In [1]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

In [3]:

```
path=r"C:\Users\jagad\Downloads\train_LZdllcl.csv"
df=pd.read_csv(path)
df
```

Out[3]:

	employee_id	department	region	education	gender	recruitment_channel	no_of_trainings
0	65438	Sales & Marketing	region_7	Master's & above	f	sourcing	1
1	65141	Operations	region_22	Bachelor's	m	other	1
2	7513	Sales & Marketing	region_19	Bachelor's	m	sourcing	1
3	2542	Sales & Marketing	region_23	Bachelor's	m	other	2
4	48945	Technology	region_26	Bachelor's	m	other	1
...	...	...	...	...	...	...	...
54803	3030	Technology	region_14	Bachelor's	m	sourcing	1
54804	74592	Operations	region_27	Master's & above	f	other	1
54805	13918	Analytics	region_1	Bachelor's	m	other	1
54806	13614	Sales & Marketing	region_9	NaN	m	sourcing	1
54807	51526	HR	region_22	Bachelor's	m	other	1

54808 rows × 14 columns

In [4]:

```
df.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
```

In [5]:

```
df.nunique()
```

Out[5]:

```
employee_id             54808
department                  9
region                     34
education                   3
gender                      2
recruitment_channel         3
no_of_trainings            10
age                        41
previous_year_rating        5
length_of_service          35
KPIs_met >80%               2
awards_won?                 2
avg_training_score         61
is_promoted                 2
dtype: int64
```

In [6]:

```
# dropping the ID column
df.drop('employee_id',axis=1,inplace=True)
df
```

Out[6]:

	department	region	education	gender	recruitment_channel	no_of_trainings	age	previous
0	Sales & Marketing	region_7	Master's & above	f	sourcing	1	35	
1	Operations	region_22	Bachelor's	m	other	1	30	
2	Sales & Marketing	region_19	Bachelor's	m	sourcing	1	34	
3	Sales & Marketing	region_23	Bachelor's	m	other	2	39	
4	Technology	region_26	Bachelor's	m	other	1	45	
...	...	...	...	...	...	...	...	
54803	Technology	region_14	Bachelor's	m	sourcing	1	48	
54804	Operations	region_27	Master's & above	f	other	1	37	
54805	Analytics	region_1	Bachelor's	m	other	1	27	
54806	Sales & Marketing	region_9	NaN	m	sourcing	1	29	
54807	HR	region_22	Bachelor's	m	other	1	27	

54808 rows × 13 columns

In [7]:

```
df.nunique()
```

Out[7]:

```
department               9
region                  34
education                3
gender                   2
recruitment_channel      3
no_of_trainings         10
age                     41
previous_year_rating     5
length_of_service       35
KPIs_met >80%            2
awards_won?              2
avg_training_score      61
is_promoted              2
dtype: int64
```

In [8]:

```
cat_cols=df.select_dtypes(include='object')
cat_cols.columns
```

Out[8]:

```
Index(['department', 'region', 'education', 'gender', 'recruitment_channel'], dtype
='object')
```

In [9]:

```
num_cols=df.select_dtypes(exclude='object')
num_cols.columns
```

Out[9]:

```
Index(['no_of_trainings', 'age', 'previous_year_rating', 'length_of_service',
       'KPIs_met >80%', 'awards_won?', 'avg_training_score', 'is_promoted'],
      dtype='object')
```

In [10]:

```
df.isnull().sum()
```

Out[10]:

```
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
```

In [11]:

```
df['education'].fillna(method='ffill',inplace=True)
median=df['previous_year_rating'].median()
print(median)
df['previous_year_rating'].fillna(median,inplace=True)
```

```
3.0
```

In [12]:

```
df.isnull().sum()
```

Out[12]:

```
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
```

In [13]:

```
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
for i in cat_cols:
    df[i]=le.fit_transform(df[i])
df
```

Out[13]:

	department	region	education	gender	recruitment_channel	no_of_trainings	age	previous_y
0	7	31	2	0	2	1	35	
1	4	14	0	1	0	1	30	
2	7	10	0	1	2	1	34	
3	7	15	0	1	0	2	39	
4	8	18	0	1	0	1	45	
...	...	...	...	...	...	...	...	
54803	8	5	0	1	2	1	48	
54804	4	19	2	0	0	1	37	
54805	0	0	0	1	0	1	27	
54806	7	33	0	1	2	1	29	
54807	2	14	0	1	0	1	27	

54808 rows × 13 columns

In [14]:

```
# Data is ready
# splitting into X and y
X=df.drop('is_promoted',axis=1)
y=df['is_promoted']
```

In [15]:

```
X.shape,y.shape
```

Out[15]:

```
((54808, 12), (54808,))
```

In [16]:

```
# train_test_split
from sklearn.model_selection import train_test_split
X_train,X_test,y_train,y_test=train_test_split(X,y,random_state=42,test_size=0.2)
```

In [17]:

```
X_train.shape,y_train.shape
```

Out[17]:

```
((43846, 12), (43846,))
```

In [18]:

```
# Model Development with HyperParameter tuning Decision Tree
#metrics
from sklearn.metrics import accuracy_score,r2_score,\
                            precision_score,recall_score,\
                            f1_score,classification_report,\
                            roc_auc_score,roc_curve,auc
from sklearn.metrics import confusion_matrix,ConfusionMatrixDisplay

from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import GridSearchCV,cross_val_score
grid_tree=DecisionTreeClassifier() # base model
grid_tree
```

Out[18]:

```
▾ DecisionTreeClassifier
DecisionTreeClassifier()
```

In [19]:

```
grid_tree.get_params()
```

Out[19]:

```
{'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': None,
 'max_leaf_nodes': None,
 'min_impurity_decrease': 0.0,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'random_state': None,
 'splitter': 'best'}
```

In [20]:

```
# creating a dictionary of hyper_parameters
param_grid={'criterion':['gini','entropy'], #2
            'max_depth':[3,4,5,6,7,8],      #6
            'min_samples_split':[2,3,4],    #3
            'min_samples_leaf':[1,2,3,4],   #4
            'random_state':[0,42,1234] }         #3

param_grid
```

Out[20]:

```
{'criterion': ['gini', 'entropy'],
 'max_depth': [3, 4, 5, 6, 7, 8],
 'min_samples_split': [2, 3, 4],
 'min_samples_leaf': [1, 2, 3, 4],
 'random_state': [0, 42, 1234]}
```

In [21]:

```
# now these parameters we apply in decision tree
# base model and params are ready now we apply GridSearchCV

grid_search= GridSearchCV(grid_tree,          #base model
                         param_grid,          # parameters
                         scoring='accuracy',  # metrics
                         cv=5,
                         verbose=True)
grid_search
```

Out[21]:

```
▸             GridSearchCV
▸ estimator: DecisionTreeClassifier
      ▸ DecisionTreeClassifier
```

In [22]:

```
import time
start=time.time()
grid_search.fit(X_train,y_train)  # in dt without hyper parameters we fit directly in
end=time.time()
print('Total time taken is : ', end-start)
```

```
Fitting 5 folds for each of 432 candidates, totalling 2160 fits
Total time taken is :  194.02883791923523
```

In [23]:
```
grid_search.best_estimator_
```

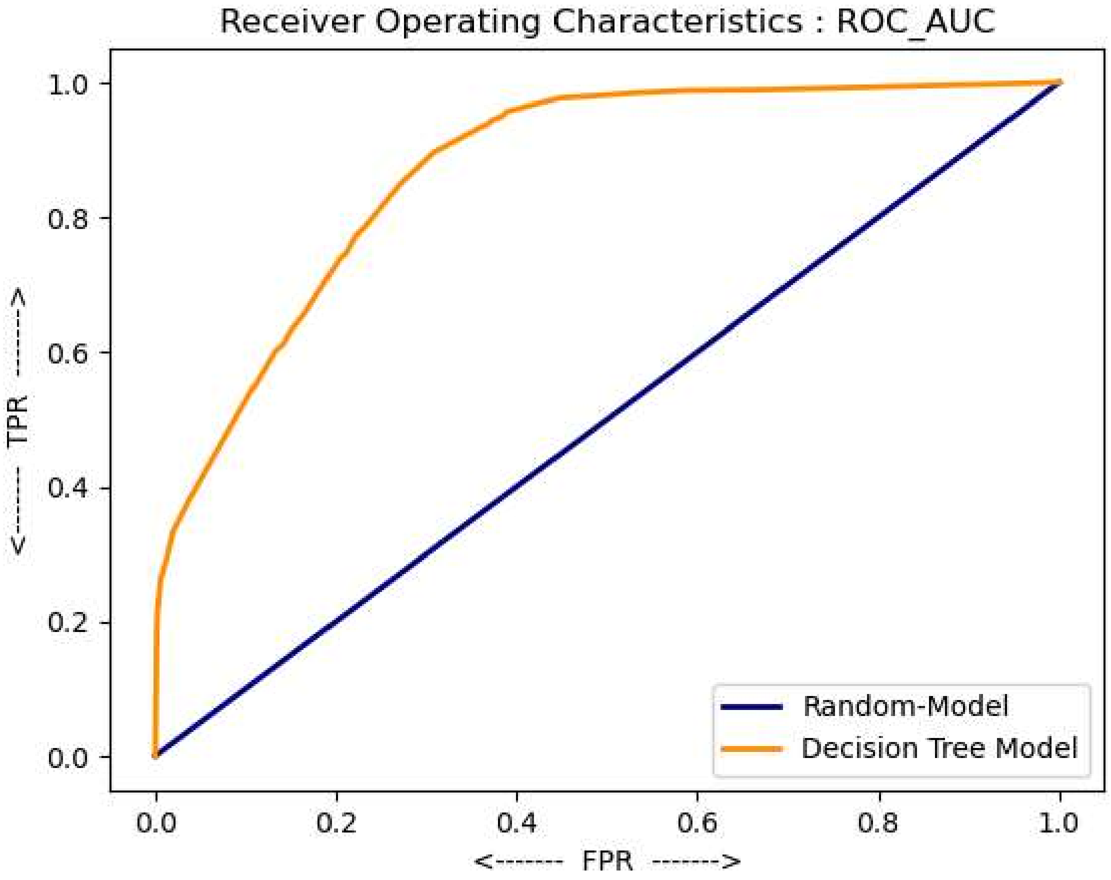
Out[23]:
```
▾                     DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy', max_depth=8, min_samples_leaf=2,
                       random_state=0)
```

In [24]:
```
grid_search.best_params_
```

Out[24]:
```
{'criterion': 'entropy',
 'max_depth': 8,
 'min_samples_leaf': 2,
 'min_samples_split': 2,
 'random_state': 0}
```

In [25]:
```
from sklearn.tree import DecisionTreeClassifier
dtree=DecisionTreeClassifier(criterion='entropy',max_depth=8,min_samples_leaf=2,min_sa
dtree.fit(X_train,y_train)

# model prediction
y_pred_dt=dtree.predict(X_test)
y_pred_dt

#metrics
from sklearn.metrics import accuracy_score,r2_score,\
                            precision_score,recall_score,\
                            f1_score,classification_report,\
                            roc_auc_score,roc_curve,auc,\
                            confusion_matrix,ConfusionMatrixDisplay

# confusion_matrix
cmt_dt = confusion_matrix(y_test,y_pred_dt)

# making confusion matrix as flat array
tn , fp ,fn ,tp = cmt_dt.ravel()

#accuracy_score,precision_score,Recall_score,f1 score
acc_dt=round(accuracy_score(y_test,y_pred_dt)*100,2)
precision_dt=round(precision_score(y_test,y_pred_dt)*100,2)
Recall_dt=round(recall_score(y_test,y_pred_dt)*100,2)
f1_dt=round(f1_score(y_test,y_pred_dt)*100,2)
print(f"Accuracy is = {acc_dt}%",)
print(f"F1 is = {f1_dt}%",)
print(f"Precision is = {precision_dt}%",)
print(f"Recall is = {Recall_dt}%",)

# instead of using seaborn we use ConfusionMatrixDisplay
#ConfusionMatrixDisplay(cmt_dt).plot()
#plt.grid(False)

dtree.predict_proba(X_test)
y_dt_pred_prob=dtree.predict_proba(X_test)[:,1]   # class-1 probabilities
fpr,tpr,threshold=roc_curve(y_test,y_dt_pred_prob)
plt.plot([0,1],[0,1],color="navy",lw=2,label="Random-Model")
plt.plot(fpr,tpr,color="darkorange",lw=2,label="Decision Tree Model")
plt.xlabel("<-------  FPR  ------->")
plt.ylabel("<-------  TPR  ------->")
plt.title("Receiver Operating Characteristics : ROC_AUC")
plt.legend()
plt.show()
AUC_dt=auc(fpr,tpr)
print("Computed Area Under the Curve (AUC) ",AUC_dt)
```

```
Accuracy is = 93.36%
F1 is = 39.43%
Precision is = 80.61%
Recall is = 26.1%
```



```
Computed Area Under the Curve (AUC)  0.8702830705380374
```

In [26]:
```
test=pd.read_csv(r"C:\Users\jagad\Downloads\test_2umaH9m.csv")
test
```

Out[26]:

	employee_id	department	region	education	gender	recruitment_channel	no_of_trainings
0	8724	Technology	region_26	Bachelor's	m	sourcing	1
1	74430	HR	region_4	Bachelor's	f	other	1
2	72255	Sales & Marketing	region_13	Bachelor's	m	other	1
3	38562	Procurement	region_2	Bachelor's	f	other	3
4	64486	Finance	region_29	Bachelor's	m	sourcing	1
...	...	...	...	...	...	...	...
23485	53478	Legal	region_2	Below Secondary	m	sourcing	1
23486	25600	Technology	region_25	Bachelor's	m	sourcing	1
23487	45409	HR	region_16	Bachelor's	f	sourcing	1
23488	1186	Procurement	region_31	Bachelor's	m	sourcing	3
23489	5973	Technology	region_17	Master's & above	m	other	3

23490 rows × 13 columns

In [27]:

```
id=test['employee_id']
id
```

Out[27]:

```
0         8724
1        74430
2        72255
3        38562
4        64486
         ...
23485    53478
23486    25600
23487    45409
23488     1186
23489     5973
Name: employee_id, Length: 23490, dtype: int64
```

In [28]:

```
test.drop('employee_id',axis=1,inplace=True)

test['education'].fillna(method='ffill',inplace=True)
median=test['previous_year_rating'].median()
print(median)
test['previous_year_rating'].fillna(median,inplace=True)
```

```
3.0
```

In [29]:

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

Out[29]:

```
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
```

In [30]:

```python
from sklearn.preprocessing import LabelEncoder
le=LabelEncoder()
for i in cat_cols:
    test[i]=le.fit_transform(test[i])
test
```

Out[30]:

	department	region	education	gender	recruitment_channel	no_of_trainings	age	previous_y
0	8	18	0	1	2	1	24	
1	2	28	0	0	0	1	31	
2	7	4	0	1	0	1	31	
3	5	11	0	0	0	3	31	
4	1	21	0	1	2	1	30	
...	...	...	...	...	...	...	...	
23485	3	11	1	1	2	1	24	
23486	8	17	0	1	2	1	31	
23487	2	7	0	0	2	1	26	
23488	5	24	0	1	2	3	27	
23489	8	8	2	1	0	3	40	

23490 rows × 12 columns

In [31]:

```python
y_final_pred_dt=dtree.predict(test)
y_final_pred_dt
```

Out[31]:

```
array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

In [32]:

```python
dff1=pd.DataFrame(zip(id,y_final_pred_dt),columns=['employee_id','is_promoted'])
dff1
```

Out[32]:

	employee_id	is_promoted
0	8724	0
1	74430	0
2	72255	0
3	38562	0
4	64486	0
...	...	...
23485	53478	0
23486	25600	0
23487	45409	0
23488	1186	0
23489	5973	0

23490 rows × 2 columns

In [33]:

```
dff1.to_csv('final_submission.csv',index=False)
```

In [ ]: