In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:
```
import io
%cd '/Users/rajeshprabhakar/Desktop/Hackathon/HR Analytics'
```

```
/Users/rajeshprabhakar/Desktop/Hackathon/HR Analytics
```

In [3]:
```
hrtrain=pd.read_csv('train_LZdllcl.csv')
```

In [4]:
```
hrtest=pd.read_csv('test_2umaH9m.csv')
```

In [5]:
```
hrtrain.isnull().sum().sort_values(ascending=False)
```

Out[5]:
```
previous_year_rating    4124
education               2409
employee_id                0
department                 0
region                     0
gender                     0
recruitment_channel        0
no_of_trainings            0
age                        0
length_of_service          0
KPIs_met >80%              0
awards_won?                0
avg_training_score         0
is_promoted                0
dtype: int64
```

In [6]:
```
hrtest.isnull().sum().sort_values(ascending=False)
```

Out[6]:
```
previous_year_rating    1812
education               1034
employee_id                0
department                 0
region                     0
gender                     0
recruitment_channel        0
no_of_trainings            0
age                        0
length_of_service          0
KPIs_met >80%              0
awards_won?                0
avg_training_score         0
dtype: int64
```

In [7]:
```
# Dependent Variable - is_promoted (0/1)(No/Yes)
hrtrain.is_promoted.value_counts()
```

Out[7]:
```
0    50140
1     4668
Name: is_promoted, dtype: int64
```

In [8]:
```
# How many Male/Female Promoted?
```

```
pd.crosstab(hrtrain.is_promoted,hrtrain.gender)
```

Out[8]:

gender	f	m
is_promoted		
0	14845	35295
1	1467	3201

In [9]:
```
# Hypothesis Testing
# Type 1 Error - Finding Criminal Not Guilty - Accepting a False
# Hypothesis. Patient has No Covid but RTPCR Test gave Positive
# Type 2 Error - Hanging an innocent Man - Rejecting a True
# Hypothesis. Patient has Covid but RTPCR Test gave Negative
```

In [12]:
```
hrtrain.previous_year_rating.value_counts(dropna=False)
```

Out[12]:
```
3.0    22742
5.0    11741
4.0     9877
1.0     6223
2.0     4225
Name: previous_year_rating, dtype: int64
```

In [11]:
```
hrtrain.previous_year_rating=hrtrain.previous_year_rating.fillna(3.0)
```

In [15]:
```
hrtest.previous_year_rating.value_counts(dropna=False)
```

Out[15]:
```
3.0    9733
5.0    5097
4.0    4249
1.0    2680
2.0    1731
Name: previous_year_rating, dtype: int64
```

In [14]:
```
hrtest.previous_year_rating=hrtest.previous_year_rating.fillna(3.0)
```

In [19]:
```
hrtrain.education.value_counts(dropna=False)
```

Out[19]:
```
Bachelor's          39078
Master's & above    14925
Below Secondary       805
Name: education, dtype: int64
```

In [18]:
```
hrtrain.education=hrtrain.education.fillna("Bachelor's")
```

In [20]:
```
hrtest.education=hrtest.education.fillna("Bachelor's")
```

In [22]:
```
hrtrain.columns
```

Out[22]:
```
Index(['employee_id', 'department', 'region', 'education', 'gender',
       'recruitment_channel', 'no_of_trainings', 'age', 'previous_year_ratin
g',
       'length_of_service', 'KPIs_met >80%', 'awards_won?',
```

```
       'avg_training_score', 'is_promoted'],
      dtype='object')
```

In [23]:
```
# Test Null Average avg_training_score of is_promoted(0/1) Equal
# groupby(), Null & Alt, Split Dataframe, Conduct test & Interpret
hrtrain.avg_training_score.groupby(hrtrain.is_promoted).mean()
```

Out[23]:
```
is_promoted
0    62.647686
1    71.325193
Name: avg_training_score, dtype: float64
```

In [30]:
```
hrtrain.avg_training_score.groupby(hrtrain.is_promoted).var()
```

Out[30]:
```
is_promoted
0    168.791268
1    217.448116
Name: avg_training_score, dtype: float64
```

In [24]:
```
promotedyes=hrtrain[hrtrain.is_promoted==1]
promotedno=hrtrain[hrtrain.is_promoted==0]
```

In [25]:
```
# Null - No Significant difference in Average avg_training_score of
# is_promoted(0/1) equal.
# Alt - Significant difference in Average avg_training_score of
# is_promoted(0/1) equal.
```

In [26]:
```
from scipy.stats import ttest_ind
```

In [29]:
```
ttest_ind(promotedyes.avg_training_score,
          promotedno.avg_training_score,equal_var=False)
# Since pvalue=7.662329172468838e-291 is less than 0.05,Reject
# Null Hypothesis
```

Out[29]:
```
Ttest_indResult(statistic=38.82675007357188, pvalue=7.662329172468838e-291)
```

In [31]:
```
# Test Null Average avg_training_score of Female & Male Equal
# groupby(), Null & Alt, Split Dataframe, Conduct test & Interpret
hrtrain.avg_training_score.groupby(hrtrain.gender).mean()
```

Out[31]:
```
gender
f    63.889897
m    63.173550
Name: avg_training_score, dtype: float64
```

In [32]:
```
male=hrtrain[hrtrain.gender=='m']
female=hrtrain[hrtrain.gender=='f']
```

In [33]:
```
ttest_ind(male.avg_training_score,female.avg_training_score,
        equal_var=False)
```

Out[33]:
```
Ttest_indResult(statistic=-6.122262326710493, pvalue=9.321257169457923e-10)
```

In [34]:
```
# ttest=t statistic=(Mean1-Mean2)/sqrt((var1/n1)+(var2/n2))
```

In [35]:
```
# Test Null avg_training_score of different education levels equal
# groupby(), Null & Alt, Split Dataframe, Conduct test & Interpret
```

In [36]:
```
hrtrain.avg_training_score.groupby(hrtrain.education).mean()
```

Out[36]:
```
education
Bachelor's          63.097446
Below Secondary     64.925466
Master's & above    64.061240
Name: avg_training_score, dtype: float64
```

In [37]:
```
ug=hrtrain[hrtrain.education=="Bachelor's"]
pg=hrtrain[hrtrain.education=="Master's & above"]
bs=hrtrain[hrtrain.education=="Below Secondary"]
```

In [38]:
```
from scipy.stats import f_oneway
```

In [39]:
```
f_oneway(ug.avg_training_score,pg.avg_training_score,
        bs.avg_training_score)
```

Out[39]:
```
F_onewayResult(statistic=33.5035375621275, pvalue=2.873996658407989e-15)
```

In [40]:
```
# Test Null No Association between gender & is_promoted?
# Both Categorical Variables
# Cross tabulation is input
```

In [41]:
```
pd.crosstab(hrtrain.is_promoted,hrtrain.gender)
```

Out[41]:

gender	f	m
is_promoted		
0	14845	35295
1	1467	3201

In [42]:
```
from scipy.stats import chi2_contingency
```

In [43]:
```
chi2_contingency(pd.crosstab(hrtrain.is_promoted,
                             hrtrain.gender))
# Since p-value=0.00976509 is less than 0.05, Reject null
```

Out[43]:
```
(6.677254566546107,
 0.009765091521176657,
 1,
 array([[14922.70617428, 35217.29382572],
        [ 1389.29382572,  3278.70617428]]))
```

In [44]:
```
# MACHINE LEARNING - SUPERVISED LEARNING - CLASSIFICATION MODELS
# IF DEPENDENT VARIABLE(y) IS NON NUMERIC AND CATEGORICAL AND
# BINARY(YES/NO), THEN BINARY LOGISTIC REGRESSION IS USED.
# IF THERE ARE MORE THAN 2 LEVELS THEN MULTINOMIAL LOGISTIC
```

```
# REGRESSION IS USED.
# BINARY LOGISTIC REGRESSION -
#        EXP^(B0+B1X1+B2X2+B3X3+B4X4+..BnXn)
# P = ---------------------------------------------
#       1 + EXP^(B0+B1X1+B2X2+B3X3+B4X4+..BnXn)
# p - Probability lies between 0 & 1
# EXP - Exponential - 2.718
# B0 - Intercept or Constant
# B1,B2,B3,B4,..Bn - Coefficients
# X1,X2,X3,X4,...Xn - Independent variables
# Equation predicts predicted probability
# Classification Rule for all Classification Models
# probability greater than equal to 0.50 ---- 1 (yes)
# probability less than 0.50 ------ 0  (no)

# Assumptions
# Dependent Variable(y) must be Binary.(yes/no)
# Independent Variables can be both numerical and categorical.
# No Multicollinearity(strong correlation >0.95)
# Exogeneity
# Sample Size is minimum 50 observations per variable

# Interpreatation of Output
# Accuracy calculated from Confusion Matrix
# intercept + Coefficients

# Confusion Matrix is a 2 X 2 matrix of Actual Class & Predicted
# class. Cross Tabulation of y and predicted y
# Actual Class is positive & Predicted class is Positive  -
# True Positive (TP)
# Actual Class is Positive but Predicted class is Negative -
# False Negative (Type II Error) (FN)
# Actual Class is Negative but Predicted class is Positive -
# False Positive (Type I Error) (FP)
# Actual Class is Negative & Predicted Class is Negative-
# True Negative (TN)

# Primary metric for all Classification Models is
#                      True positive + True negative
# Accuracy = ---------------------------------------------------
#            True positive+FalseNegative+FalsePositive+TrueNegative
# Accuracy must be between 0.70 - 0.90

#                               True Positive
# Sensitivity or Recall = -----------------------------
#                           True Positive + False Negative
# Sensitivity must be higher closer to 1
# Sensitivity is also called as True Positive Rate (TPR)

#                 True Negative
# Specificty = -----------------------------
#                True Negative + False Positive
# Specificity is als called as True Negative Rate
# Specificity must be higher closer to 1.

#                  True positive
# Precision = ----------------------------
#                True Positive + False Positive
# Precision must be higher closer to 1

#                Precision X Recall
# F1 Score = 2 X -------------------
#                Precision + Recall
```

In [46]:
```
hrtrain.columns
```

Out[46]:
```
Index(['employee_id', 'department', 'region', 'education', 'gender',
       'recruitment_channel', 'no_of_trainings', 'age', 'previous_year_ratin
g',
       'length_of_service', 'KPIs_met >80%', 'awards_won?',
       'avg_training_score', 'is_promoted'],
      dtype='object')
```

In [47]:
```
objectcolumns=hrtrain[['department', 'region', 'education', 'gender',
       'recruitment_channel','previous_year_rating',
                      'KPIs_met >80%', 'awards_won?','is_promoted']]
```

In [48]:
```
numericcolumns=hrtrain[['no_of_trainings', 'age',
                        'avg_training_score']]
```

In [49]:
```
from sklearn.preprocessing import LabelEncoder
```

In [50]:
```
le=LabelEncoder()
```

In [51]:
```
objectcolumnsdummy=objectcolumns.apply(le.fit_transform)
```

In [52]:
```
hrtraindf=pd.concat([numericcolumns,objectcolumnsdummy],axis=1)
```

In [53]:
```
y=hrtraindf.is_promoted
X=hrtraindf.drop('is_promoted',axis=1)
```

In [54]:
```
from sklearn.linear_model import LogisticRegression
```

In [57]:
```
logreg=LogisticRegression(max_iter=2000)
# Convergence Warning means Not All Coefficients are Calculated
```

In [58]:
```
logregmodel=logreg.fit(X,y)
```

In [59]:
```
logregmodel.score(X,y) # Accuracy from Confusion Matrix
```

Out[59]:
```
0.9172018683403883
```

In [60]:
```
logitpredict=logregmodel.predict(X)
```

In [61]:
```
pd.crosstab(y,logitpredict)
```

Out[61]:

col_0	0	1
is_promoted		
0	49942	198

col_0	0	1
is_promoted		
1	4340	328

In [62]:
```
(49942+328)/(49942+198+4340+328) # Accuracy = 91.72%
```

Out[62]:
```
0.9172018683403883
```

In [63]:
```
logregmodel.intercept_
```

Out[63]:
```
array([-6.97681531])
```

In [70]:
```
pd.DataFrame(logregmodel.coef_,columns=X.columns).transpose()
```

Out[70]:

	0
no_of_trainings	-0.185060
age	-0.011947
avg_training_score	0.046200
department	0.082881
region	0.002446
education	0.103925
gender	0.010243
recruitment_channel	0.008747
previous_year_rating	0.340080
KPIs_met >80%	1.271397
awards_won?	1.879833

In [71]:
```
from sklearn.metrics import classification_report
```

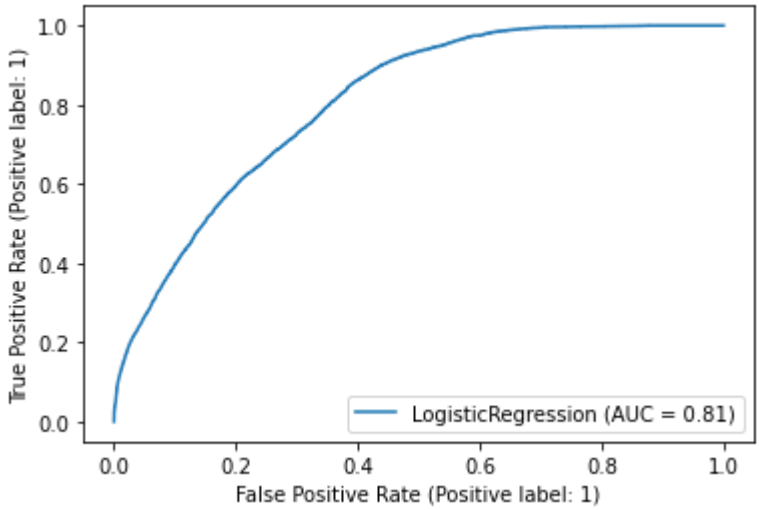
In [72]:
```
print(classification_report(y,logitpredict))
```

```
              precision    recall  f1-score   support

           0       0.92      1.00      0.96     50140
           1       0.62      0.07      0.13      4668

    accuracy                           0.92     54808
   macro avg       0.77      0.53      0.54     54808
weighted avg       0.89      0.92      0.89     54808
```

In [73]:
```
from sklearn.metrics import plot_roc_curve
```

In [74]:
```
plot_roc_curve(logreg,X,y)
# Area Under ROC Curve (AUC) = 0.81 or 81%
```

Out[74]: <sklearn.metrics._plot.roc_curve.RocCurveDisplay at 0x7f934056d880>



In [ ]: