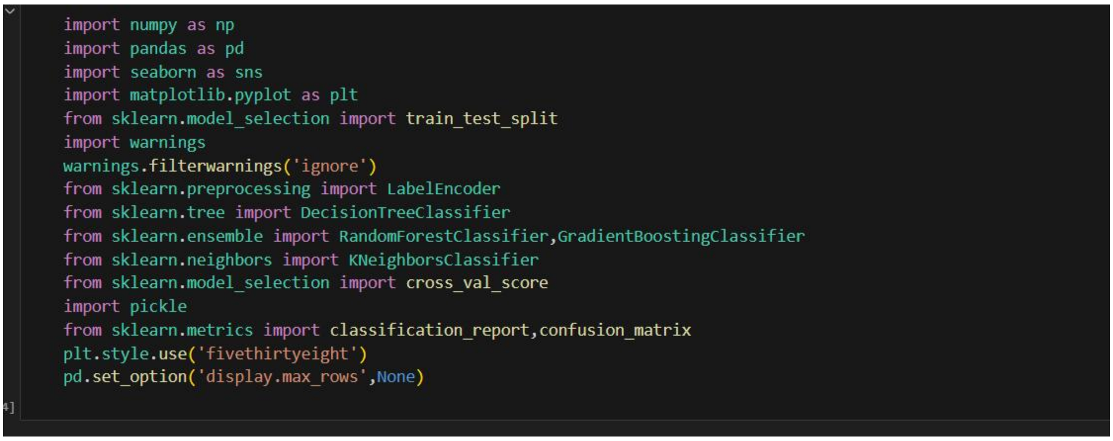
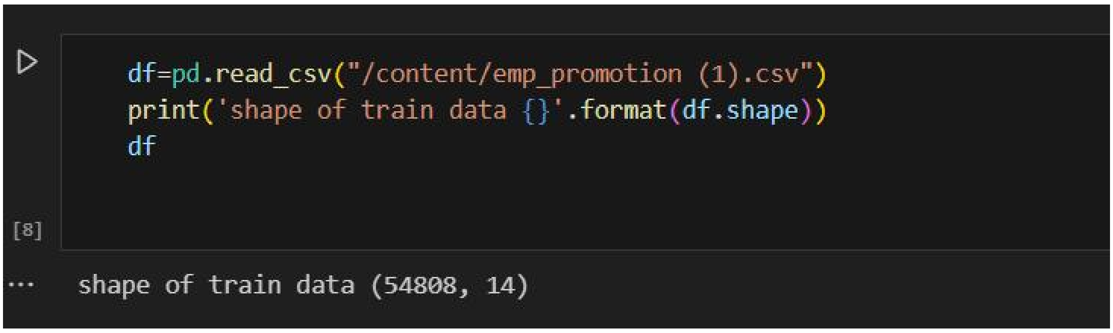
Results



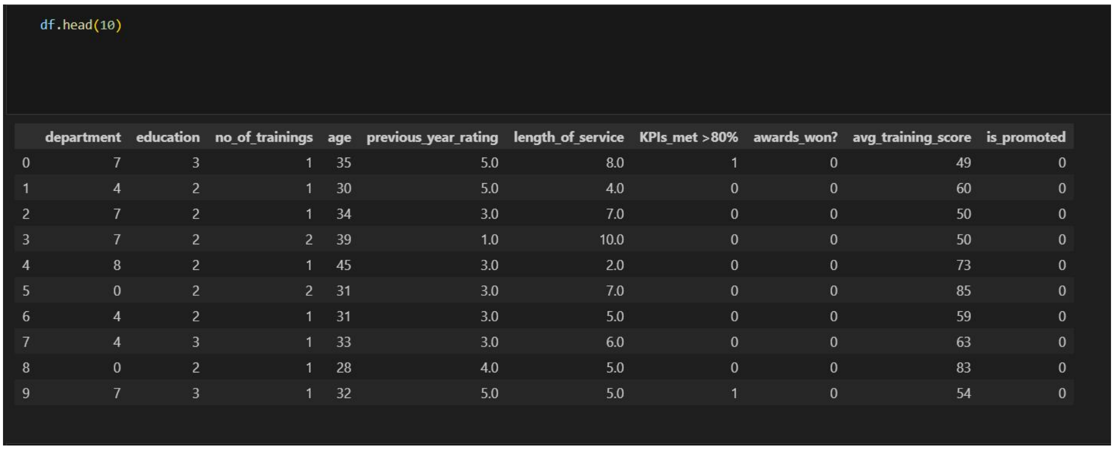
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
import warnings
warnings.filterwarnings('ignore')
from sklearn.preprocessing import LabelEncoder
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier,GradientBoostingClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import cross_val_score
import pickle
from sklearn.metrics import classification_report,confusion_matrix
plt.style.use('fivethirtyeight')
pd.set_option('display.max_rows',None)
```



```
df=pd.read_csv("/content/emp_promotion (1).csv")
print('shape of train data {}'.format(df.shape))
df
```

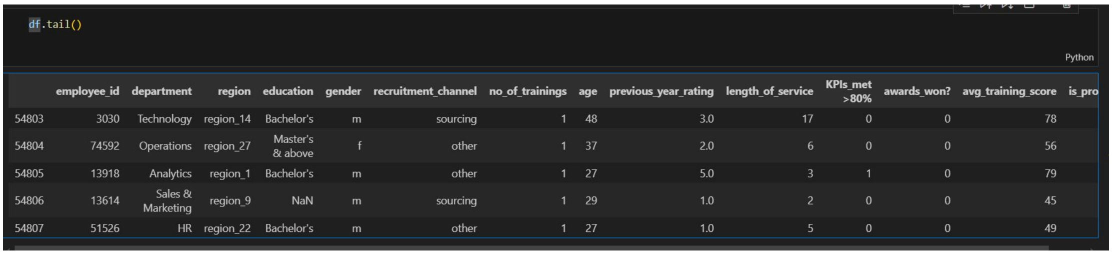
[8]

```
shape of train data (54808, 14)
```



```
df.head(10)
```

	department	education	no_of_trainings	age	previous_year_rating	length_of_service	KPIs_met >80%	awards_won?	avg_training_score	is_promoted
0	7	3	1	35	5.0	8.0	1	0	49	0
1	4	2	1	30	5.0	4.0	0	0	60	0
2	7	2	1	34	3.0	7.0	0	0	50	0
3	7	2	2	39	1.0	10.0	0	0	50	0
4	8	2	1	45	3.0	2.0	0	0	73	0
5	0	2	2	31	3.0	7.0	0	0	85	0
6	4	2	1	31	3.0	5.0	0	0	59	0
7	4	3	1	33	3.0	6.0	0	0	63	0
8	0	2	1	28	4.0	5.0	0	0	83	0
9	7	3	1	32	5.0	5.0	1	0	54	0

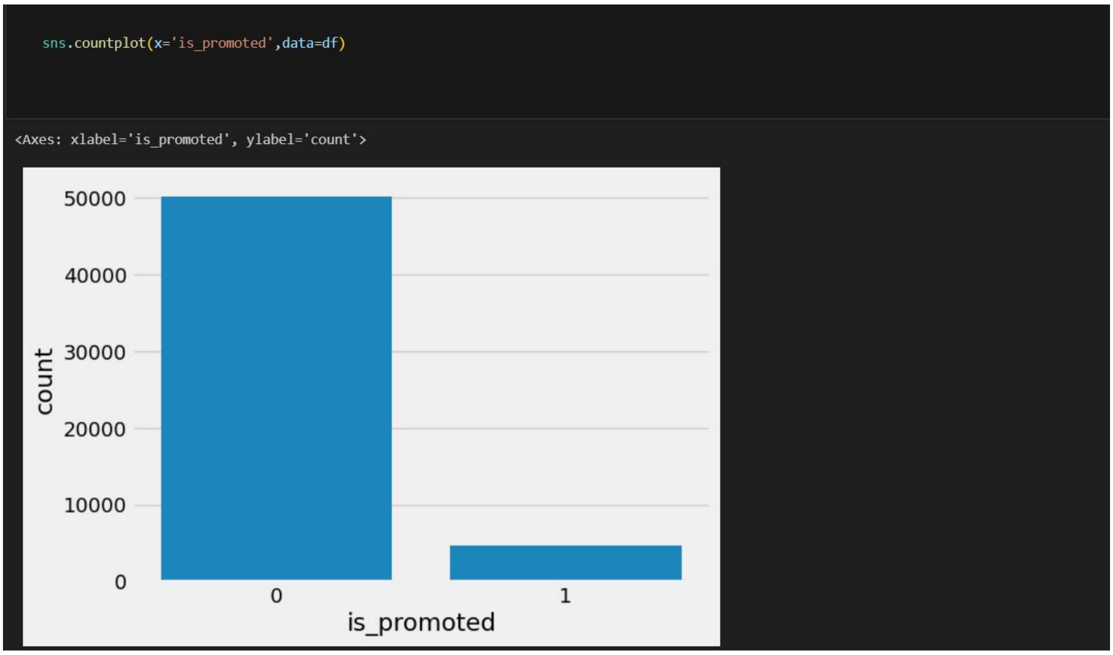


```
df.tail()
```

Python

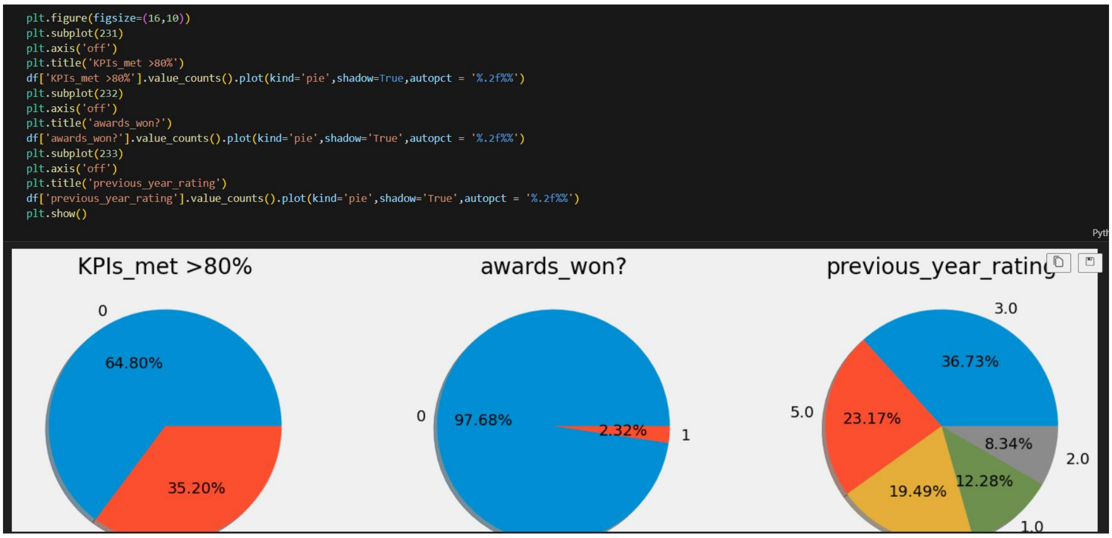
	employee_id	department	region	education	gender	recruitment_channel	no_of_trainings	age	previous_year_rating	length_of_service	KPIs_met >80%	awards_won?	avg_training_score	is_pro
54803	3030	Technology	region_14	Bachelor's	m	sourcing	1	48	3.0	17	0	0	78	
54804	74592	Operations	region_27	Master's & above	f	other	1	37	2.0	6	0	0	56	
54805	13918	Analytics	region_1	Bachelor's	m	other	1	27	5.0	3	1	0	79	
54806	13614	Sales & Marketing	region_9	NaN	m	sourcing	1	29	1.0	2	0	0	45	
54807	51526	HR	region_22	Bachelor's	m	other	1	27	1.0	5	0	0	49	

Results

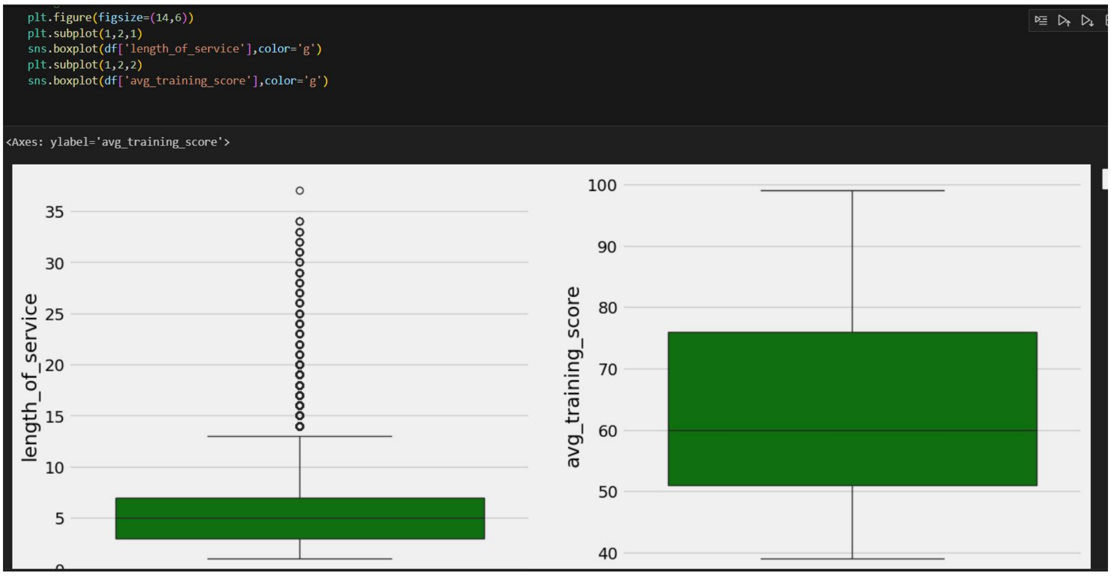


```
sns.countplot(x='is_promoted',data=df)
```

```
<Axes: xlabel='is_promoted', ylabel='count'>
```



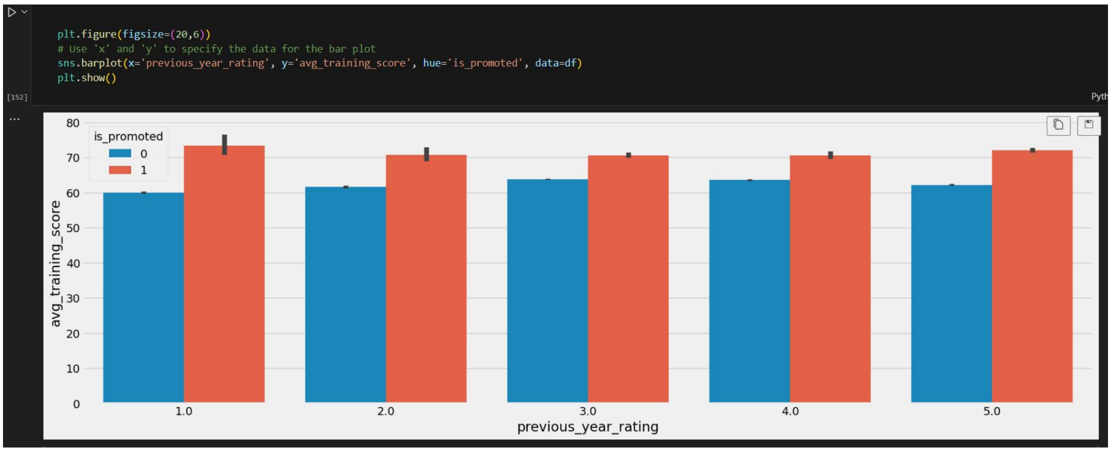
```
plt.figure(figsize=(16,10))
plt.subplot(231)
plt.axis('off')
plt.title('KPIs_met >80%')
df['KPIs_met >80%'].value_counts().plot(kind='pie',shadow=True,autopct = '%.2f%%')
plt.subplot(232)
plt.axis('off')
plt.title('awards_won?')
df['awards_won?'].value_counts().plot(kind='pie',shadow='True',autopct = '%.2f%%')
plt.subplot(233)
plt.axis('off')
plt.title('previous_year_rating')
df['previous_year_rating'].value_counts().plot(kind='pie',shadow='True',autopct = '%.2f%%')
plt.show()
```



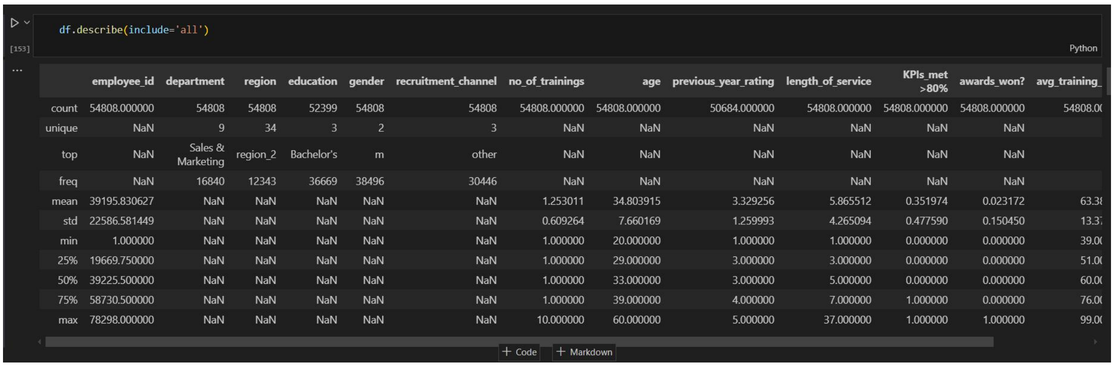
```
plt.figure(figsize=(14,6))
plt.subplot(1,2,1)
sns.boxplot(df['length_of_service'],color='g')
plt.subplot(1,2,2)
sns.boxplot(df['avg_training_score'],color='g')
```

```
<Axes: ylabel='avg_training_score'>
```

Results

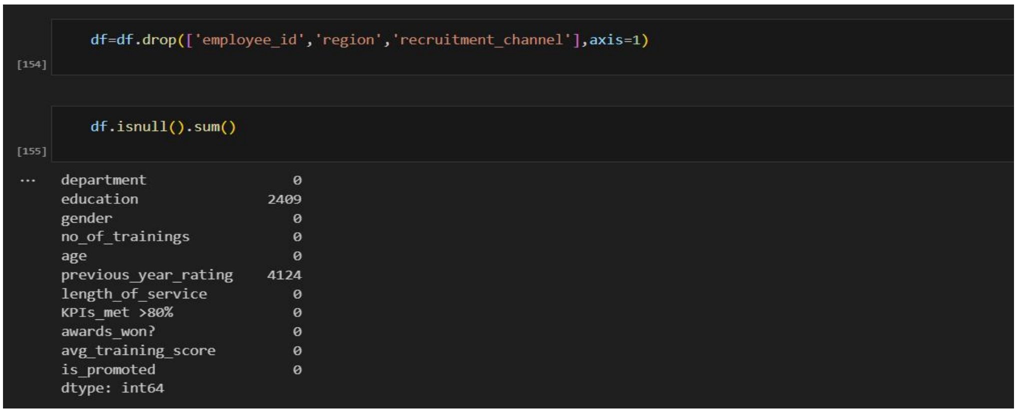


```
plt.figure(figsize=(20,6))
# Use 'x' and 'y' to specify the data for the bar plot
sns.barplot(x='previous_year_rating', y='avg_training_score', hue='is_promoted', data=df)
plt.show()
```



```
df.describe(include='all')
```

	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_
count	54808.000000	54808	54808	52399	54808	54808	54808.000000	54808.000000	50684.000000	54808.000000	54808.000000	54808.000000	54808.0
unique	NaN	9	34	3	2	3	NaN	NaN	NaN	NaN	NaN	NaN	
top	NaN	Sales & Marketing	region_2	Bachelor's	m	other	NaN	NaN	NaN	NaN	NaN	NaN	
freq	NaN	16840	12343	36669	38496	30446	NaN	NaN	NaN	NaN	NaN	NaN	
mean	39195.830627	NaN	NaN	NaN	NaN	NaN	1.253011	34.803915	3.329256	5.865512	0.351974	0.023172	63.3
std	22586.581449	NaN	NaN	NaN	NaN	NaN	0.609264	7.660169	1.259993	4.265094	0.477590	0.150450	13.3
min	1.000000	NaN	NaN	NaN	NaN	NaN	1.000000	20.000000	1.000000	1.000000	0.000000	0.000000	39.0
25%	19669.750000	NaN	NaN	NaN	NaN	NaN	1.000000	29.000000	3.000000	3.000000	0.000000	0.000000	51.0
50%	39225.500000	NaN	NaN	NaN	NaN	NaN	1.000000	33.000000	3.000000	5.000000	0.000000	0.000000	60.0
75%	58730.500000	NaN	NaN	NaN	NaN	NaN	1.000000	39.000000	4.000000	7.000000	1.000000	0.000000	76.0
max	78298.000000	NaN	NaN	NaN	NaN	NaN	10.000000	60.000000	5.000000	37.000000	1.000000	1.000000	99.0



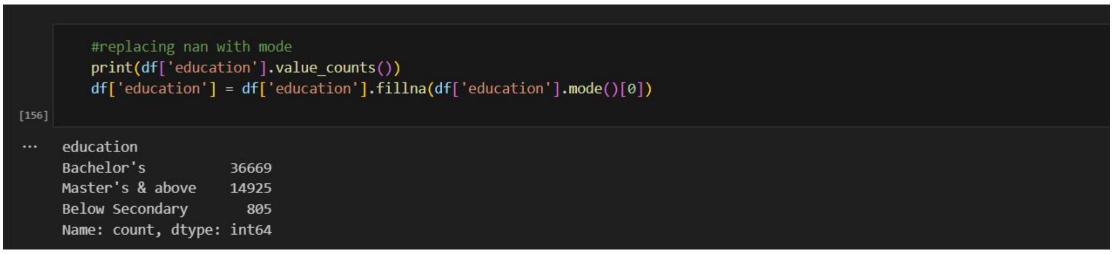
[154]

```
df=df.drop(['employee_id','region','recruitment_channel'],axis=1)
```

[155]

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

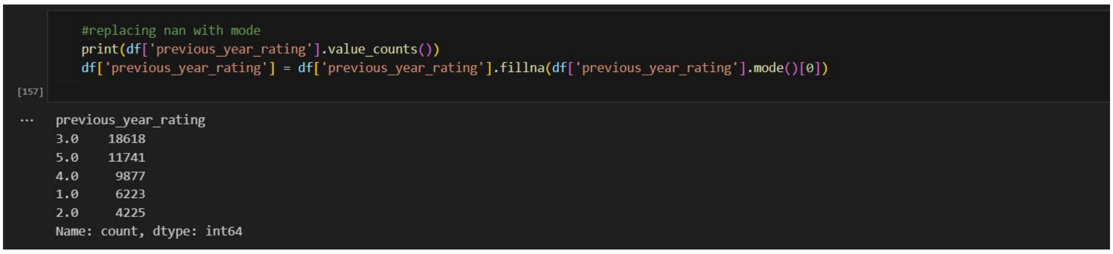
```
department                0
education              2409
gender                    0
no_of_trainings           0
age                       0
previous_year_rating   4124
length_of_service         0
KPIs_met >80%             0
awards_won?               0
avg_training_score        0
is_promoted               0
dtype: int64
```



[156]

```
#replacing nan with mode
print(df['education'].value_counts())
df['education'] = df['education'].fillna(df['education'].mode()[0])
```

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

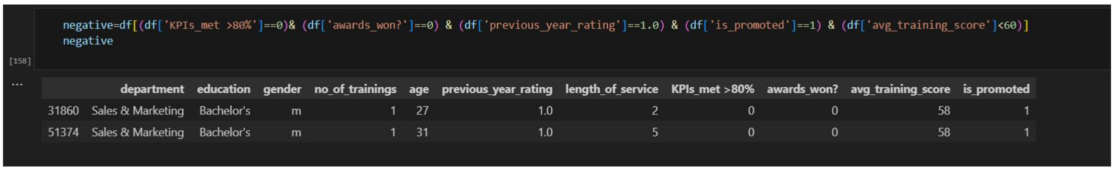


[157]

```
#replacing nan with mode
print(df['previous_year_rating'].value_counts())
df['previous_year_rating'] = df['previous_year_rating'].fillna(df['previous_year_rating'].mode()[0])
```

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

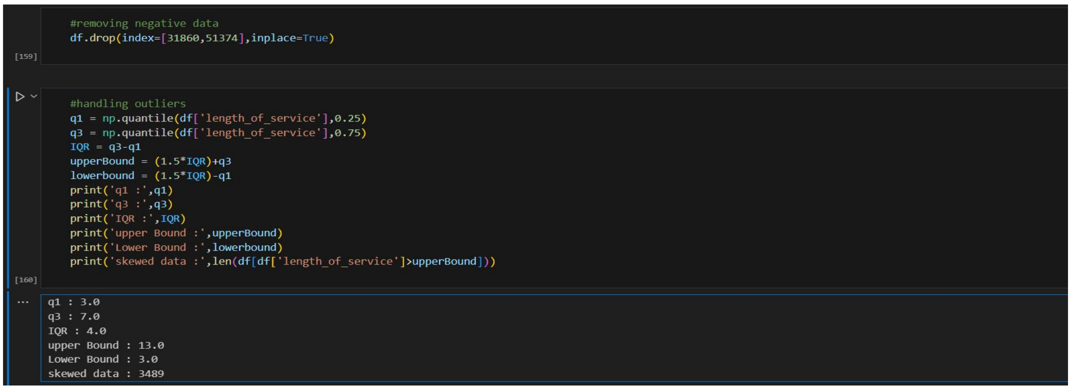
Results



```python
negative=df[(df['KPIs_met >80%']==0)& (df['awards_won?']==0) & (df['previous_year_rating']==1.0) & (df['is_promoted']==1) & (df['avg_training_score']<60)]
negative
```

[158]

	department	education	gender	no_of_trainings	age	previous_year_rating	length_of_service	KPIs_met >80%	awards_won?	avg_training_score	is_promoted
31860	Sales & Marketing	Bachelor's	m	1	27	1.0	2	0	0	58	1
51374	Sales & Marketing	Bachelor's	m	1	31	1.0	5	0	0	58	1



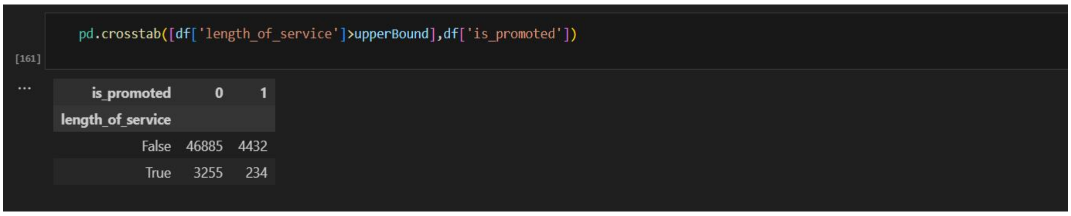
```python
#removing negative data
df.drop(index=[31860,51374],inplace=True)
```

[159]

```python
#handling outliers
q1 = np.quantile(df['length_of_service'],0.25)
q3 = np.quantile(df['length_of_service'],0.75)
IQR = q3-q1
upperBound = (1.5*IQR)+q3
lowerbound = (1.5*IQR)-q1
print('q1 :',q1)
print('q3 :',q3)
print('IQR :',IQR)
print('upper Bound :',upperBound)
print('Lower Bound :',lowerbound)
print('skewed data :',len(df[df['length_of_service']>upperBound]))
```

[160]

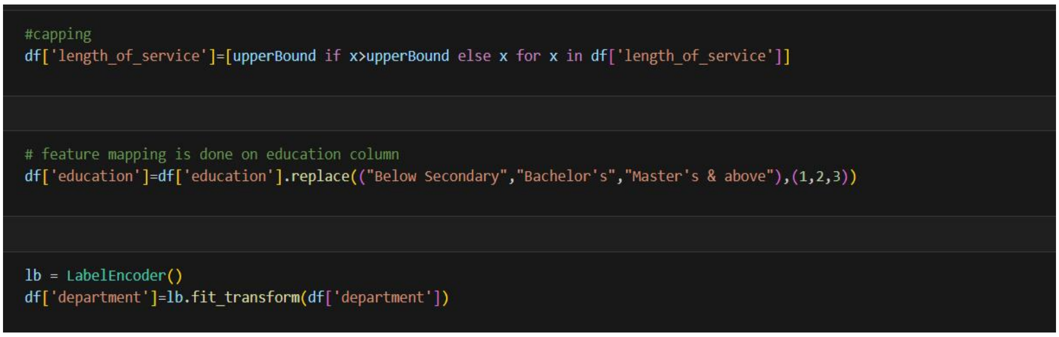
```
q1 : 3.0
q3 : 7.0
IQR : 4.0
upper Bound : 13.0
Lower Bound : 3.0
skewed data : 3489
```



```python
pd.crosstab([df['length_of_service']>upperBound],df['is_promoted'])
```

[161]

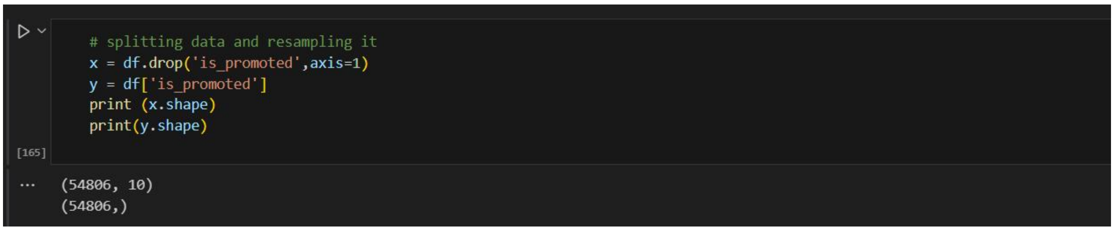
is_promoted	0	1
length_of_service		
False	46885	4432
True	3255	234



```python
#capping
df['length_of_service']=[upperBound if x>upperBound else x for x in df['length_of_service']]
```

```python
# feature mapping is done on education column
df['education']=df['education'].replace(("Below Secondary","Bachelor's","Master's & above"),(1,2,3))
```

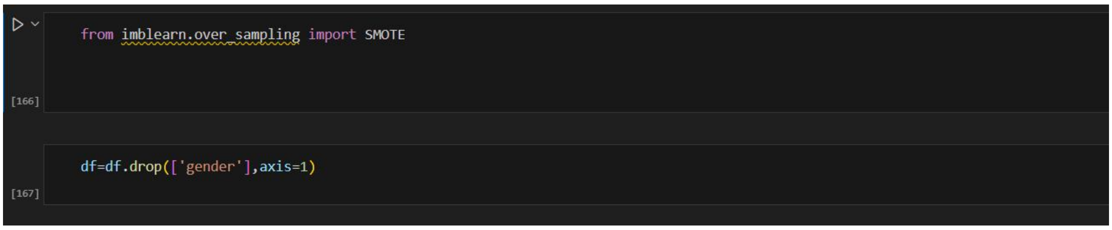
```python
lb = LabelEncoder()
df['department']=lb.fit_transform(df['department'])
```



```python
# splitting data and resampling it
x = df.drop('is_promoted',axis=1)
y = df['is_promoted']
print (x.shape)
print(y.shape)
```

[165]

```
(54806, 10)
(54806,)
```



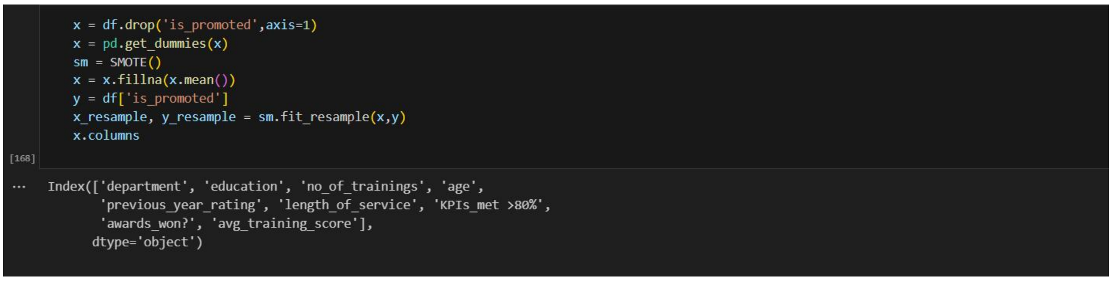
```python
from imblearn.over_sampling import SMOTE
```

[166]

```python
df=df.drop(['gender'],axis=1)
```

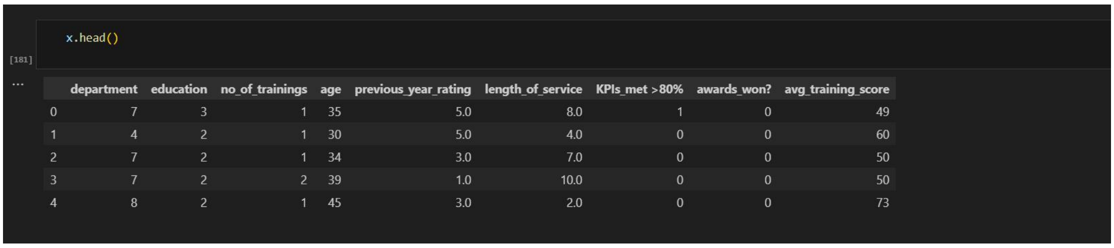
[167]

Results



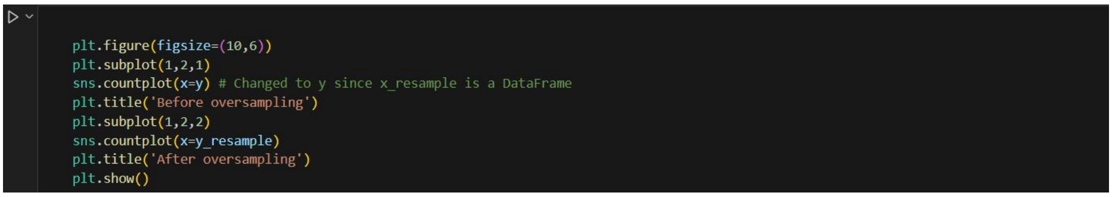
```
x = df.drop('is_promoted',axis=1)
x = pd.get_dummies(x)
sm = SMOTE()
x = x.fillna(x.mean())
y = df['is_promoted']
x_resample, y_resample = sm.fit_resample(x,y)
x.columns
```

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

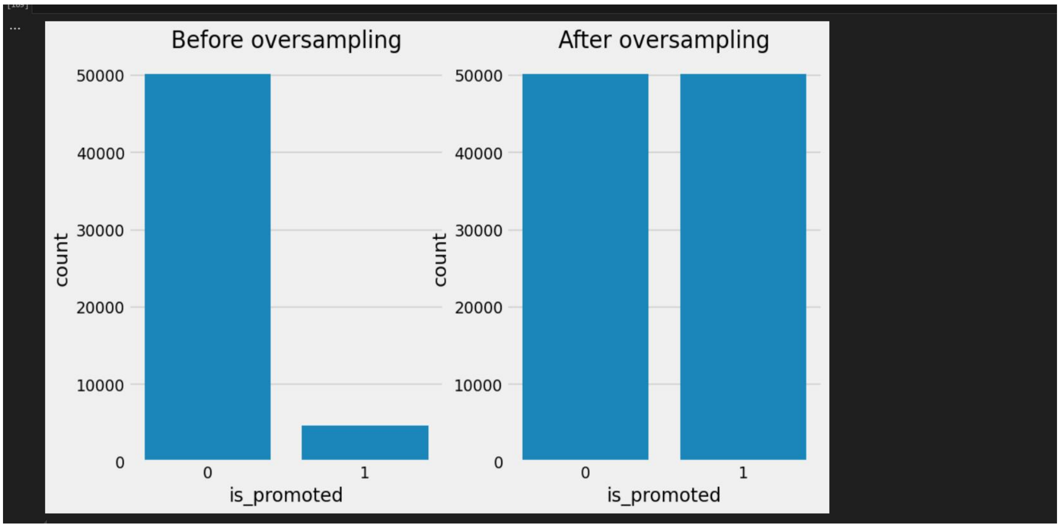


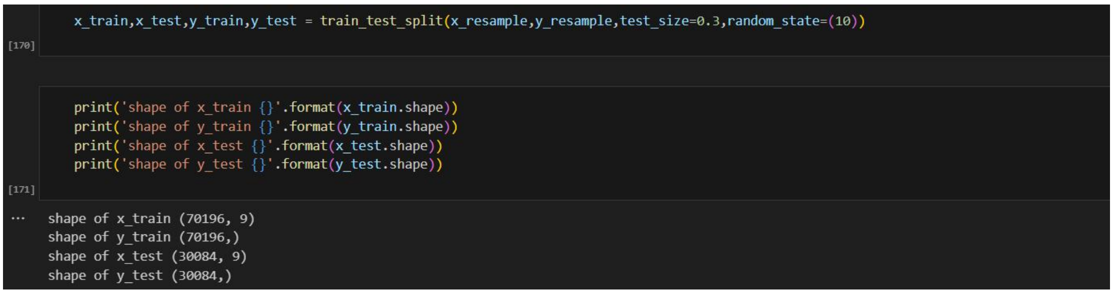
```
x.head()
```

	department	education	no_of_trainings	age	previous_year_rating	length_of_service	KPIs_met >80%	awards_won?	avg_training_score
0	7	3	1	35	5.0	8.0	1	0	49
1	4	2	1	30	5.0	4.0	0	0	60
2	7	2	1	34	3.0	7.0	0	0	50
3	7	2	2	39	1.0	10.0	0	0	50
4	8	2	1	45	3.0	2.0	0	0	73



```
plt.figure(figsize=(10,6))
plt.subplot(1,2,1)
sns.countplot(x=y) # Changed to y since x_resample is a DataFrame
plt.title('Before oversampling')
plt.subplot(1,2,2)
sns.countplot(x=y_resample)
plt.title('After oversampling')
plt.show()
```



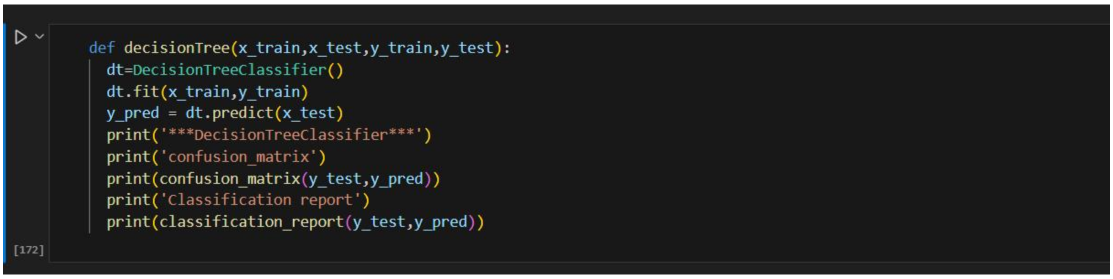


```
x_train,x_test,y_train,y_test = train_test_split(x_resample,y_resample,test_size=0.3,random_state=(10))
```

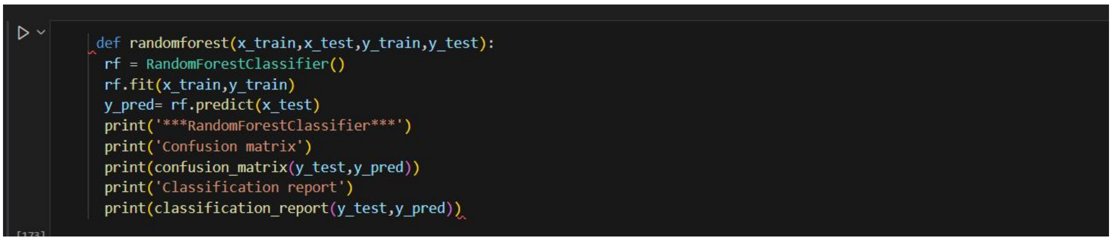
```
print('shape of x_train {}'.format(x_train.shape))
print('shape of y_train {}'.format(y_train.shape))
print('shape of x_test {}'.format(x_test.shape))
print('shape of y_test {}'.format(y_test.shape))
```

```
shape of x_train (70196, 9)
shape of y_train (70196,)
shape of x_test (30084, 9)
shape of y_test (30084,)
```

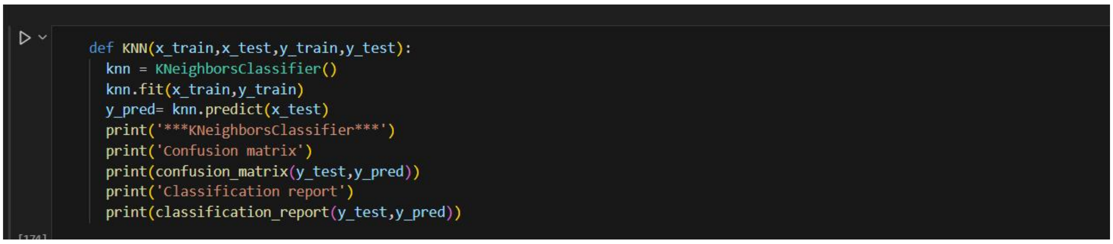
Results



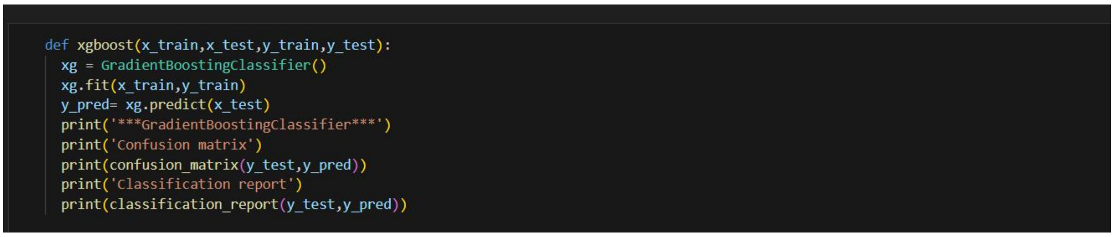
```
def decisionTree(x_train,x_test,y_train,y_test):
    dt=DecisionTreeClassifier()
    dt.fit(x_train,y_train)
    y_pred = dt.predict(x_test)
    print('***DecisionTreeClassifier***')
    print('confusion_matrix')
    print(confusion_matrix(y_test,y_pred))
    print('Classification report')
    print(classification_report(y_test,y_pred))
```



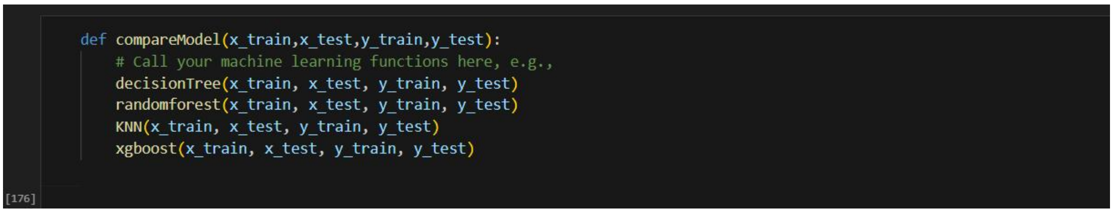
```
def randomforest(x_train,x_test,y_train,y_test):
    rf = RandomForestClassifier()
    rf.fit(x_train,y_train)
    y_pred= rf.predict(x_test)
    print('***RandomForestClassifier***')
    print('Confusion matrix')
    print(confusion_matrix(y_test,y_pred))
    print('Classification report')
    print(classification_report(y_test,y_pred))
```



```
def KNN(x_train,x_test,y_train,y_test):
    knn = KNeighborsClassifier()
    knn.fit(x_train,y_train)
    y_pred= knn.predict(x_test)
    print('***KNeighborsClassifier***')
    print('Confusion matrix')
    print(confusion_matrix(y_test,y_pred))
    print('Classification report')
    print(classification_report(y_test,y_pred))
```

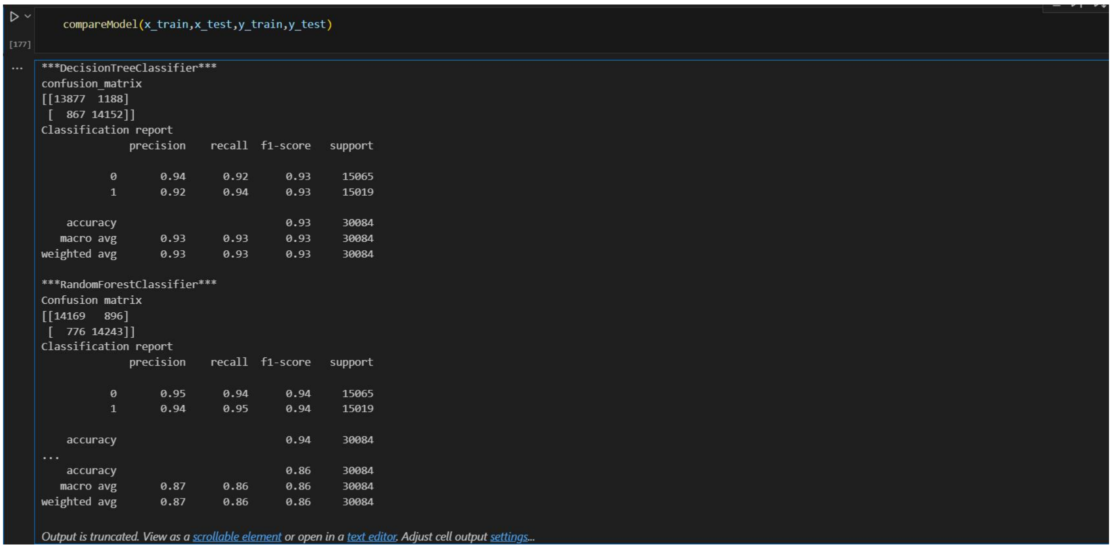


```
def xgboost(x_train,x_test,y_train,y_test):
    xg = GradientBoostingClassifier()
    xg.fit(x_train,y_train)
    y_pred= xg.predict(x_test)
    print('***GradientBoostingClassifier***')
    print('Confusion matrix')
    print(confusion_matrix(y_test,y_pred))
    print('Classification report')
    print(classification_report(y_test,y_pred))
```



```
def compareModel(x_train,x_test,y_train,y_test):
    # Call your machine learning functions here, e.g.,
    decisionTree(x_train, x_test, y_train, y_test)
    randomforest(x_train, x_test, y_train, y_test)
    KNN(x_train, x_test, y_train, y_test)
    xgboost(x_train, x_test, y_train, y_test)
```

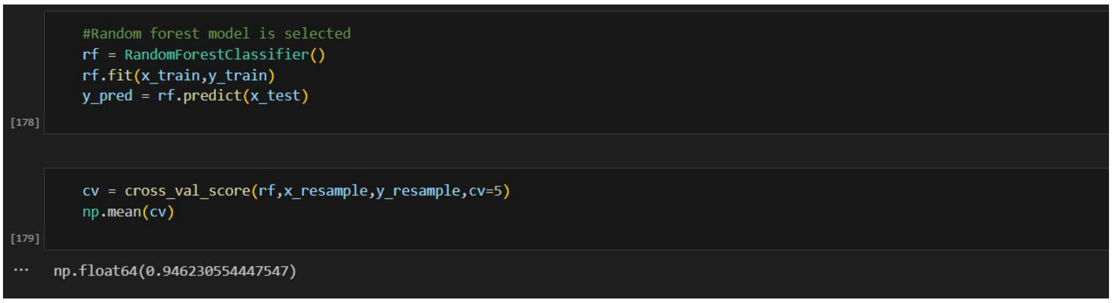
Results



```
[177]
compareModel(x_train,x_test,y_train,y_test)
```

```
***DecisionTreeClassifier***
confusion_matrix
[[13877  1188]
 [  867 14152]]
Classification report
              precision    recall  f1-score   support

           0       0.94      0.92      0.93     15065
           1       0.92      0.94      0.93     15019

    accuracy                           0.93     30084
   macro avg       0.93      0.93      0.93     30084
weighted avg       0.93      0.93      0.93     30084

***RandomForestClassifier***
Confusion matrix
[[14169   896]
 [  776 14243]]
Classification report
              precision    recall  f1-score   support

           0       0.95      0.94      0.94     15065
           1       0.94      0.95      0.94     15019

    accuracy                           0.94     30084
...
    accuracy                           0.86     30084
   macro avg       0.87      0.86      0.86     30084
weighted avg       0.87      0.86      0.86     30084
```

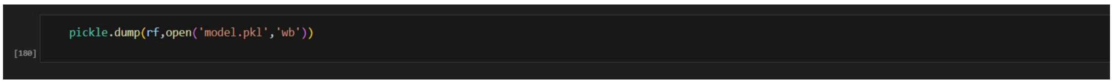
Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...



```
#Random forest model is selected
rf = RandomForestClassifier()
rf.fit(x_train,y_train)
y_pred = rf.predict(x_test)
[178]
```

```
cv = cross_val_score(rf,x_resample,y_resample,cv=5)
np.mean(cv)
[179]
```

```
np.float64(0.946230554447547)
```



```
pickle.dump(rf,open('model.pkl','wb'))
[180]
```