score(y_test, xg_pred))
```

```
[[9484 3051]
 [ 222  945]]
              precision    recall  f1-score   support

           0       0.98      0.76      0.85     12535
           1       0.24      0.81      0.37      1167

    accuracy                           0.76     13702
   macro avg       0.61      0.78      0.61     13702
weighted avg       0.91      0.76      0.81     13702

Accuracy: 0.7611297620785287
```

```
[46]: recall_score(y_test, xg_pred)
```

```
[46]: 0.8097686375321337
```

```
[47]: xgb_pred = clf_xgb.predict(test[rel_feat]).astype(int)
      sub = pd.DataFrame()
      sub['employee_id'] = test['employee_id']
      sub['is_promoted'] = xgb_pred
```

```
sub[['employee_id','is_promoted']].to_csv('submission_xgb.csv',index=False)
```

```
[48]: sub.is_promoted.value_counts()
```

```
[48]: 0    16706
      1     6784
      Name: is_promoted, dtype: int64
```

4 GBM

```
[49]: from sklearn import ensemble
      gbm = ensemble.GradientBoostingClassifier(n_estimators = 500, max_depth = 10,␣
       ↪min_samples_split = 10, learning_rate = 0.1)
      gbm.fit(X_train,y_train)
```

```
[49]: GradientBoostingClassifier(ccp_alpha=0.0, criterion='friedman_mse', init=None,
                                 learning_rate=0.1, loss='deviance', max_depth=10,
                                 max_features=None, max_leaf_nodes=None,
                                 min_impurity_decrease=0.0, min_impurity_split=None,
                                 min_samples_leaf=1, min_samples_split=10,
                                 min_weight_fraction_leaf=0.0, n_estimators=500,
                                 n_iter_no_change=None, presort='deprecated',
                                 random_state=None, subsample=1.0, tol=0.0001,
                                 validation_fraction=0.1, verbose=0,
                                 warm_start=False)
```

```
[50]: gbm_pred = gbm.predict(X_test)
```

```
[51]: # evaluate predictions
      print(confusion_matrix(y_test,gbm_pred))
      print(classification_report(y_test,gbm_pred))
      print("Accuracy:",accuracy_score(y_test, gbm_pred))
```

```
[[11919   616]
 [  667   500]]
              precision    recall  f1-score   support

           0       0.95      0.95      0.95     12535
           1       0.45      0.43      0.44      1167

    accuracy                           0.91     13702
   macro avg       0.70      0.69      0.69     13702
weighted avg       0.90      0.91      0.91     13702

Accuracy: 0.9063640344475259
```

[52]:

```
recall_score(y_test, gbm_pred)
```

[52]:

```
0.4284490145672665
```

[53]:

```
gbm_pred = gbm.predict(test[rel_feat]).astype(int)
sub = pd.DataFrame()
sub['employee_id'] = test['employee_id']
sub['is_promoted'] = gbm_pred
sub[['employee_id','is_promoted']].to_csv('submission_gbm.csv',index=False)
```

[54]:

```
sub.is_promoted.value_counts()
```

[54]:

```
0    21514
1     1976
Name: is_promoted, dtype: int64
```