In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
loan = pd.read_csv("loan.csv", sep=",")
```

In [2]:
```
# summarising number of missing values in each column
pd.set_option('display.max_columns', None)
pd.set_option('display.max_rows', None)
#pd.set_option('display.max_columns', None)
loan.isnull().sum()
```

Out[2]:

id	0
member_id	0
loan_amnt	0
funded_amnt	0
funded_amnt_inv	0
term	0
int_rate	0
installment	0
grade	0
sub_grade	0
emp_title	2459
emp_length	1075
home_ownership	0
annual_inc	0
verification_status	0
issue_d	0
loan_status	0
pymnt_plan	0
url	0
desc	12940
purpose	0
title	11
zip_code	0
addr_state	0
dti	0
delinq_2yrs	0
earliest_cr_line	0
inq_last_6mths	0
mths_since_last_delinq	25682
mths_since_last_record	36931
open_acc	0
pub_rec	0
revol_bal	0
revol_util	50
total_acc	0
initial_list_status	0
out_prncp	0
out_prncp_inv	0
total_pymnt	0
total_pymnt_inv	0
total_rec_prncp	0
total_rec_int	0
total_rec_late_fee	0
recoveries	0
collection_recovery_fee	0
last_pymnt_d	71
last_pymnt_amnt	0
next_pymnt_d	38577
last_credit_pull_d	2
collections_12_mths_ex_med	56
mths_since_last_major_derog	39717
policy_code	0
application_type	0
annual_inc_joint	39717
dti_joint	39717
verification_status_joint	39717
acc_now_delinq	0
tot_coll_amt	39717
tot_cur_bal	39717
open_acc_6m	39717
open_il_6m	39717
open_il_12m	39717
open_il_24m	39717
mths_since_rcnt_il	39717

```
total_bal_il                    39717
il_util                         39717
open_rv_12m                     39717
open_rv_24m                     39717
max_bal_bc                      39717
all_util                        39717
total_rev_hi_lim                39717
inq_fi                          39717
total_cu_tl                     39717
inq_last_12m                    39717
acc_open_past_24mths            39717
avg_cur_bal                     39717
bc_open_to_buy                  39717
bc_util                         39717
chargeoff_within_12_mths           56
delinq_amnt                         0
mo_sin_old_il_acct              39717
mo_sin_old_rev_tl_op            39717
mo_sin_rcnt_rev_tl_op           39717
mo_sin_rcnt_tl                  39717
mort_acc                        39717
mths_since_recent_bc            39717
mths_since_recent_bc_dlq        39717
mths_since_recent_inq           39717
mths_since_recent_revol_delinq  39717
num_accts_ever_120_pd           39717
num_actv_bc_tl                  39717
num_actv_rev_tl                 39717
num_bc_sats                     39717
num_bc_tl                       39717
num_il_tl                       39717
num_op_rev_tl                   39717
num_rev_accts                   39717
num_rev_tl_bal_gt_0             39717
num_sats                        39717
num_tl_120dpd_2m                39717
num_tl_30dpd                    39717
num_tl_90g_dpd_24m              39717
num_tl_op_past_12m              39717
pct_tl_nvr_dlq                  39717
percent_bc_gt_75                39717
pub_rec_bankruptcies              697
tax_liens                          39
tot_hi_cred_lim                 39717
total_bal_ex_mort               39717
total_bc_limit                  39717
total_il_high_credit_limit      39717
dtype: int64
```

In [3]:

```
# removing the columns having more than 90% missing values
missing_columns = loan.columns[100*(loan.isnull().sum()/len(loan.index)) > 90]
print(missing_columns)
```

```
Index(['mths_since_last_record', 'next_pymnt_d', 'mths_since_last_major_derog',
       'annual_inc_joint', 'dti_joint', 'verification_status_joint',
       'tot_coll_amt', 'tot_cur_bal', 'open_acc_6m', 'open_il_6m',
       'open_il_12m', 'open_il_24m', 'mths_since_rcnt_il', 'total_bal_il',
       'il_util', 'open_rv_12m', 'open_rv_24m', 'max_bal_bc', 'all_util',
       'total_rev_hi_lim', 'inq_fi', 'total_cu_tl', 'inq_last_12m',
       'acc_open_past_24mths', 'avg_cur_bal', 'bc_open_to_buy', 'bc_util',
       'mo_sin_old_il_acct', 'mo_sin_old_rev_tl_op', 'mo_sin_rcnt_rev_tl_op',
       'mo_sin_rcnt_tl', 'mort_acc', 'mths_since_recent_bc',
       'mths_since_recent_bc_dlq', 'mths_since_recent_inq',
       'mths_since_recent_revol_delinq', 'num_accts_ever_120_pd',
       'num_actv_bc_tl', 'num_actv_rev_tl', 'num_bc_sats', 'num_bc_tl',
       'num_il_tl', 'num_op_rev_tl', 'num_rev_accts', 'num_rev_tl_bal_gt_0',
       'num_sats', 'num_tl_120dpd_2m', 'num_tl_30dpd', 'num_tl_90g_dpd_24m',
       'num_tl_op_past_12m', 'pct_tl_nvr_dlq', 'percent_bc_gt_75',
       'tot_hi_cred_lim', 'total_bal_ex_mort', 'total_bc_limit',
       'total_il_high_credit_limit'],
      dtype='object')
```

In [4]:
```
loan = loan.drop(missing_columns, axis=1)
print(loan.shape)
```

```
(39717, 55)
```

In [5]:
```
loan.head()
```

Out[5]:

	id	member_id	loan_amnt	funded_amnt	funded_amnt_inv	term	int_rate	installment
0	1077501	1296599	5000	5000	4975.0	36 months	10.65%	162.87
1	1077430	1314167	2500	2500	2500.0	60 months	15.27%	59.83
2	1077175	1313524	2400	2400	2400.0	36 months	15.96%	84.33
3	1076863	1277178	10000	10000	10000.0	36 months	13.49%	339.31
4	1075358	1311748	3000	3000	3000.0	60 months	12.69%	67.79

In [6]:
```
loan.isnull().sum()/loan.shape[0]*100
```

Out[6]:
```
id                            0.000000
member_id                     0.000000
loan_amnt                     0.000000
funded_amnt                   0.000000
funded_amnt_inv               0.000000
term                          0.000000
int_rate                      0.000000
installment                   0.000000
grade                         0.000000
sub_grade                     0.000000
emp_title                     6.191303
emp_length                    2.706650
home_ownership                0.000000
annual_inc                    0.000000
verification_status           0.000000
issue_d                       0.000000
loan_status                   0.000000
pymnt_plan                    0.000000
url                           0.000000
desc                         32.580507
purpose                       0.000000
title                         0.027696
zip_code                      0.000000
addr_state                    0.000000
dti                           0.000000
delinq_2yrs                   0.000000
earliest_cr_line              0.000000
inq_last_6mths                0.000000
mths_since_last_delinq       64.662487
open_acc                      0.000000
pub_rec                       0.000000
revol_bal                     0.000000
revol_util                    0.125891
total_acc                     0.000000
initial_list_status           0.000000
out_prncp                     0.000000
out_prncp_inv                 0.000000
total_pymnt                   0.000000
total_pymnt_inv               0.000000
total_rec_prncp               0.000000
total_rec_int                 0.000000
total_rec_late_fee            0.000000
recoveries                    0.000000
collection_recovery_fee       0.000000
last_pymnt_d                  0.178765
last_pymnt_amnt               0.000000
last_credit_pull_d            0.005036
collections_12_mths_ex_med    0.140998
policy_code                   0.000000
application_type              0.000000
acc_now_delinq                0.000000
chargeoff_within_12_mths      0.140998
delinq_amnt                   0.000000
pub_rec_bankruptcies          1.754916
tax_liens                     0.098195
dtype: float64
```

In [7]:
```
m=loan['emp_length'].mode()
loan['emp_length'].fillna(m,inplace=True)
```

In [8]:
```
loan.isnull().sum()
```

Out[8]:

```
id                             0
member_id                      0
loan_amnt                      0
funded_amnt                    0
funded_amnt_inv                0
term                           0
int_rate                       0
installment                    0
grade                          0
sub_grade                      0
emp_title                   2459
emp_length                  1075
home_ownership                 0
annual_inc                     0
verification_status            0
issue_d                        0
loan_status                    0
pymnt_plan                     0
url                            0
desc                       12940
purpose                        0
title                         11
zip_code                       0
addr_state                     0
dti                            0
delinq_2yrs                    0
earliest_cr_line               0
inq_last_6mths                 0
mths_since_last_delinq     25682
open_acc                       0
pub_rec                        0
revol_bal                      0
revol_util                    50
total_acc                      0
initial_list_status            0
out_prncp                      0
out_prncp_inv                  0
total_pymnt                    0
total_pymnt_inv                0
total_rec_prncp                0
total_rec_int                  0
total_rec_late_fee             0
recoveries                     0
collection_recovery_fee        0
last_pymnt_d                  71
last_pymnt_amnt                0
last_credit_pull_d             2
collections_12_mths_ex_med    56
policy_code                    0
application_type               0
acc_now_delinq                 0
chargeoff_within_12_mths      56
delinq_amnt                    0
pub_rec_bankruptcies         697
tax_liens                     39
dtype: int64
```

In [9]:

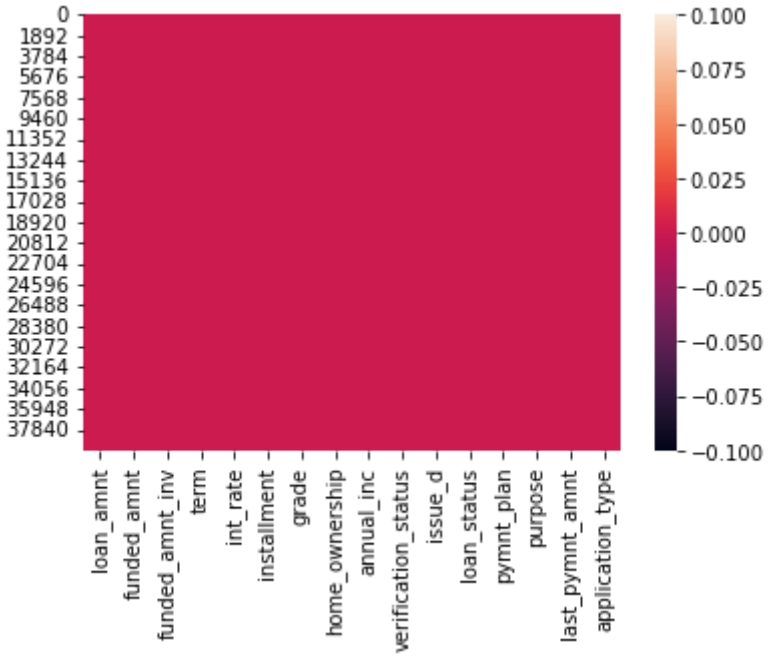
```
#as above these columns are not getting filled with mode despite having less
#percent of null values so directly dropping the columns
loan.drop('id',axis=1,inplace=True)
loan.drop('member_id',axis=1,inplace=True)
loan.drop('sub_grade',axis=1,inplace=True)
loan.drop('url',axis=1,inplace=True)
loan.drop('desc',axis=1,inplace=True)
```

```
loan.drop('title',axis=1,inplace=True)
loan.drop('zip_code',axis=1,inplace=True)
loan.drop('addr_state',axis=1,inplace=True)
loan.drop('dti',axis=1,inplace=True)
loan.drop('delinq_2yrs',axis=1,inplace=True)
loan.drop('earliest_cr_line',axis=1,inplace=True)
loan.drop('inq_last_6mths',axis=1,inplace=True)
loan.drop('mths_since_last_delinq',axis=1,inplace=True)
loan.drop('open_acc',axis=1,inplace=True)
loan.drop('pub_rec',axis=1,inplace=True)
loan.drop('revol_bal',axis=1,inplace=True)
loan.drop('revol_util',axis=1,inplace=True)
loan.drop('total_acc',axis=1,inplace=True)
loan.drop('initial_list_status',axis=1,inplace=True)
loan.drop('out_prncp',axis=1,inplace=True)
loan.drop('out_prncp_inv',axis=1,inplace=True)
loan.drop('total_pymnt',axis=1,inplace=True)
loan.drop('total_pymnt_inv',axis=1,inplace=True)
loan.drop('total_rec_prncp',axis=1,inplace=True)
loan.drop('total_rec_int',axis=1,inplace=True)
loan.drop('total_rec_late_fee',axis=1,inplace=True)
loan.drop('recoveries',axis=1,inplace=True)
loan.drop('collection_recovery_fee',axis=1,inplace=True)
loan.drop('collections_12_mths_ex_med',axis=1,inplace=True)
loan.drop('policy_code',axis=1,inplace=True)
loan.drop('acc_now_delinq',axis=1,inplace=True)
loan.drop('chargeoff_within_12_mths',axis=1,inplace=True)
loan.drop('delinq_amnt',axis=1,inplace=True)
loan.drop('pub_rec_bankruptcies',axis=1,inplace=True)
loan.drop('tax_liens',axis=1,inplace=True)
loan.drop('emp_title',axis=1,inplace=True)
loan.drop('emp_length',axis=1,inplace=True)
loan.drop('last_pymnt_d',axis=1,inplace=True)
loan.drop('last_credit_pull_d',axis=1,inplace=True)
```

In [10]:
```
loan.isnull().sum()
```

Out[10]:
```
loan_amnt              0
funded_amnt            0
funded_amnt_inv        0
term                   0
int_rate               0
installment            0
grade                  0
home_ownership         0
annual_inc             0
verification_status    0
issue_d                0
loan_status            0
pymnt_plan             0
purpose                0
last_pymnt_amnt        0
application_type       0
dtype: int64
```

In [11]:
```
sns.heatmap(loan.isnull())
plt.show()
```



In [12]:
```
loan.head()
```

Out[12]:

	loan_amnt	funded_amnt	funded_amnt_inv	term	int_rate	installment	grade	home_owners
0	5000	5000	4975.0	36 months	10.65%	162.87	B	RE
1	2500	2500	2500.0	60 months	15.27%	59.83	C	RE
2	2400	2400	2400.0	36 months	15.96%	84.33	C	RE
3	10000	10000	10000.0	36 months	13.49%	339.31	C	RE
4	3000	3000	3000.0	60 months	12.69%	67.79	B	RE

In [13]:
```
#checking that if we have duplcates
loan.duplicated().sum()
```

Out[13]:
```
0
```

In [14]:
```
#as we need single datatype so converting the dataset by applying
#LabelEncoder before that checking which types of datatypes we have
loan.dtypes
```

Out[14]:
```
loan_amnt                int64
funded_amnt              int64
funded_amnt_inv        float64
term                    object
int_rate                object
installment            float64
grade                   object
home_ownership          object
annual_inc             float64
verification_status     object
issue_d                 object
loan_status             object
pymnt_plan              object
purpose                 object
last_pymnt_amnt        float64
application_type        object
dtype: object
```

In [15]:
```
#we diffrent type of data we first bifurcate it and then apply label encoder
loan_cat=loan.select_dtypes(object)
loan_cat.dtypes
```

Out[15]:
```
term                    object
int_rate                object
grade                   object
home_ownership          object
verification_status     object
issue_d                 object
loan_status             object
pymnt_plan              object
purpose                 object
application_type        object
dtype: object
```

In [16]:
```
loan_num=loan.select_dtypes(['int64','float64'])
loan_num.dtypes
```

Out[16]:
```
loan_amnt              int64
funded_amnt            int64
funded_amnt_inv      float64
installment          float64
annual_inc           float64
last_pymnt_amnt      float64
dtype: object
```

In [17]:
```
from sklearn.preprocessing import LabelEncoder
for col in loan_cat:
    le=LabelEncoder()
    loan_cat[col]=le.fit_transform(loan_cat[col])
```

In [18]:
```
loan_cat.head()
```

Out[18]:

	term	int_rate	grade	home_ownership	verification_status	issue_d	loan_status	pymnt_plan	p
0	0	17	1	4	2	13	2	0	
1	1	158	2	4	1	13	0	0	
2	0	175	2	4	0	13	2	0	
3	0	99	2	4	1	13	2	0	
4	1	74	1	4	1	13	1	0	

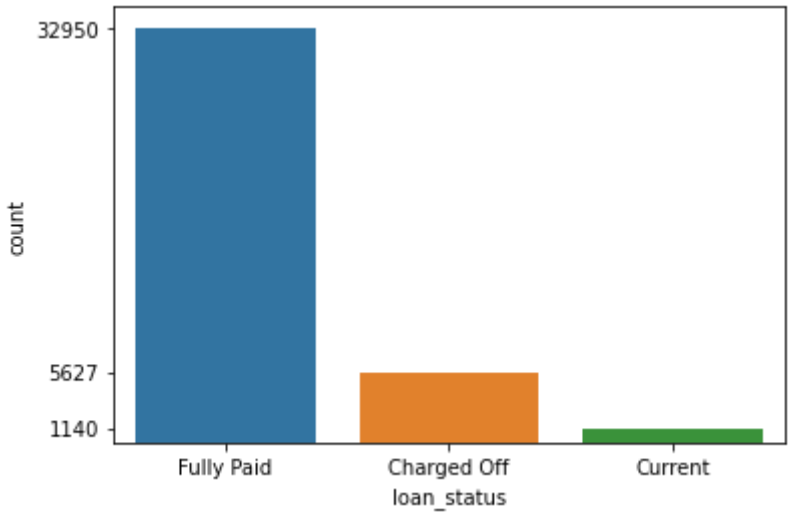
In [19]:
```
loan_new=pd.concat([loan_cat,loan_num],axis=1)
```

In [20]:
```
loan_new.head()
```

Out[20]:

	term	int_rate	grade	home_ownership	verification_status	issue_d	loan_status	pymnt_plan	p
0	0	17	1	4	2	13	2	0	
1	1	158	2	4	1	13	0	0	
2	0	175	2	4	0	13	2	0	
3	0	99	2	4	1	13	2	0	
4	1	74	1	4	1	13	1	0	

In [21]:
```
f=loan['loan_status'].value_counts()
sns.countplot(data=loan,x='loan_status')
plt.yticks(f)
plt.show()
print(f)
```




```
Fully Paid     32950
Charged Off     5627
Current         1140
Name: loan_status, dtype: int64
```

In [22]:
```
#now bifurcating the data in input and output
X=loan_new.drop('loan_status',axis=1)
Y=loan_new['loan_status']
```

In [23]:
```
#this is the data having in column X
X.head()
```

Out[23]:

	term	int_rate	grade	home_ownership	verification_status	issue_d	pymnt_plan	purpose	app
0	0	17	1	4	2	13	0	1	
1	1	158	2	4	1	13	0	0	
2	0	175	2	4	0	13	0	11	
3	0	99	2	4	1	13	0	9	
4	1	74	1	4	1	13	0	9	

In [24]:
```
#these are the headed columns for y columns as we dropped it from X
Y.head()
```

Out[24]:
```
0    2
1    0
2    2
3    2
4    1
Name: loan_status, dtype: int32
```

In [25]:
```
#now apply train_test_split
from sklearn.model_selection import train_test_split
X_train,X_test,Y_train,Y_test=train_test_split(X,Y,test_size=0.3,random_state=1)
```

In [26]:
```
X_train.shape,X_test.shape
```

Out[26]:
```
((27801, 15), (11916, 15))
```

In [27]:
```
#here in output we have unbalanced counts of output that too our data has
#three output class so we will apply smote function now
Y_train.value_counts()
```

Out[27]:
```
2    23067
0     3946
1      788
Name: loan_status, dtype: int64
```

In [28]:
```
#importing the smote function to make balance data
from imblearn.over_sampling import SMOTE
```

In [29]:
```
#applying the smote for training data
X_train1,Y_train1=SMOTE().fit_resample(X_train,Y_train)
```

In [30]:
```
Y_train1.value_counts()
```

Out[30]:
```
2    23067
1    23067
0    23067
Name: loan_status, dtype: int64
```

In [31]:
```
#applying the smote for test data
X_test1,Y_test1=SMOTE().fit_resample(X_test,Y_test)
```

In [32]:
```
#now data seems to be balanced
Y_test1.value_counts()
```

Out[32]:
```
2    9883
0    9883
1    9883
Name: loan_status, dtype: int64
```

In [33]:
```
#apply Stabdard Scaler on Training input X_train1 and testing input
#X_test1
from sklearn.preprocessing import StandardScaler
ss=StandardScaler()
X_train1=ss.fit_transform(X_train1)
X_test1=ss.transform(X_test1)
```

In [34]:
```
X_train1
```

Out[34]:
```
array([[-0.99115199,  1.67483228, -1.41788272, ..., -0.94237819,
         0.45564172,  1.00383959],
       [-0.99115199,  1.39653694, -1.41788272, ..., -0.51486645,
         0.36679455,  0.34177372],
       [ 1.008927  ,  1.08842425,  2.53555955, ..., -0.48177513,
         0.132238  , -0.34143678],
       ...,
       [ 1.008927  ,  0.52189446,  0.95418264, ..., -0.18334582,
        -0.25513568, -0.32058425],
       [ 1.008927  ,  0.10445145,  0.16349418, ..., -0.9678556 ,
         0.0556337 , -0.3754013 ],
       [ 1.008927  ,  0.26347736, -0.62719427, ..., -1.26446506,
        -0.34398286, -0.39612667]])
```

In [35]:
```
#applying standard scaler for the reason to get data into same scale
```

In [36]:
```
#creating the class for not applyning agian and again
def create_model(model):
    model.fit(X_train1,Y_train1)
    Y_pred=model.predict(X_test1)
    print(classification_report(Y_test1,Y_pred))
    print(confusion_matrix(Y_test1,Y_pred))
    return model
```

In [37]:
```
#importing the two essential class
from sklearn.metrics import classification_report,confusion_matrix
```

In [38]:
```
#first model perfromance checking with loisticRegression
from sklearn.linear_model import LogisticRegression
```

In [39]:
```
#creating the object
lr=LogisticRegression()
create_model(lr)
```

```
              precision    recall  f1-score   support

           0       0.70      0.64      0.67      9883
           1       0.77      0.99      0.87      9883
           2       0.85      0.70      0.76      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.77     29649
weighted avg       0.78      0.77      0.77     29649

[[6316 2327 1240]
 [ 143 9740    0]
 [2502  511 6870]]
```

Out[39]:
```
LogisticRegression()
```

In [40]:
```
# as we can see above we had multiclass data so we will look for F1 score
#and accuracy of the dataset
#we got a quite good accuracy but applying diffrent algo may result in more
#good score.
```

In [41]:
```
#second algo applying is Decision tree Classifier
from sklearn.tree import DecisionTreeClassifier
```

In [42]:
```
#creating the object for decisiontree classifier
dt=DecisionTreeClassifier()
```

In [43]:
```
create_model(dt)
```

```
              precision    recall  f1-score   support

           0       0.65      0.71      0.68      9883
           1       0.88      0.70      0.78      9883
           2       0.77      0.86      0.81      9883

    accuracy                           0.76     29649
   macro avg       0.77      0.76      0.76     29649
weighted avg       0.77      0.76      0.76     29649

[[7013  838 2032]
 [2500 6876  507]
 [1273   74 8536]]
```

Out[43]:
```
DecisionTreeClassifier()
```

In [44]:
```
# we got less accuracy score in decisiontreeClassifier it seems that
#data is overfit
```

In [45]:
```
#show the information gain of all input features
IG=dt.feature_importances_
print("information gain:",IG)
```

```
information gain: [0.25539767 0.11085004 0.02499277 0.02242697 0.01152655 0.045814
79
 0.         0.02437303 0.         0.02885724 0.03082064 0.04272952
 0.0487285  0.06423061 0.28925168]
```

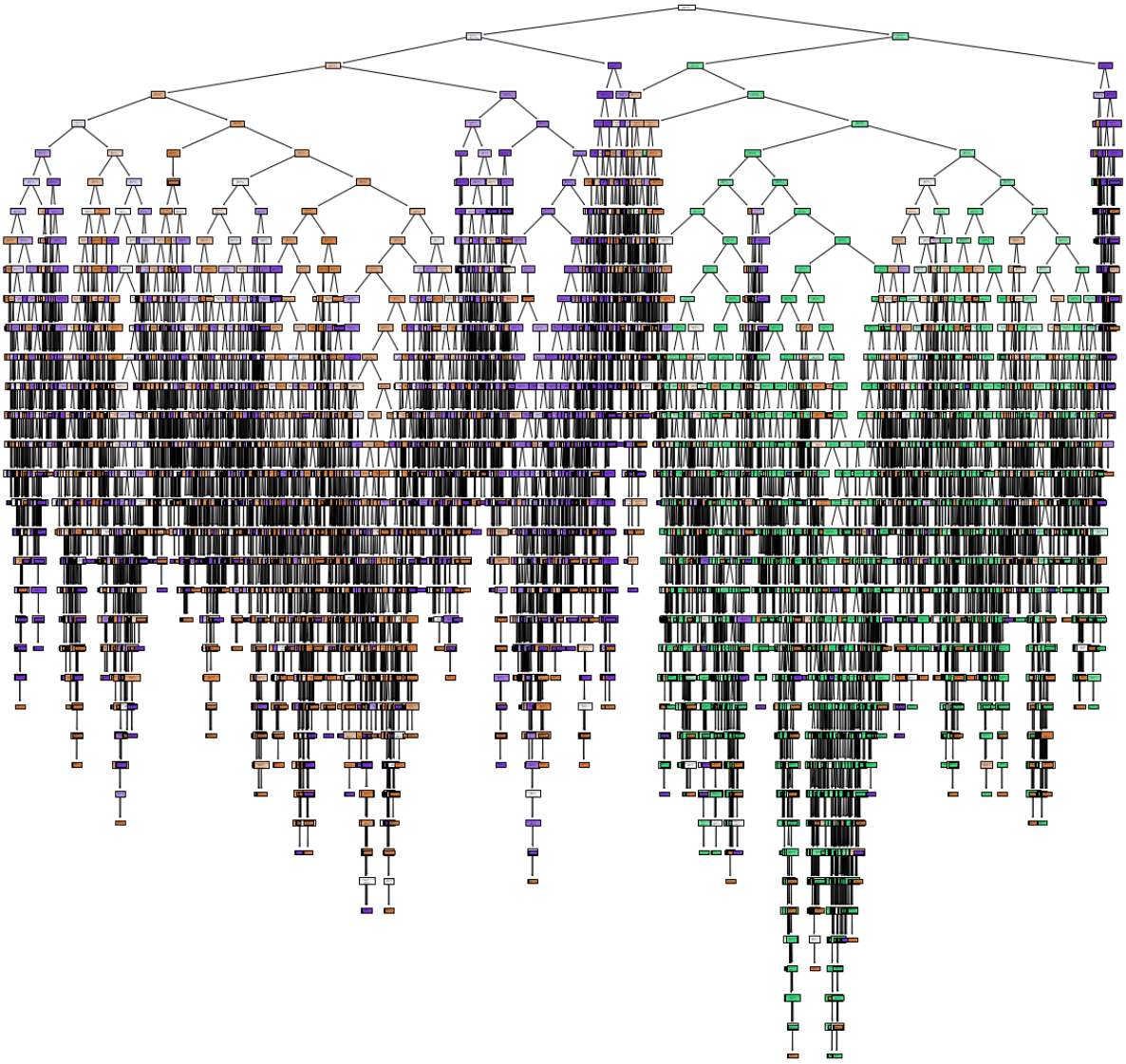
In [46]:
```
dict={'input':X.columns,'IG':IG}
df1=pd.DataFrame(dict)
df1.sort_values('IG',ascending=False)
#descending order according to IG
```

Out[46]:

	input	IG
14	last_pymnt_amnt	0.289252
0	term	0.255398
1	int_rate	0.110850
13	annual_inc	0.064231
12	installment	0.048728
5	issue_d	0.045815
11	funded_amnt_inv	0.042730
10	funded_amnt	0.030821
9	loan_amnt	0.028857
2	grade	0.024993
7	purpose	0.024373
3	home_ownership	0.022427
4	verification_status	0.011527
6	pymnt_plan	0.000000
8	application_type	0.000000

In [47]:

```
#create the tree
from sklearn import tree
features=X.columns#input features
fig=plt.figure(figsize=(20,20))
#_=tree.plot_tree(dt,feature_names=features,filled=True)
```



In [48]:
```
# our data is overfit in Decsion tree we apply pruning if our data is overfit
```

In [49]:
```
#for applying pruning first we will do hit and trial method
```

In [50]:
```
for i in range(1,9):
    dt1=DecisionTreeClassifier(max_depth=i,random_state=1)
    print('max_depth:',i)
    dt1=create_model(dt1)
```

```
max_depth: 1
              precision    recall  f1-score   support

           0       0.00      0.00      0.00      9883
           1       0.68      1.00      0.81      9883
           2       0.52      0.79      0.63      9883

    accuracy                           0.60     29649
   macro avg       0.40      0.60      0.48     29649
weighted avg       0.40      0.60      0.48     29649

[[   0 2621 7262]
 [   0 9883    0]
 [   0 2072 7811]]
max_depth: 2
              precision    recall  f1-score   support

           0       0.62      0.72      0.67      9883
           1       0.76      1.00      0.86      9883
           2       0.97      0.49      0.66      9883

    accuracy                           0.74     29649
   macro avg       0.78      0.74      0.73     29649
weighted avg       0.78      0.74      0.73     29649

[[7158 2582  143]
 [   0 9881    2]
 [4426  573 4884]]
max_depth: 3
              precision    recall  f1-score   support

           0       0.71      0.67      0.69      9883
           1       0.77      1.00      0.87      9883
           2       0.89      0.68      0.77      9883

    accuracy                           0.78     29649
   macro avg       0.79      0.78      0.77     29649
weighted avg       0.79      0.78      0.77     29649

[[6586 2444  853]
 [  27 9854    2]
 [2719  481 6683]]
max_depth: 4
              precision    recall  f1-score   support

           0       0.77      0.59      0.67      9883
           1       0.78      1.00      0.88      9883
           2       0.81      0.78      0.79      9883

    accuracy                           0.79     29649
   macro avg       0.79      0.79      0.78     29649
weighted avg       0.79      0.79      0.78     29649

[[5825 2292 1766]
 [  10 9849   24]
 [1757  436 7690]]
max_depth: 5
              precision    recall  f1-score   support

           0       0.74      0.65      0.69      9883
           1       0.78      1.00      0.88      9883
           2       0.86      0.73      0.79      9883

    accuracy                           0.79     29649
```

```
   macro avg       0.79      0.79      0.79     29649
weighted avg       0.79      0.79      0.79     29649

[[6442 2299 1142]
 [   5 9854   24]
 [2253  438 7192]]
max_depth: 6
              precision    recall  f1-score   support

           0       0.75      0.64      0.69      9883
           1       0.78      1.00      0.88      9883
           2       0.86      0.75      0.80      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.79     29649
weighted avg       0.80      0.80      0.79     29649

[[6344 2292 1247]
 [  29 9849    5]
 [2036  436 7411]]
max_depth: 7
              precision    recall  f1-score   support

           0       0.74      0.69      0.72      9883
           1       0.81      0.98      0.88      9883
           2       0.87      0.75      0.81      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6864 1953 1066]
 [ 241 9637    5]
 [2181  317 7385]]
max_depth: 8
              precision    recall  f1-score   support

           0       0.76      0.69      0.72      9883
           1       0.82      0.97      0.89      9883
           2       0.86      0.78      0.82      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[6836 1827 1220]
 [ 290 9567   26]
 [1879  252 7752]]
```

In [51]:

```
#above we got the good accuracy score at 8 loop
dt1=DecisionTreeClassifier(max_depth=7,random_state=1)
dt1=create_model(dt1)
```

```
              precision    recall  f1-score   support

           0       0.74      0.69      0.72      9883
           1       0.81      0.98      0.88      9883
           2       0.87      0.75      0.81      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6864 1953 1066]
 [ 241 9637    5]
 [2181  317 7385]]
```

In [52]:
```
#again coming back to the information gain
IG=dt1.feature_importances_
print('information gain:',IG)
```

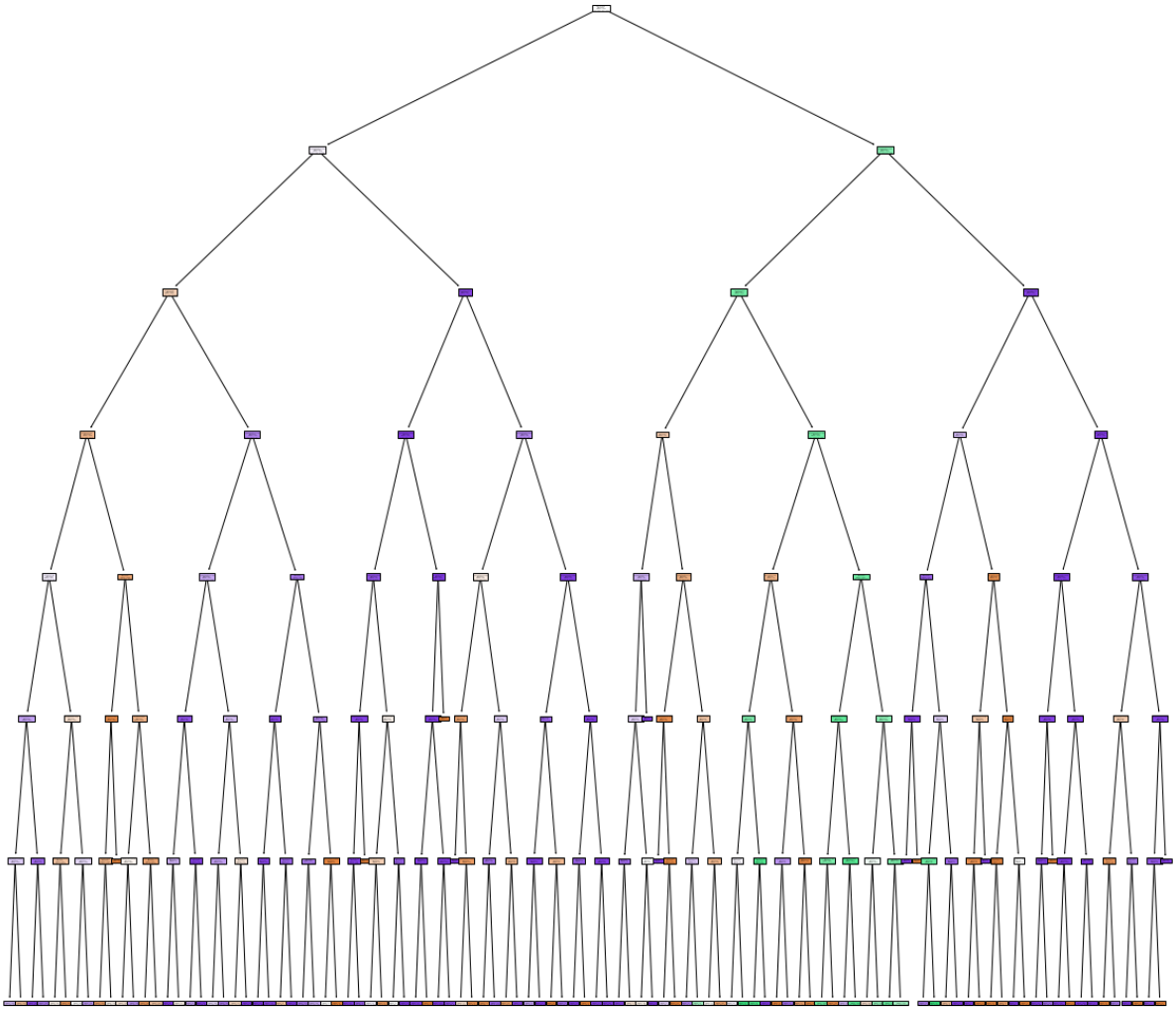
```
information gain: [4.27091568e-01 1.11849857e-01 2.57293287e-02 1.10001470e-02
 1.55017219e-03 1.95533160e-02 0.00000000e+00 3.21620220e-04
 0.00000000e+00 3.77093643e-03 9.70983957e-03 2.83250811e-03
 2.65893011e-02 2.25797348e-03 3.57743432e-01]
```

In [53]:
```
dict={'input':X.columns,'IG':IG}
df1=pd.DataFrame(dict)
df1.sort_values('IG',ascending=False)
```

Out[53]:

	input	IG
0	term	0.427092
14	last_pymnt_amnt	0.357743
1	int_rate	0.111850
12	installment	0.026589
2	grade	0.025729
5	issue_d	0.019553
3	home_ownership	0.011000
10	funded_amnt	0.009710
9	loan_amnt	0.003771
11	funded_amnt_inv	0.002833
13	annual_inc	0.002258
4	verification_status	0.001550
7	purpose	0.000322
6	pymnt_plan	0.000000
8	application_type	0.000000

In [58]:
```
#create the tree
#decison tree max depth pruning technique
from sklearn import tree
features=X.columns#input features
fig=plt.figure(figsize=(20,20))
#_=tree.plot_tree(dt1,feature_names=features,filled=True)
```



In [57]:
```
for i in range(45,101):
    dt2=DecisionTreeClassifier(min_samples_leaf=i,random_state=1)
    print('min samples:',i)
    dt2=create_model(dt2)
```

```
min samples: 45
              precision    recall  f1-score   support

           0       0.71      0.71      0.71      9883
           1       0.85      0.85      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7058 1276 1549]
 [1468 8384   31]
 [1363  191 8329]]
min samples: 46
              precision    recall  f1-score   support

           0       0.71      0.71      0.71      9883
           1       0.85      0.85      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7065 1288 1530]
 [1451 8388   44]
 [1385  191 8307]]
min samples: 47
              precision    recall  f1-score   support

           0       0.72      0.71      0.71      9883
           1       0.85      0.85      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7019 1302 1562]
 [1392 8447   44]
 [1368  188 8327]]
min samples: 48
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7046 1298 1539]
 [1386 8453   44]
 [1379  188 8316]]
min samples: 49
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.86      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
```

```
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7032 1313 1538]
 [1312 8527   44]
 [1387  195 8301]]
min samples: 50
              precision    recall  f1-score   support

           0       0.73      0.71      0.72      9883
           1       0.85      0.87      0.86      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[7014 1337 1532]
 [1254 8585   44]
 [1373  198 8312]]
min samples: 51
              precision    recall  f1-score   support

           0       0.72      0.72      0.72      9883
           1       0.85      0.85      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7075 1290 1518]
 [1426 8413   44]
 [1377  197 8309]]
min samples: 52
              precision    recall  f1-score   support

           0       0.72      0.72      0.72      9883
           1       0.85      0.85      0.85      9883
           2       0.85      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7134 1290 1459]
 [1422 8417   44]
 [1416  198 8269]]
min samples: 53
              precision    recall  f1-score   support

           0       0.72      0.72      0.72      9883
           1       0.85      0.86      0.85      9883
           2       0.85      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7139 1289 1455]
 [1388 8452   43]
 [1421  198 8264]]
min samples: 54
              precision    recall  f1-score   support
```

```
              precision    recall  f1-score   support

           0       0.72      0.72      0.72      9883
           1       0.85      0.86      0.85      9883
           2       0.85      0.84      0.84      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[7081 1346 1456]
 [1324 8518   41]
 [1398  203 8282]]
min samples: 55
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7055 1346 1482]
 [1329 8513   41]
 [1385  203 8295]]
min samples: 56
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.86      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7026 1354 1503]
 [1296 8546   41]
 [1385  205 8293]]
min samples: 57
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7028 1351 1504]
 [1322 8521   40]
 [1386  201 8296]]
min samples: 58
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.85      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649
```

```
[[6993 1355 1535]
 [1309 8533   41]
 [1371  201 8311]]
min samples: 59
              precision    recall  f1-score   support

           0       0.73      0.71      0.72      9883
           1       0.85      0.87      0.86      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.81     29649
   macro avg       0.80      0.81      0.81     29649
weighted avg       0.80      0.81      0.81     29649

[[6988 1342 1553]
 [1277 8575   31]
 [1345  206 8332]]
min samples: 60
              precision    recall  f1-score   support

           0       0.72      0.71      0.72      9883
           1       0.85      0.86      0.86      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.80     29649
weighted avg       0.80      0.80      0.80     29649

[[7018 1324 1541]
 [1327 8525   31]
 [1360  202 8321]]
min samples: 61
              precision    recall  f1-score   support

           0       0.73      0.71      0.72      9883
           1       0.85      0.87      0.86      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[7058 1303 1522]
 [1221 8638   24]
 [1386  203 8294]]
min samples: 62
              precision    recall  f1-score   support

           0       0.74      0.71      0.73      9883
           1       0.85      0.89      0.87      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[7043 1321 1519]
 [1074 8785   24]
 [1391  209 8283]]
min samples: 63
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
```

```
           1       0.85      0.90      0.87      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6993 1361 1529]
 [ 966 8893   24]
 [1356  212 8315]]
min samples: 64
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.90      0.87      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.82     29649
weighted avg       0.81      0.82      0.82     29649

[[6996 1357 1530]
 [ 970 8889   24]
 [1346  211 8326]]
min samples: 65
              precision    recall  f1-score   support

           0       0.76      0.71      0.73      9883
           1       0.85      0.90      0.88      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6979 1351 1553]
 [ 926 8933   24]
 [1333  212 8338]]
min samples: 66
              precision    recall  f1-score   support

           0       0.76      0.71      0.73      9883
           1       0.85      0.90      0.88      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7005 1351 1527]
 [ 919 8940   24]
 [1354  212 8317]]
min samples: 67
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.90      0.88      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7031 1332 1520]
```

```
 [ 942 8917   24]
 [1355  214 8314]]
min samples: 68
              precision    recall  f1-score   support

           0       0.76      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7029 1358 1496]
 [ 883 8976   24]
 [1380  221 8282]]
min samples: 69
              precision    recall  f1-score   support

           0       0.75      0.72      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7072 1358 1453]
 [ 886 8973   24]
 [1426  221 8236]]
min samples: 70
              precision    recall  f1-score   support

           0       0.75      0.72      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7085 1346 1452]
 [ 907 8952   24]
 [1437  218 8228]]
min samples: 71
              precision    recall  f1-score   support

           0       0.75      0.72      0.74      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7107 1345 1431]
 [ 904 8955   24]
 [1444  217 8222]]
min samples: 72
              precision    recall  f1-score   support

           0       0.75      0.72      0.74      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883
```

```
    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7109 1348 1426]
 [ 895 8964   24]
 [1448  217 8218]]
min samples: 73
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7066 1348 1469]
 [ 895 8964   24]
 [1416  218 8249]]
min samples: 74
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7066 1348 1469]
 [ 895 8964   24]
 [1420  217 8246]]
min samples: 75
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7056 1358 1469]
 [ 888 8971   24]
 [1418  217 8248]]
min samples: 76
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7058 1339 1486]
 [ 906 8953   24]
 [1418  217 8248]]
```

```
min samples: 77
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.85      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7062 1339 1482]
 [ 906 8953   24]
 [1439  217 8227]]
min samples: 78
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.84      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7063 1334 1486]
 [ 886 8973   24]
 [1490  207 8186]]
min samples: 79
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.84      0.83      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.82     29649
weighted avg       0.81      0.82      0.82     29649

[[7014 1334 1535]
 [ 885 8974   24]
 [1453  207 8223]]
min samples: 80
              precision    recall  f1-score   support

           0       0.74      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.84      0.83      0.83      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[7030 1334 1519]
 [ 887 8972   24]
 [1521  207 8155]]
min samples: 81
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
```

```
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[7032 1342 1509]
 [ 834 9025   24]
 [1542  208 8133]]
min samples: 82
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.88      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[7020 1360 1503]
 [ 815 9044   24]
 [1535  207 8141]]
min samples: 83
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.88      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7051 1352 1480]
 [ 785 9074   24]
 [1540  214 8129]]
min samples: 84
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.88      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7060 1355 1468]
 [ 789 9070   24]
 [1566  215 8102]]
min samples: 85
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.91      0.88      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[7034 1347 1502]
 [ 817 9042   24]
 [1550  215 8118]]
min samples: 86
              precision    recall  f1-score   support
```

```
              0       0.75      0.71      0.73      9883
              1       0.85      0.91      0.88      9883
              2       0.84      0.82      0.83      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[7016 1362 1505]
 [ 831 9028   24]
 [1558  211 8114]]
min samples: 87
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.88      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6995 1378 1510]
 [ 799 9060   24]
 [1550  210 8123]]
min samples: 88
              precision    recall  f1-score   support

           0       0.75      0.70      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6959 1385 1539]
 [ 745 9114   24]
 [1548  212 8123]]
min samples: 89
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6970 1385 1528]
 [ 745 9114   24]
 [1556  213 8114]]
min samples: 90
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649
```

```
[[6974 1404 1505]
 [ 723 9136   24]
 [1551  213 8119]]
min samples: 91
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7013 1377 1493]
 [ 720 9139   24]
 [1578  207 8098]]
min samples: 92
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7013 1372 1498]
 [ 720 9139   24]
 [1580  188 8115]]
min samples: 93
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.93      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6987 1372 1524]
 [ 717 9142   24]
 [1565  187 8131]]
min samples: 94
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[7004 1371 1508]
 [ 723 9136   24]
 [1557  188 8138]]
min samples: 95
              precision    recall  f1-score   support

           0       0.76      0.71      0.73      9883
```

```
           1       0.85      0.92      0.89      9883
           2       0.84      0.83      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6969 1371 1543]
 [ 723 9136   24]
 [1513  187 8183]]
min samples: 96
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6989 1366 1528]
 [ 731 9128   24]
 [1544  188 8151]]
min samples: 97
              precision    recall  f1-score   support

           0       0.75      0.70      0.73      9883
           1       0.86      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6965 1363 1555]
 [ 721 9136   26]
 [1554  185 8144]]
min samples: 98
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.86      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6999 1363 1521]
 [ 721 9136   26]
 [1594  185 8104]]
min samples: 99
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6969 1386 1528]
```

```
 [ 717 9140   26]
 [1588  195 8100]]
min samples: 100
              precision    recall  f1-score   support

           0       0.75      0.70      0.73      9883
           1       0.85      0.92      0.89      9883
           2       0.84      0.82      0.83      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6933 1385 1565]
 [ 717 9140   26]
 [1541  194 8148]]
```

In [59]:
```
dt2=DecisionTreeClassifier(min_samples_leaf=63,random_state=1)
dt2=create_model(dt2)
```

```
              precision    recall  f1-score   support

           0       0.75      0.71      0.73      9883
           1       0.85      0.90      0.87      9883
           2       0.84      0.84      0.84      9883

    accuracy                           0.82     29649
   macro avg       0.81      0.82      0.81     29649
weighted avg       0.81      0.82      0.81     29649

[[6993 1361 1529]
 [ 966 8893   24]
 [1356  212 8315]]
```

In [60]:
```
#in min_samples_leaf we got bit good accuracy but yet we have remaining
#more algos that if we apply we might get good score
```

In [61]:
```
IG=dt2.feature_importances_
print('information gain:',IG)
```

```
information gain: [0.36286826 0.11654338 0.02985772 0.01957757 0.00397664 0.024542
53
 0.         0.00387262 0.         0.01280442 0.01800513 0.01255553
 0.03374593 0.02531025 0.33634002]
```

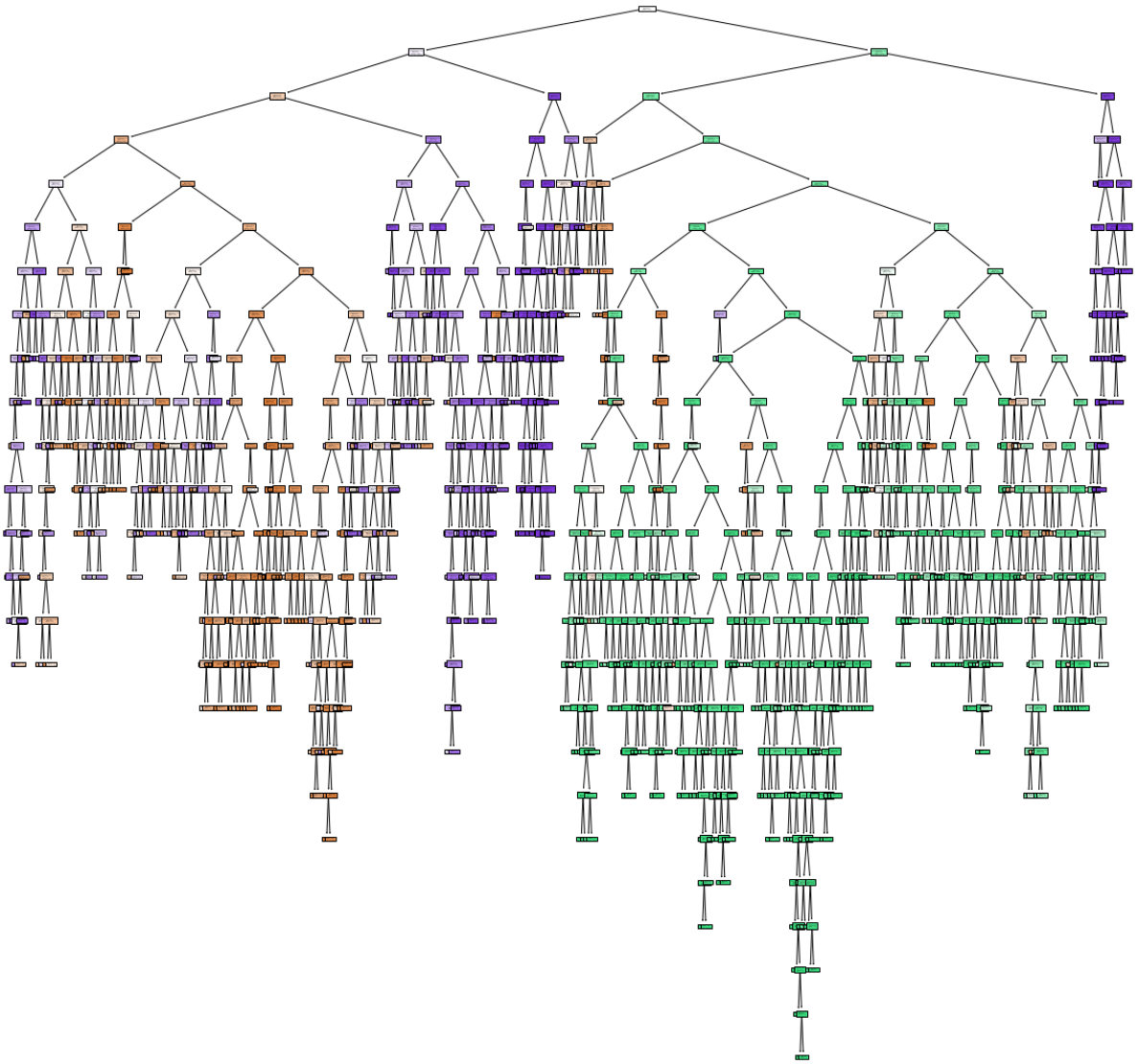
In [62]:
```
dict={'Input':X.columns,'IG':IG}
df1=pd.DataFrame(dict)
df1.sort_values('IG',ascending=False)#descending order according to IG
```

Out[62]:

	Input	IG
0	term	0.362868
14	last_pymnt_amnt	0.336340
1	int_rate	0.116543
12	installment	0.033746
2	grade	0.029858
13	annual_inc	0.025310
5	issue_d	0.024543
3	home_ownership	0.019578
10	funded_amnt	0.018005
9	loan_amnt	0.012804
11	funded_amnt_inv	0.012556
4	verification_status	0.003977
7	purpose	0.003873
6	pymnt_plan	0.000000
8	application_type	0.000000

In [63]:

```
#making tree with the help of min_samples_leaf
from sklearn import tree
features=X.columns#input features
fig=plt.figure(figsize=(20,20))
#_=tree.plot_tree(dt2,feature_names=features,filled=True)
```



In [64]:
```
for i in range(1,9):
    dt1=DecisionTreeClassifier(max_depth=i,random_state=1,
                               criterion='entropy')
    print('max_depth:',i)
    dt1=create_model(dt1)
```

```
max_depth: 1
              precision    recall  f1-score   support

           0       0.00      0.00      0.00      9883
           1       0.68      1.00      0.81      9883
           2       0.52      0.79      0.63      9883

    accuracy                           0.60     29649
   macro avg       0.40      0.60      0.48     29649
weighted avg       0.40      0.60      0.48     29649

[[   0 2621 7262]
 [   0 9883    0]
 [   0 2072 7811]]
max_depth: 2
              precision    recall  f1-score   support

           0       0.61      0.73      0.66      9883
           1       0.76      1.00      0.86      9883
           2       0.98      0.47      0.63      9883

    accuracy                           0.73     29649
   macro avg       0.78      0.73      0.72     29649
weighted avg       0.78      0.73      0.72     29649

[[7202 2593   88]
 [   0 9883    0]
 [4663  588 4632]]
max_depth: 3
              precision    recall  f1-score   support

           0       0.70      0.67      0.68      9883
           1       0.77      1.00      0.87      9883
           2       0.89      0.66      0.76      9883

    accuracy                           0.78     29649
   macro avg       0.79      0.78      0.77     29649
weighted avg       0.79      0.78      0.77     29649

[[6627 2455  801]
 [  27 9856    0]
 [2876  492 6515]]
max_depth: 4
              precision    recall  f1-score   support

           0       0.70      0.68      0.69      9883
           1       0.78      1.00      0.88      9883
           2       0.89      0.66      0.76      9883

    accuracy                           0.78     29649
   macro avg       0.79      0.78      0.77     29649
weighted avg       0.79      0.78      0.77     29649

[[6762 2305  816]
 [   8 9851   24]
 [2918  448 6517]]
max_depth: 5
              precision    recall  f1-score   support

           0       0.74      0.64      0.69      9883
           1       0.78      1.00      0.88      9883
           2       0.85      0.72      0.78      9883

    accuracy                           0.79     29649
```

```
   macro avg       0.79      0.79      0.78     29649
weighted avg       0.79      0.79      0.78     29649

[[6346 2312 1225]
 [   3 9856   24]
 [2270  451 7162]]
max_depth: 6
              precision    recall  f1-score   support

           0       0.74      0.64      0.69      9883
           1       0.78      1.00      0.88      9883
           2       0.85      0.73      0.78      9883

    accuracy                           0.79     29649
   macro avg       0.79      0.79      0.78     29649
weighted avg       0.79      0.79      0.78     29649

[[6333 2305 1245]
 [   3 9851   29]
 [2233  448 7202]]
max_depth: 7
              precision    recall  f1-score   support

           0       0.75      0.65      0.70      9883
           1       0.81      0.98      0.88      9883
           2       0.84      0.77      0.80      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.79     29649
weighted avg       0.80      0.80      0.79     29649

[[6459 1982 1442]
 [ 215 9639   29]
 [1963  316 7604]]
max_depth: 8
              precision    recall  f1-score   support

           0       0.76      0.67      0.71      9883
           1       0.82      0.97      0.89      9883
           2       0.85      0.79      0.82      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[6622 1839 1422]
 [ 297 9581    5]
 [1793  270 7820]]
```

In [66]:
```
#by applying the impurities removal techique i.e entropy our score is reducing
#so by applying the min_samples_leaf accuracy has reduced from 82% to 81% max
#and we have importance for 1% single percent
```

In [67]:
```
#applying the third Algo to the dataset
from sklearn.svm import LinearSVC
```

In [68]:
```
#creating the object
svc=LinearSVC(random_state=1)
```

In [69]:
```
svc=create_model(svc)
```

```
              precision    recall  f1-score   support

           0       0.70      0.65      0.67      9883
           1       0.76      1.00      0.86      9883
           2       0.87      0.66      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.76     29649
weighted avg       0.78      0.77      0.76     29649

[[6444 2497  942]
 [  40 9843    0]
 [2734  586 6563]]
```

In [70]:
```
#the score has been decreased in every aspect support vector classifier
#of the dataset accuracy score has reduced
```

In [71]:
```
#adding some external feature to the dataset
```

In [73]:
```
svc1=LinearSVC(random_state=1,C=0.01)
svc1=create_model(svc1)
#no effct of external parameter  score is same i.e less
#so no change in score that means data is non linear
```

```
              precision    recall  f1-score   support

           0       0.70      0.65      0.67      9883
           1       0.76      1.00      0.86      9883
           2       0.87      0.66      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.76     29649
weighted avg       0.78      0.77      0.76     29649

[[6421 2526  936]
 [  49 9834    0]
 [2740  603 6540]]
```

In [74]:
```
from sklearn.svm import SVC
```

In [76]:
```
#so here given dataset to the kernel function bcoz data is non linear
#for finding the optimal linearty of the data
svc1=SVC(random_state=1,kernel='poly')
```

In [77]:
```
svc1=create_model(svc1)
#poly has given bit good score but not the best
```

```
              precision    recall  f1-score   support

           0       0.79      0.65      0.71      9883
           1       0.78      0.99      0.87      9883
           2       0.87      0.78      0.82      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6453 2291 1139]
 [ 109 9771    3]
 [1636  530 7717]]
```

In [79]:
```
#applying the second kernel function
svc2=SVC(random_state=1,kernel='rbf')
```

```
svc2=create_model(svc2)
#by using rbf score has been intact as of dt with min_sample_leaf technique
```

```
              precision    recall  f1-score   support

           0       0.83      0.64      0.72      9883
           1       0.79      0.98      0.88      9883
           2       0.85      0.85      0.85      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6303 2134 1446]
 [ 201 9668   14]
 [1135  372 8376]]
```

In [80]:
```
#using ensemble technique
from sklearn.ensemble import RandomForestClassifier
```

In [81]:
```
#using hit and trail method for rfc
for i in range(10,101):
    rfc=RandomForestClassifier(n_estimators=i,random_state=1)
    print('no. of trees:',i)
    rfc=create_model(rfc)
```

```
no. of trees: 10
              precision    recall  f1-score   support

           0       0.74      0.77      0.76      9883
           1       0.90      0.84      0.87      9883
           2       0.85      0.87      0.86      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7640  859 1384]
 [1521 8286   76]
 [1191  109 8583]]
no. of trees: 11
              precision    recall  f1-score   support

           0       0.76      0.75      0.75      9883
           1       0.89      0.85      0.87      9883
           2       0.84      0.89      0.86      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7366  905 1612]
 [1378 8440   65]
 [1004  109 8770]]
no. of trees: 12
              precision    recall  f1-score   support

           0       0.74      0.77      0.76      9883
           1       0.90      0.84      0.87      9883
           2       0.85      0.87      0.86      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7611  856 1416]
 [1481 8326   76]
 [1140  106 8637]]
no. of trees: 13
              precision    recall  f1-score   support

           0       0.76      0.74      0.75      9883
           1       0.89      0.85      0.87      9883
           2       0.84      0.89      0.86      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7348  903 1632]
 [1375 8430   78]
 [ 983  105 8795]]
no. of trees: 14
              precision    recall  f1-score   support

           0       0.75      0.76      0.75      9883
           1       0.89      0.85      0.87      9883
           2       0.85      0.88      0.86      9883

    accuracy                           0.83     29649
```

```
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7528  895 1460]
 [1437 8366   80]
 [1096  103 8684]]
no. of trees: 15
              precision    recall  f1-score   support

           0       0.76      0.74      0.75      9883
           1       0.89      0.86      0.87      9883
           2       0.84      0.89      0.86      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7324  917 1642]
 [1328 8475   80]
 [ 954  106 8823]]
no. of trees: 16
              precision    recall  f1-score   support

           0       0.75      0.76      0.76      9883
           1       0.89      0.85      0.87      9883
           2       0.85      0.88      0.86      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7491  907 1485]
 [1388 8411   84]
 [1055  106 8722]]
no. of trees: 17
              precision    recall  f1-score   support

           0       0.77      0.74      0.75      9883
           1       0.89      0.86      0.88      9883
           2       0.84      0.89      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7330  924 1629]
 [1280 8519   84]
 [ 942  102 8839]]
no. of trees: 18
              precision    recall  f1-score   support

           0       0.76      0.76      0.76      9883
           1       0.89      0.85      0.87      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7471  918 1494]
 [1366 8433   84]
 [1014  102 8767]]
no. of trees: 19
              precision    recall  f1-score   support
```

```
              0       0.77      0.74      0.75      9883
              1       0.89      0.86      0.88      9883
              2       0.84      0.90      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7314  926 1643]
 [1265 8533   85]
 [ 934   98 8851]]
no. of trees: 20
              precision    recall  f1-score   support

              0       0.76      0.75      0.76      9883
              1       0.89      0.86      0.88      9883
              2       0.85      0.89      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7443  915 1525]
 [1320 8488   75]
 [1028  100 8755]]
no. of trees: 21
              precision    recall  f1-score   support

              0       0.77      0.74      0.76      9883
              1       0.89      0.87      0.88      9883
              2       0.84      0.90      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7317  921 1645]
 [1246 8561   76]
 [ 932  100 8851]]
no. of trees: 22
              precision    recall  f1-score   support

              0       0.77      0.75      0.76      9883
              1       0.89      0.86      0.88      9883
              2       0.85      0.89      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7429  933 1521]
 [1269 8541   73]
 [1002  101 8780]]
no. of trees: 23
              precision    recall  f1-score   support

              0       0.77      0.74      0.76      9883
              1       0.89      0.87      0.88      9883
              2       0.84      0.90      0.87      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649
```

```
[[7315  932 1636]
 [1225 8580   78]
 [ 929  103 8851]]
no. of trees: 24
              precision    recall  f1-score   support

           0       0.77      0.75      0.76      9883
           1       0.89      0.87      0.88      9883
           2       0.84      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7426  923 1534]
 [1240 8565   78]
 [ 996  101 8786]]
no. of trees: 25
              precision    recall  f1-score   support

           0       0.78      0.74      0.76      9883
           1       0.89      0.87      0.88      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7314  934 1635]
 [1185 8624   74]
 [ 925  104 8854]]
no. of trees: 26
              precision    recall  f1-score   support

           0       0.77      0.75      0.76      9883
           1       0.89      0.87      0.88      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7445  930 1508]
 [1214 8596   73]
 [ 985  103 8795]]
no. of trees: 27
              precision    recall  f1-score   support

           0       0.78      0.74      0.76      9883
           1       0.89      0.87      0.88      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7342  936 1605]
 [1166 8636   81]
 [ 922  102 8859]]
no. of trees: 28
              precision    recall  f1-score   support

           0       0.77      0.75      0.76      9883
```

```
           1       0.89      0.87      0.88      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7444  922 1517]
 [1201 8604   78]
 [ 985  102 8796]]
no. of trees: 29
              precision    recall  f1-score   support

           0       0.78      0.74      0.76      9883
           1       0.89      0.87      0.88      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7353  924 1606]
 [1170 8637   76]
 [ 916   99 8868]]
no. of trees: 30
              precision    recall  f1-score   support

           0       0.78      0.75      0.76      9883
           1       0.89      0.88      0.88      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7409  940 1534]
 [1154 8653   76]
 [ 955   97 8831]]
no. of trees: 31
              precision    recall  f1-score   support

           0       0.78      0.74      0.76      9883
           1       0.89      0.88      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7332  941 1610]
 [1138 8673   72]
 [ 913   97 8873]]
no. of trees: 32
              precision    recall  f1-score   support

           0       0.78      0.75      0.76      9883
           1       0.89      0.88      0.88      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7413  937 1533]
```

```
 [1158 8655   70]
 [ 954   96 8833]]
no. of trees: 33
              precision    recall  f1-score   support

           0       0.79      0.74      0.76      9883
           1       0.89      0.88      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7340  937 1606]
 [1100 8710   73]
 [ 899  101 8883]]
no. of trees: 34
              precision    recall  f1-score   support

           0       0.78      0.75      0.77      9883
           1       0.89      0.88      0.89      9883
           2       0.84      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7402  931 1550]
 [1109 8694   80]
 [ 953   98 8832]]
no. of trees: 35
              precision    recall  f1-score   support

           0       0.79      0.74      0.76      9883
           1       0.89      0.88      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7341  931 1611]
 [1079 8724   80]
 [ 908   98 8877]]
no. of trees: 36
              precision    recall  f1-score   support

           0       0.79      0.75      0.77      9883
           1       0.89      0.88      0.89      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7408  935 1540]
 [1086 8722   75]
 [ 942  101 8840]]
no. of trees: 37
              precision    recall  f1-score   support

           0       0.79      0.74      0.76      9883
           1       0.89      0.88      0.89      9883
           2       0.84      0.90      0.87      9883
```

```
    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7332  935 1616]
 [1069 8737   77]
 [ 899  105 8879]]
no. of trees: 38
              precision    recall  f1-score   support

           0       0.79      0.75      0.77      9883
           1       0.89      0.88      0.89      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7386  950 1547]
 [1076 8737   70]
 [ 941  102 8840]]
no. of trees: 39
              precision    recall  f1-score   support

           0       0.79      0.74      0.76      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7318  946 1619]
 [1058 8758   67]
 [ 896  100 8887]]
no. of trees: 40
              precision    recall  f1-score   support

           0       0.79      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7381  954 1548]
 [1038 8772   73]
 [ 935  104 8844]]
no. of trees: 41
              precision    recall  f1-score   support

           0       0.79      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7330  942 1611]
 [1042 8773   68]
 [ 891  103 8889]]
```

```
no. of trees: 42
              precision    recall  f1-score   support

           0       0.79      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.89      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7382  945 1556]
 [1041 8766   76]
 [ 935  104 8844]]
no. of trees: 43
              precision    recall  f1-score   support

           0       0.79      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7324  949 1610]
 [1052 8757   74]
 [ 870  103 8910]]
no. of trees: 44
              precision    recall  f1-score   support

           0       0.79      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7400  943 1540]
 [1046 8765   72]
 [ 915  101 8867]]
no. of trees: 45
              precision    recall  f1-score   support

           0       0.79      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7344  940 1599]
 [1038 8772   73]
 [ 873  101 8909]]
no. of trees: 46
              precision    recall  f1-score   support

           0       0.79      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
```

```
   macro avg       0.84      0.85      0.84     29649
weighted avg       0.84      0.85      0.84     29649

[[7397  937 1549]
 [1033 8780   70]
 [ 905  101 8877]]
no. of trees: 47
              precision    recall  f1-score   support

           0       0.79      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7334  943 1606]
 [1026 8784   73]
 [ 866  102 8915]]
no. of trees: 48
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.84      0.85      0.84     29649
weighted avg       0.84      0.85      0.84     29649

[[7398  945 1540]
 [1009 8797   77]
 [ 897  102 8884]]
no. of trees: 49
              precision    recall  f1-score   support

           0       0.80      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.84      0.85      0.84     29649
weighted avg       0.84      0.85      0.84     29649

[[7338  948 1597]
 [ 982 8821   80]
 [ 859  103 8921]]
no. of trees: 50
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7399  941 1543]
 [ 986 8819   78]
 [ 892  101 8890]]
no. of trees: 51
              precision    recall  f1-score   support
```

```
           0       0.80      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7345  947 1591]
 [ 979 8819   85]
 [ 860  102 8921]]
no. of trees: 52
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7405  936 1542]
 [ 989 8812   82]
 [ 896  102 8885]]
no. of trees: 53
              precision    recall  f1-score   support

           0       0.80      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7354  943 1586]
 [ 985 8816   82]
 [ 857  107 8919]]
no. of trees: 54
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7406  945 1532]
 [ 979 8821   83]
 [ 883  104 8896]]
no. of trees: 55
              precision    recall  f1-score   support

           0       0.80      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649
```

```
[[7351  950 1582]
 [ 970 8832   81]
 [ 852  104 8927]]
no. of trees: 56
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7395  950 1538]
 [ 978 8826   79]
 [ 881  107 8895]]
no. of trees: 57
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7366  943 1574]
 [ 976 8831   76]
 [ 856  106 8921]]
no. of trees: 58
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7390  951 1542]
 [ 975 8825   83]
 [ 877  109 8897]]
no. of trees: 59
              precision    recall  f1-score   support

           0       0.80      0.74      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7359  943 1581]
 [ 976 8823   84]
 [ 845  108 8930]]
no. of trees: 60
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
```

```
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7410  937 1536]
 [ 981 8815   87]
 [ 881  106 8896]]
no. of trees: 61
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7369  936 1578]
 [ 966 8835   82]
 [ 854  106 8923]]
no. of trees: 62
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7403  941 1539]
 [ 960 8843   80]
 [ 882  107 8894]]
no. of trees: 63
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.89      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7381  942 1560]
 [ 955 8851   77]
 [ 855  105 8923]]
no. of trees: 64
              precision    recall  f1-score   support

           0       0.80      0.75      0.78      9883
           1       0.89      0.90      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7413  949 1521]
```

```
 [ 956 8850   77]
 [ 874  109 8900]]
no. of trees: 65
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7379  945 1559]
 [ 958 8851   74]
 [ 852  107 8924]]
no. of trees: 66
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7402  951 1530]
 [ 963 8848   72]
 [ 869  107 8907]]
no. of trees: 67
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7378  947 1558]
 [ 955 8853   75]
 [ 852  104 8927]]
no. of trees: 68
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7401  950 1532]
 [ 959 8851   73]
 [ 867  106 8910]]
no. of trees: 69
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.90      9883
           2       0.84      0.90      0.87      9883
```

```
    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7369  949 1565]
 [ 944 8865   74]
 [ 851  109 8923]]
no. of trees: 70
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7401  952 1530]
 [ 951 8855   77]
 [ 869  110 8904]]
no. of trees: 71
              precision    recall  f1-score   support

           0       0.80      0.74      0.77      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7360  955 1568]
 [ 937 8879   67]
 [ 851  108 8924]]
no. of trees: 72
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7391  950 1542]
 [ 949 8862   72]
 [ 867  108 8908]]
no. of trees: 73
              precision    recall  f1-score   support

           0       0.81      0.75      0.77      9883
           1       0.89      0.90      0.90      9883
           2       0.84      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7366  943 1574]
 [ 933 8879   71]
 [ 844  107 8932]]
```

```
no. of trees: 74
              precision    recall  f1-score   support

           0       0.80      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7401  945 1537]
 [ 949 8861   73]
 [ 861  109 8913]]
no. of trees: 75
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7375  950 1558]
 [ 934 8879   70]
 [ 836  109 8938]]
no. of trees: 76
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7398  952 1533]
 [ 934 8877   72]
 [ 857  109 8917]]
no. of trees: 77
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7375  949 1559]
 [ 931 8880   72]
 [ 835  107 8941]]
no. of trees: 78
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
```

```
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7404  952 1527]
 [ 935 8876   72]
 [ 849  108 8926]]
no. of trees: 79
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7378  947 1558]
 [ 917 8891   75]
 [ 834  106 8943]]
no. of trees: 80
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7396  955 1532]
 [ 936 8878   69]
 [ 855  108 8920]]
no. of trees: 81
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7385  947 1551]
 [ 926 8887   70]
 [ 834  107 8942]]
no. of trees: 82
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.88      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7406  955 1522]
 [ 923 8896   64]
 [ 853  107 8923]]
no. of trees: 83
              precision    recall  f1-score   support
```

```
           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7383  950 1550]
 [ 918 8897   68]
 [ 836  107 8940]]
no. of trees: 84
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7402  950 1531]
 [ 934 8883   66]
 [ 852  108 8923]]
no. of trees: 85
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7387  946 1550]
 [ 931 8887   65]
 [ 840  109 8934]]
no. of trees: 86
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7416  946 1521]
 [ 926 8890   67]
 [ 857  108 8918]]
no. of trees: 87
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649
```

```
[[7392  941 1550]
 [ 916 8901   66]
 [ 839  108 8936]]
no. of trees: 88
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7407  941 1535]
 [ 931 8887   65]
 [ 854  108 8921]]
no. of trees: 89
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7379  941 1563]
 [ 931 8888   64]
 [ 835  108 8940]]
no. of trees: 90
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7411  939 1533]
 [ 939 8879   65]
 [ 856  109 8918]]
no. of trees: 91
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7393  936 1554]
 [ 932 8887   64]
 [ 834  108 8941]]
no. of trees: 92
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
```

```
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7409  938 1536]
 [ 934 8880   69]
 [ 853  109 8921]]
no. of trees: 93
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7382  939 1562]
 [ 940 8878   65]
 [ 836  108 8939]]
no. of trees: 94
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7411  940 1532]
 [ 939 8877   67]
 [ 851  110 8922]]
no. of trees: 95
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7379  938 1566]
 [ 942 8875   66]
 [ 838  110 8935]]
no. of trees: 96
              precision    recall  f1-score   support

           0       0.80      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7403  934 1546]
```

```
 [ 942 8876   65]
 [ 854  109 8920]]
no. of trees: 97
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7380  942 1561]
 [ 936 8880   67]
 [ 839  110 8934]]
no. of trees: 98
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7412  934 1537]
 [ 934 8880   69]
 [ 860  110 8913]]
no. of trees: 99
              precision    recall  f1-score   support

           0       0.81      0.75      0.77      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7375  942 1566]
 [ 934 8881   68]
 [ 843  110 8930]]
no. of trees: 100
              precision    recall  f1-score   support

           0       0.81      0.75      0.78      9883
           1       0.90      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7404  934 1545]
 [ 922 8894   67]
 [ 855  109 8919]]
```

In [82]:

```
rfc=RandomForestClassifier(n_estimators=48,random_state=1)
rfc=create_model(rfc)
```

```
                precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.84      0.85      0.84     29649
weighted avg       0.84      0.85      0.84     29649

[[7398  945 1540]
 [1009 8797   77]
 [ 897  102 8884]]
```

In [83]:
```
#dtc=82%
#svc=82%
#rfc=85%
#rfc min sample leaf=86%
#ada boost=85%
#xgboost=88%
```

In [84]:
```
#applying the pruning for randomForestTree
for i in range(1,9):
    rfc1=RandomForestClassifier(n_estimators=48,random_state=1,max_depth=i)
    print(i)
    rfc1=create_model(rfc1)
```

```
1
              precision    recall  f1-score   support

           0       0.69      0.60      0.64      9883
           1       0.69      0.99      0.81      9883
           2       0.79      0.55      0.65      9883

    accuracy                           0.71     29649
   macro avg       0.72      0.71      0.70     29649
weighted avg       0.72      0.71      0.70     29649

[[5970 2603 1310]
 [   0 9762  121]
 [2707 1771 5405]]
2
              precision    recall  f1-score   support

           0       0.71      0.66      0.68      9883
           1       0.71      0.99      0.83      9883
           2       0.86      0.59      0.70      9883

    accuracy                           0.74     29649
   macro avg       0.76      0.74      0.74     29649
weighted avg       0.76      0.74      0.74     29649

[[6488 2552  843]
 [  20 9743  120]
 [2647 1419 5817]]
3
              precision    recall  f1-score   support

           0       0.72      0.65      0.68      9883
           1       0.76      1.00      0.86      9883
           2       0.89      0.69      0.78      9883

    accuracy                           0.78     29649
   macro avg       0.79      0.78      0.77     29649
weighted avg       0.79      0.78      0.77     29649

[[6449 2580  854]
 [   4 9854   25]
 [2535  533 6815]]
4
              precision    recall  f1-score   support

           0       0.72      0.65      0.69      9883
           1       0.76      1.00      0.87      9883
           2       0.89      0.70      0.78      9883

    accuracy                           0.78     29649
   macro avg       0.79      0.78      0.78     29649
weighted avg       0.79      0.78      0.78     29649

[[6463 2532  888]
 [  18 9856    9]
 [2439  512 6932]]
5
              precision    recall  f1-score   support

           0       0.74      0.66      0.69      9883
           1       0.77      1.00      0.87      9883
           2       0.89      0.72      0.79      9883

    accuracy                           0.79     29649
```

```
   macro avg       0.80      0.79      0.79     29649
weighted avg       0.80      0.79      0.79     29649

[[6503 2490  890]
 [  14 9856   13]
 [2322  482 7079]]
6
              precision    recall  f1-score   support

           0       0.74      0.66      0.70      9883
           1       0.77      1.00      0.87      9883
           2       0.89      0.72      0.80      9883

    accuracy                           0.79     29649
   macro avg       0.80      0.79      0.79     29649
weighted avg       0.80      0.79      0.79     29649

[[6532 2472  879]
 [  19 9855    9]
 [2266  471 7146]]
7
              precision    recall  f1-score   support

           0       0.76      0.67      0.71      9883
           1       0.78      0.99      0.88      9883
           2       0.89      0.75      0.81      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6656 2290  937]
 [  36 9832   15]
 [2076  425 7382]]
8
              precision    recall  f1-score   support

           0       0.77      0.67      0.72      9883
           1       0.79      1.00      0.88      9883
           2       0.88      0.76      0.82      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[6620 2250 1013]
 [  30 9845    8]
 [1940  392 7551]]
```

In [85]:
```
#no use of applying pruning on rfc as scores get reduced
```

In [87]:
```
#trail for rfc with min_sample_leaf
for i in range(1,9):
    rfc2=RandomForestClassifier(n_estimators=48,random_state=1,min_samples_leaf=i)
    print(i)
    rfc2=create_model(rfc2)
```

```
1
              precision    recall  f1-score   support

           0       0.80      0.75      0.77      9883
           1       0.89      0.89      0.89      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.84      0.85      0.84     29649
weighted avg       0.84      0.85      0.84     29649

[[7398  945 1540]
 [1009 8797   77]
 [ 897  102 8884]]
2
              precision    recall  f1-score   support

           0       0.80      0.74      0.77      9883
           1       0.89      0.90      0.90      9883
           2       0.85      0.90      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7314 1015 1554]
 [ 898 8930   55]
 [ 897  121 8865]]
3
              precision    recall  f1-score   support

           0       0.81      0.74      0.77      9883
           1       0.88      0.92      0.90      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7327 1062 1494]
 [ 762 9086   35]
 [ 948  133 8802]]
4
              precision    recall  f1-score   support

           0       0.82      0.75      0.78      9883
           1       0.88      0.93      0.91      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.85      0.86      0.85     29649
weighted avg       0.85      0.86      0.85     29649

[[7369 1068 1446]
 [ 639 9196   48]
 [ 949  141 8793]]
5
              precision    recall  f1-score   support

           0       0.82      0.74      0.78      9883
           1       0.88      0.94      0.91      9883
           2       0.86      0.88      0.87      9883

    accuracy                           0.85     29649
```

```
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7310 1139 1434]
 [ 614 9249   20]
 [1005  155 8723]]
6
              precision    recall  f1-score   support

           0       0.82      0.74      0.78      9883
           1       0.87      0.94      0.91      9883
           2       0.86      0.88      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7270 1172 1441]
 [ 584 9279   20]
 [1013  157 8713]]
7
              precision    recall  f1-score   support

           0       0.83      0.74      0.78      9883
           1       0.88      0.95      0.91      9883
           2       0.86      0.88      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.85      0.86      0.85     29649
weighted avg       0.85      0.86      0.85     29649

[[7321 1160 1402]
 [ 508 9349   26]
 [1036  164 8683]]
8
              precision    recall  f1-score   support

           0       0.82      0.73      0.77      9883
           1       0.87      0.95      0.91      9883
           2       0.86      0.87      0.87      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7244 1213 1426]
 [ 501 9370   12]
 [1083  170 8630]]
```

In [88]:

```
rfc2=RandomForestClassifier(n_estimators=48,random_state=1,min_samples_leaf=4)
rfc2=create_model(rfc2)
```

```
                precision    recall  f1-score   support

           0       0.82      0.75      0.78      9883
           1       0.88      0.93      0.91      9883
           2       0.85      0.89      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.85      0.86      0.85     29649
weighted avg       0.85      0.86      0.85     29649

[[7369 1068 1446]
 [ 639 9196   48]
 [ 949  141 8793]]
```

In [89]:
```
#only bit of effct of one percent on pruning in min samples leaf incerasing
#it at 86%
```

In [90]:
```
from sklearn.ensemble import AdaBoostClassifier
```

In [91]:
```
for i in range(1,17):
    ada=AdaBoostClassifier(n_estimators=i,random_state=1)
    print('decision stump:',i)
    ada=create_model(ada)
```

```
decision stump: 1
              precision    recall  f1-score   support

           0       0.00      0.00      0.00      9883
           1       0.68      1.00      0.81      9883
           2       0.52      0.79      0.63      9883

    accuracy                           0.60     29649
   macro avg       0.40      0.60      0.48     29649
weighted avg       0.40      0.60      0.48     29649

[[   0 2621 7262]
 [   0 9883    0]
 [   0 2072 7811]]
decision stump: 2
              precision    recall  f1-score   support

           0       0.61      0.73      0.66      9883
           1       0.76      1.00      0.86      9883
           2       0.98      0.47      0.64      9883

    accuracy                           0.73     29649
   macro avg       0.78      0.73      0.72     29649
weighted avg       0.78      0.73      0.72     29649

[[7194 2594   95]
 [   0 9883    0]
 [4618  588 4677]]
decision stump: 3
              precision    recall  f1-score   support

           0       0.61      0.73      0.66      9883
           1       0.76      1.00      0.86      9883
           2       0.98      0.47      0.64      9883

    accuracy                           0.73     29649
   macro avg       0.78      0.73      0.72     29649
weighted avg       0.78      0.73      0.72     29649

[[7194 2594   95]
 [   0 9883    0]
 [4618  588 4677]]
decision stump: 4
              precision    recall  f1-score   support

           0       0.62      0.71      0.66      9883
           1       0.77      1.00      0.87      9883
           2       0.92      0.51      0.66      9883

    accuracy                           0.74     29649
   macro avg       0.77      0.74      0.73     29649
weighted avg       0.77      0.74      0.73     29649

[[7009 2456  418]
 [   0 9856   27]
 [4352  492 5039]]
decision stump: 5
              precision    recall  f1-score   support

           0       0.62      0.71      0.66      9883
           1       0.77      1.00      0.87      9883
           2       0.92      0.51      0.66      9883

    accuracy                           0.74     29649
```

```
   macro avg       0.77      0.74      0.73     29649
weighted avg       0.77      0.74      0.73     29649

[[7009 2456  418]
 [   0 9856   27]
 [4352  492 5039]]
decision stump: 6
              precision    recall  f1-score   support

           0       0.62      0.72      0.66      9883
           1       0.77      1.00      0.87      9883
           2       0.94      0.51      0.66      9883

    accuracy                           0.74     29649
   macro avg       0.77      0.74      0.73     29649
weighted avg       0.77      0.74      0.73     29649

[[7100 2456  327]
 [  17 9856   10]
 [4385  492 5006]]
decision stump: 7
              precision    recall  f1-score   support

           0       0.63      0.71      0.67      9883
           1       0.77      1.00      0.87      9883
           2       0.92      0.53      0.68      9883

    accuracy                           0.75     29649
   macro avg       0.77      0.75      0.74     29649
weighted avg       0.77      0.75      0.74     29649

[[7012 2444  427]
 [  17 9856   10]
 [4142  457 5284]]
decision stump: 8
              precision    recall  f1-score   support

           0       0.64      0.68      0.66      9883
           1       0.77      1.00      0.87      9883
           2       0.88      0.57      0.70      9883

    accuracy                           0.75     29649
   macro avg       0.76      0.75      0.74     29649
weighted avg       0.76      0.75      0.74     29649

[[6682 2444  757]
 [   2 9856   25]
 [3744  457 5682]]
decision stump: 9
              precision    recall  f1-score   support

           0       0.64      0.68      0.66      9883
           1       0.77      1.00      0.87      9883
           2       0.88      0.58      0.70      9883

    accuracy                           0.75     29649
   macro avg       0.76      0.75      0.74     29649
weighted avg       0.76      0.75      0.74     29649

[[6682 2444  757]
 [   2 9856   25]
 [3742  457 5684]]
decision stump: 10
              precision    recall  f1-score   support
```

```
              0       0.68      0.65      0.67      9883
              1       0.77      1.00      0.87      9883
              2       0.86      0.65      0.74      9883

    accuracy                           0.77     29649
   macro avg       0.77      0.77      0.76     29649
weighted avg       0.77      0.77      0.76     29649

[[6409 2444 1030]
 [   2 9856   25]
 [2956  457 6470]]
decision stump: 11
              precision    recall  f1-score   support

           0       0.69      0.65      0.67      9883
           1       0.77      1.00      0.87      9883
           2       0.86      0.66      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.77      0.77      0.76     29649
weighted avg       0.77      0.77      0.76     29649

[[6444 2444  995]
 [   1 9856   26]
 [2939  457 6487]]
decision stump: 12
              precision    recall  f1-score   support

           0       0.69      0.65      0.67      9883
           1       0.78      1.00      0.87      9883
           2       0.86      0.66      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.76     29649
weighted avg       0.78      0.77      0.76     29649

[[6465 2414 1004]
 [   2 9855   26]
 [2943  436 6504]]
decision stump: 13
              precision    recall  f1-score   support

           0       0.68      0.67      0.68      9883
           1       0.78      0.99      0.87      9883
           2       0.87      0.65      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.76     29649
weighted avg       0.78      0.77      0.76     29649

[[6600 2349  934]
 [  67 9806   10]
 [3004  437 6442]]
decision stump: 14
              precision    recall  f1-score   support

           0       0.68      0.69      0.68      9883
           1       0.78      0.99      0.87      9883
           2       0.89      0.64      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.77     29649
weighted avg       0.78      0.77      0.77     29649
```

```
[[6782 2317  784]
 [  71 9802   10]
 [3093  424 6366]]
decision stump: 15
              precision    recall  f1-score   support

           0       0.67      0.70      0.68      9883
           1       0.78      0.99      0.87      9883
           2       0.90      0.62      0.73      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.76     29649
weighted avg       0.78      0.77      0.76     29649

[[6893 2317  673]
 [  71 9802   10]
 [3348  424 6111]]
decision stump: 16
              precision    recall  f1-score   support

           0       0.68      0.67      0.68      9883
           1       0.78      0.99      0.87      9883
           2       0.87      0.66      0.75      9883

    accuracy                           0.77     29649
   macro avg       0.78      0.77      0.77     29649
weighted avg       0.78      0.77      0.77     29649

[[6616 2317  950]
 [  71 9802   10]
 [2979  424 6480]]
```

In [92]:
```
ada=AdaBoostClassifier(n_estimators=10,random_state=i)
ada=create_model(ada)
```

```
              precision    recall  f1-score   support

           0       0.68      0.65      0.67      9883
           1       0.77      1.00      0.87      9883
           2       0.86      0.65      0.74      9883

    accuracy                           0.77     29649
   macro avg       0.77      0.77      0.76     29649
weighted avg       0.77      0.77      0.76     29649

[[6409 2444 1030]
 [   2 9856   25]
 [2956  457 6470]]
```

In [93]:
```
#check impotant features
dict={'Input':X.columns,'IG':ada.feature_importances_}
df1=pd.DataFrame(dict)
df1.sort_values('IG',ascending=False)
```

Out[93]:

	Input	IG
1	int_rate	0.2
3	home_ownership	0.2
14	last_pymnt_amnt	0.2
0	term	0.1
2	grade	0.1
5	issue_d	0.1
12	installment	0.1
4	verification_status	0.0
6	pymnt_plan	0.0
7	purpose	0.0
8	application_type	0.0
9	loan_amnt	0.0
10	funded_amnt	0.0
11	funded_amnt_inv	0.0
13	annual_inc	0.0

In [94]:
```
#for algo and reading purpose we used the adaboost technique but here score is get
#reduced upto 77% max
```

In [95]:
```
from sklearn.ensemble import GradientBoostingClassifier
```

In [97]:
```
for i in range(10,101):
    gbc=GradientBoostingClassifier(random_state=1,n_estimators=i)
    print('no.of iteration:',i)
    gbc=create_model(gbc)
```

```
no.of iteration: 10
              precision    recall  f1-score   support

           0       0.71      0.69      0.70      9883
           1       0.79      1.00      0.88      9883
           2       0.88      0.67      0.76      9883

    accuracy                           0.79     29649
   macro avg       0.79      0.79      0.78     29649
weighted avg       0.79      0.79      0.78     29649

[[6827 2200  856]
 [  22 9852    9]
 [2783  457 6643]]
no.of iteration: 11
              precision    recall  f1-score   support

           0       0.71      0.69      0.70      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.67      0.76      9883

    accuracy                           0.79     29649
   macro avg       0.79      0.79      0.78     29649
weighted avg       0.79      0.79      0.78     29649

[[6845 2183  855]
 [  22 9852    9]
 [2762  465 6656]]
no.of iteration: 12
              precision    recall  f1-score   support

           0       0.71      0.69      0.70      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.68      0.77      9883

    accuracy                           0.79     29649
   macro avg       0.80      0.79      0.78     29649
weighted avg       0.80      0.79      0.78     29649

[[6828 2197  858]
 [  21 9853    9]
 [2703  482 6698]]
no.of iteration: 13
              precision    recall  f1-score   support

           0       0.72      0.69      0.71      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.68      0.77      9883

    accuracy                           0.79     29649
   macro avg       0.80      0.79      0.79     29649
weighted avg       0.80      0.79      0.79     29649

[[6863 2157  863]
 [  22 9852    9]
 [2693  464 6726]]
no.of iteration: 14
              precision    recall  f1-score   support

           0       0.72      0.69      0.71      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.68      0.77      9883

    accuracy                           0.79     29649
```

```
   macro avg       0.80      0.79      0.79     29649
weighted avg       0.80      0.79      0.79     29649

[[6834 2185  864]
 [  22 9852    9]
 [2645  475 6763]]
no.of iteration: 15
              precision    recall  f1-score   support

           0       0.72      0.69      0.71      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.69      0.78      9883

    accuracy                           0.79     29649
   macro avg       0.80      0.79      0.79     29649
weighted avg       0.80      0.79      0.79     29649

[[6840 2172  871]
 [  21 9853    9]
 [2589  475 6819]]
no.of iteration: 16
              precision    recall  f1-score   support

           0       0.73      0.70      0.71      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.69      0.78      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.79     29649
weighted avg       0.80      0.80      0.79     29649

[[6881 2151  851]
 [  25 9853    5]
 [2565  474 6844]]
no.of iteration: 17
              precision    recall  f1-score   support

           0       0.73      0.70      0.71      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.70      0.78      9883

    accuracy                           0.80     29649
   macro avg       0.80      0.80      0.79     29649
weighted avg       0.80      0.80      0.79     29649

[[6898 2128  857]
 [  26 9852    5]
 [2510  460 6913]]
no.of iteration: 18
              precision    recall  f1-score   support

           0       0.74      0.70      0.72      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.71      0.79      9883

    accuracy                           0.80     29649
   macro avg       0.81      0.80      0.80     29649
weighted avg       0.81      0.80      0.80     29649

[[6914 2105  864]
 [  26 9852    5]
 [2449  458 6976]]
no.of iteration: 19
              precision    recall  f1-score   support
```

```
           0       0.74      0.70      0.72      9883
           1       0.79      1.00      0.88      9883
           2       0.89      0.71      0.79      9883

    accuracy                           0.80     29649
   macro avg       0.81      0.80      0.80     29649
weighted avg       0.81      0.80      0.80     29649

[[6908 2110  865]
 [  25 9853    5]
 [2393  460 7030]]
no.of iteration: 20
              precision    recall  f1-score   support

           0       0.74      0.70      0.72      9883
           1       0.80      1.00      0.89      9883
           2       0.89      0.72      0.79      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6945 2061  877]
 [  26 9852    5]
 [2360  444 7079]]
no.of iteration: 21
              precision    recall  f1-score   support

           0       0.75      0.70      0.72      9883
           1       0.80      1.00      0.89      9883
           2       0.89      0.72      0.80      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6934 2057  892]
 [  26 9852    5]
 [2313  442 7128]]
no.of iteration: 22
              precision    recall  f1-score   support

           0       0.75      0.70      0.72      9883
           1       0.80      1.00      0.89      9883
           2       0.89      0.72      0.80      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.80     29649
weighted avg       0.81      0.81      0.80     29649

[[6928 2059  896]
 [  26 9852    5]
 [2281  442 7160]]
no.of iteration: 23
              precision    recall  f1-score   support

           0       0.76      0.70      0.73      9883
           1       0.80      1.00      0.89      9883
           2       0.89      0.73      0.80      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649
```

```
[[6953 2047  883]
 [  26 9852    5]
 [2229  437 7217]]
no.of iteration: 24
              precision    recall  f1-score   support

           0       0.76      0.70      0.73      9883
           1       0.80      1.00      0.89      9883
           2       0.89      0.74      0.80      9883

    accuracy                           0.81     29649
   macro avg       0.81      0.81      0.81     29649
weighted avg       0.81      0.81      0.81     29649

[[6919 2039  925]
 [  25 9852    6]
 [2171  437 7275]]
no.of iteration: 25
              precision    recall  f1-score   support

           0       0.76      0.70      0.73      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.74      0.81      9883

    accuracy                           0.81     29649
   macro avg       0.82      0.81      0.81     29649
weighted avg       0.82      0.81      0.81     29649

[[6887 2032  964]
 [  24 9852    7]
 [2099  430 7354]]
no.of iteration: 26
              precision    recall  f1-score   support

           0       0.77      0.70      0.73      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.75      0.81      9883

    accuracy                           0.81     29649
   macro avg       0.82      0.81      0.81     29649
weighted avg       0.82      0.81      0.81     29649

[[6895 2027  961]
 [  24 9852    7]
 [2065  428 7390]]
no.of iteration: 27
              precision    recall  f1-score   support

           0       0.77      0.70      0.73      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.75      0.81      9883

    accuracy                           0.81     29649
   macro avg       0.82      0.81      0.81     29649
weighted avg       0.82      0.81      0.81     29649

[[6880 2030  973]
 [  26 9852    5]
 [2045  431 7407]]
no.of iteration: 28
              precision    recall  f1-score   support

           0       0.77      0.70      0.73      9883
```

```
           1       0.80      1.00      0.89      9883
           2       0.88      0.75      0.81      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.81     29649
weighted avg       0.82      0.82      0.81     29649

[[6921 1993  969]
 [  25 9852    6]
 [2049  422 7412]]
no.of iteration: 29
              precision    recall  f1-score   support

           0       0.77      0.70      0.74      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.75      0.81      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.81     29649
weighted avg       0.82      0.82      0.81     29649

[[6936 1981  966]
 [  25 9852    6]
 [2017  420 7446]]
no.of iteration: 30
              precision    recall  f1-score   support

           0       0.77      0.70      0.74      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.75      0.81      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.81     29649
weighted avg       0.82      0.82      0.81     29649

[[6925 1985  973]
 [  26 9852    5]
 [2008  420 7455]]
no.of iteration: 31
              precision    recall  f1-score   support

           0       0.77      0.70      0.74      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.76      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.81     29649
weighted avg       0.82      0.82      0.81     29649

[[6917 1982  984]
 [  26 9852    5]
 [1985  419 7479]]
no.of iteration: 32
              precision    recall  f1-score   support

           0       0.78      0.70      0.74      9883
           1       0.80      1.00      0.89      9883
           2       0.88      0.76      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.81     29649
weighted avg       0.82      0.82      0.81     29649

[[6917 1974  992]
```

```
 [  26 9852    5]
 [1968  416 7499]]
no.of iteration: 33
              precision    recall  f1-score   support

           0       0.78      0.70      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.76      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6947 1968  968]
 [  25 9852    6]
 [1939  415 7529]]
no.of iteration: 34
              precision    recall  f1-score   support

           0       0.78      0.70      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.88      0.76      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6944 1964  975]
 [  25 9852    6]
 [1944  413 7526]]
no.of iteration: 35
              precision    recall  f1-score   support

           0       0.78      0.70      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.76      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.82      0.82      0.82     29649
weighted avg       0.82      0.82      0.82     29649

[[6967 1955  961]
 [  26 9852    5]
 [1924  408 7551]]
no.of iteration: 36
              precision    recall  f1-score   support

           0       0.78      0.71      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.76      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.83      0.82      0.82     29649
weighted avg       0.83      0.82      0.82     29649

[[6989 1933  961]
 [  26 9852    5]
 [1920  406 7557]]
no.of iteration: 37
              precision    recall  f1-score   support

           0       0.78      0.71      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.77      0.82      9883
```

```
    accuracy                           0.82     29649
   macro avg       0.83      0.82      0.82     29649
weighted avg       0.83      0.82      0.82     29649

[[6986 1929  968]
 [  26 9852    5]
 [1908  404 7571]]
no.of iteration: 38
              precision    recall  f1-score   support

           0       0.78      0.71      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.77      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.83      0.82      0.82     29649
weighted avg       0.83      0.82      0.82     29649

[[6997 1916  970]
 [  26 9852    5]
 [1893  400 7590]]
no.of iteration: 39
              precision    recall  f1-score   support

           0       0.79      0.71      0.74      9883
           1       0.81      1.00      0.89      9883
           2       0.88      0.77      0.82      9883

    accuracy                           0.82     29649
   macro avg       0.83      0.82      0.82     29649
weighted avg       0.83      0.82      0.82     29649

[[6982 1909  992]
 [  27 9851    5]
 [1875  394 7614]]
no.of iteration: 40
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.77      0.82      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[6998 1905  980]
 [  27 9851    5]
 [1868  394 7621]]
no.of iteration: 41
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.89      9883
           2       0.88      0.77      0.82      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[6992 1903  988]
 [  27 9851    5]
 [1862  394 7627]]
```

```
no.of iteration: 42
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.89      9883
           2       0.89      0.77      0.82      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[7006 1892  985]
 [  27 9851    5]
 [1856  393 7634]]
no.of iteration: 43
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.90      9883
           2       0.88      0.77      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[6998 1888  997]
 [  27 9851    5]
 [1840  391 7652]]
no.of iteration: 44
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[7007 1883  993]
 [  27 9851    5]
 [1833  387 7663]]
no.of iteration: 45
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[6993 1882 1008]
 [  27 9851    5]
 [1814  387 7682]]
no.of iteration: 46
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
```

```
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[6999 1874 1010]
 [  27 9851    5]
 [1795  387 7701]]
no.of iteration: 47
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.81      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7020 1860 1003]
 [  27 9851    5]
 [1790  382 7711]]
no.of iteration: 48
              precision    recall  f1-score   support

           0       0.79      0.71      0.75      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.82     29649
weighted avg       0.83      0.83      0.82     29649

[[7009 1853 1021]
 [  30 9848    5]
 [1788  380 7715]]
no.of iteration: 49
              precision    recall  f1-score   support

           0       0.80      0.71      0.75      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7028 1844 1011]
 [  30 9848    5]
 [1765  381 7737]]
no.of iteration: 50
              precision    recall  f1-score   support

           0       0.80      0.71      0.75      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.78      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7030 1838 1015]
 [  30 9848    5]
 [1756  381 7746]]
no.of iteration: 51
              precision    recall  f1-score   support
```

```
           0       0.80      0.71      0.75      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7026 1832 1025]
 [  31 9846    6]
 [1734  376 7773]]
no.of iteration: 52
              precision    recall  f1-score   support

           0       0.80      0.71      0.75      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7044 1824 1015]
 [  33 9845    5]
 [1727  373 7783]]
no.of iteration: 53
              precision    recall  f1-score   support

           0       0.80      0.71      0.75      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.83      0.83      0.83     29649
weighted avg       0.83      0.83      0.83     29649

[[7050 1823 1010]
 [  33 9845    5]
 [1710  374 7799]]
no.of iteration: 54
              precision    recall  f1-score   support

           0       0.80      0.71      0.76      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.83      9883

    accuracy                           0.83     29649
   macro avg       0.84      0.83      0.83     29649
weighted avg       0.84      0.83      0.83     29649

[[7049 1815 1019]
 [  33 9845    5]
 [1693  373 7817]]
no.of iteration: 55
              precision    recall  f1-score   support

           0       0.80      0.71      0.76      9883
           1       0.82      1.00      0.90      9883
           2       0.89      0.79      0.84      9883

    accuracy                           0.83     29649
   macro avg       0.84      0.83      0.83     29649
weighted avg       0.84      0.83      0.83     29649
```

```
[[7064 1809 1010]
 [  38 9840    5]
 [1687  370 7826]]
no.of iteration: 56
              precision    recall  f1-score   support

           0       0.80      0.71      0.76      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.84      9883

    accuracy                           0.83     29649
   macro avg       0.84      0.83      0.83     29649
weighted avg       0.84      0.83      0.83     29649

[[7061 1801 1021]
 [  38 9840    5]
 [1685  366 7832]]
no.of iteration: 57
              precision    recall  f1-score   support

           0       0.81      0.71      0.76      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.84      9883

    accuracy                           0.83     29649
   macro avg       0.84      0.83      0.83     29649
weighted avg       0.84      0.83      0.83     29649

[[7058 1797 1028]
 [  38 9839    6]
 [1666  361 7856]]
no.of iteration: 58
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.79      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7073 1781 1029]
 [  41 9836    6]
 [1671  359 7853]]
no.of iteration: 59
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.82      1.00      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7078 1773 1032]
 [  38 9839    6]
 [1662  358 7863]]
no.of iteration: 60
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
```

```
           1       0.82      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7087 1762 1034]
 [  48 9829    6]
 [1649  356 7878]]
no.of iteration: 61
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.82      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7084 1757 1042]
 [  48 9829    6]
 [1631  354 7898]]
no.of iteration: 62
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.82      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7078 1755 1050]
 [  48 9829    6]
 [1629  353 7901]]
no.of iteration: 63
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.82      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7081 1746 1056]
 [  51 9826    6]
 [1610  350 7923]]
no.of iteration: 64
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7080 1739 1064]
```

```
 [  55 9822    6]
 [1600  343 7940]]
no.of iteration: 65
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7093 1728 1062]
 [  58 9819    6]
 [1603  343 7937]]
no.of iteration: 66
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7097 1724 1062]
 [  60 9817    6]
 [1586  342 7955]]
no.of iteration: 67
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7090 1719 1074]
 [  59 9818    6]
 [1573  342 7968]]
no.of iteration: 68
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7092 1718 1073]
 [  59 9818    6]
 [1565  339 7979]]
no.of iteration: 69
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883
```

```
    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7093 1715 1075]
 [  59 9818    6]
 [1561  338 7984]]
no.of iteration: 70
              precision    recall  f1-score   support

           0       0.82      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7086 1712 1085]
 [  59 9818    6]
 [1549  332 8002]]
no.of iteration: 71
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7088 1710 1085]
 [  59 9818    6]
 [1550  331 8002]]
no.of iteration: 72
              precision    recall  f1-score   support

           0       0.82      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7089 1710 1084]
 [  59 9818    6]
 [1536  331 8016]]
no.of iteration: 73
              precision    recall  f1-score   support

           0       0.82      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7099 1704 1080]
 [  59 9818    6]
 [1530  332 8021]]
```

```
no.of iteration: 74
              precision    recall  f1-score   support

           0       0.82      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7099 1704 1080]
 [  60 9817    6]
 [1525  332 8026]]
no.of iteration: 75
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7101 1702 1080]
 [  60 9817    6]
 [1519  332 8032]]
no.of iteration: 76
              precision    recall  f1-score   support

           0       0.82      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7103 1697 1083]
 [  68 9809    6]
 [1519  332 8032]]
no.of iteration: 77
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7098 1695 1090]
 [  65 9812    6]
 [1503  333 8047]]
no.of iteration: 78
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.85      9883

    accuracy                           0.84     29649
```

```
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7108 1690 1085]
 [  68 9809    6]
 [1501  329 8053]]
no.of iteration: 79
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7104 1691 1088]
 [  69 9808    6]
 [1497  329 8057]]
no.of iteration: 80
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7100 1683 1100]
 [  69 9808    6]
 [1486  328 8069]]
no.of iteration: 81
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7106 1683 1094]
 [  70 9807    6]
 [1485  325 8073]]
no.of iteration: 82
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7106 1682 1095]
 [  73 9804    6]
 [1482  324 8077]]
no.of iteration: 83
              precision    recall  f1-score   support
```

```
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7112 1682 1089]
 [  74 9803    6]
 [1478  322 8083]]
no.of iteration: 84
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7103 1676 1104]
 [  75 9802    6]
 [1468  321 8094]]
no.of iteration: 85
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7117 1671 1095]
 [  74 9803    6]
 [1474  318 8091]]
no.of iteration: 86
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7120 1669 1094]
 [  75 9802    6]
 [1473  318 8092]]
no.of iteration: 87
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649
```

```
[[7120 1668 1095]
 [  77 9800    6]
 [1463  317 8103]]
no.of iteration: 88
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.85      0.84      0.84     29649
weighted avg       0.85      0.84      0.84     29649

[[7124 1664 1095]
 [  77 9800    6]
 [1456  317 8110]]
no.of iteration: 89
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.85      0.84      0.84     29649
weighted avg       0.85      0.84      0.84     29649

[[7124 1665 1094]
 [  79 9798    6]
 [1452  317 8114]]
no.of iteration: 90
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.85      0.84      0.84     29649
weighted avg       0.85      0.84      0.84     29649

[[7127 1658 1098]
 [  79 9798    6]
 [1451  314 8118]]
no.of iteration: 91
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.85      0.84      0.84     29649
weighted avg       0.85      0.84      0.84     29649

[[7127 1654 1102]
 [  80 9797    6]
 [1444  314 8125]]
no.of iteration: 92
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
```

```
           1       0.83      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7137 1650 1096]
 [  85 9792    6]
 [1431  311 8141]]
no.of iteration: 93
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7139 1643 1101]
 [  87 9790    6]
 [1422  308 8153]]
no.of iteration: 94
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7134 1640 1109]
 [  89 9788    6]
 [1409  309 8165]]
no.of iteration: 95
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7139 1637 1107]
 [  94 9783    6]
 [1415  306 8162]]
no.of iteration: 96
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7141 1633 1109]
```

```
 [  94 9783    6]
 [1405  306 8172]]
no.of iteration: 97
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7145 1628 1110]
 [  96 9781    6]
 [1389  302 8192]]
no.of iteration: 98
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7145 1623 1115]
 [ 101 9776    6]
 [1391  299 8193]]
no.of iteration: 99
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7152 1622 1109]
 [ 109 9768    6]
 [1388  296 8199]]
no.of iteration: 100
              precision    recall  f1-score   support

           0       0.83      0.72      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7163 1616 1104]
 [ 105 9770    8]
 [1384  295 8204]]
```

In [98]:

```
gbc=GradientBoostingClassifier(random_state=1,n_estimators=92)
gbc=create_model(gbc)
#score is neutral in terms of algos
```

```
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7137 1650 1096]
 [  85 9792    6]
 [1431  311 8141]]
```

In [99]:
```
from xgboost import XGBClassifier
```

In [100…
```
for i in range(10,101):
    xgb=XGBClassifier(n_estimators=i,reg_alpha=1)
    print(i)
    xgb=create_model(xgb)
```

```
10
              precision    recall  f1-score   support

           0       0.80      0.71      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.80      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.83     29649
weighted avg       0.84      0.84      0.83     29649

[[7052 1754 1077]
 [  53 9800   30]
 [1656  295 7932]]
11
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.84      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7108 1708 1067]
 [  57 9801   25]
 [1608  282 7993]]
12
              precision    recall  f1-score   support

           0       0.81      0.72      0.76      9883
           1       0.83      0.99      0.90      9883
           2       0.88      0.81      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7081 1712 1090]
 [  62 9805   16]
 [1563  277 8043]]
13
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.83      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.84     29649
   macro avg       0.84      0.84      0.84     29649
weighted avg       0.84      0.84      0.84     29649

[[7128 1683 1072]
 [  69 9802   12]
 [1530  273 8080]]
14
              precision    recall  f1-score   support

           0       0.82      0.72      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.82      0.85      9883

    accuracy                           0.85     29649
```

```
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7162 1648 1073]
 [  83 9793    7]
 [1505  268 8110]]
15
              precision    recall  f1-score   support

           0       0.82      0.73      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.83      0.85      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.84     29649
weighted avg       0.85      0.85      0.84     29649

[[7199 1617 1067]
 [ 107 9768    8]
 [1469  246 8168]]
16
              precision    recall  f1-score   support

           0       0.83      0.73      0.77      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.83      0.86      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7197 1602 1084]
 [  98 9777    8]
 [1406  240 8237]]
17
              precision    recall  f1-score   support

           0       0.83      0.73      0.78      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.84      0.86      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7224 1578 1081]
 [ 112 9755   16]
 [1384  233 8266]]
18
              precision    recall  f1-score   support

           0       0.83      0.73      0.78      9883
           1       0.84      0.99      0.91      9883
           2       0.88      0.84      0.86      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7239 1559 1085]
 [ 118 9749   16]
 [1328  231 8324]]
19
              precision    recall  f1-score   support
```

```
           0       0.84      0.73      0.78      9883
           1       0.85      0.99      0.91      9883
           2       0.88      0.85      0.86      9883

    accuracy                           0.85     29649
   macro avg       0.85      0.85      0.85     29649
weighted avg       0.85      0.85      0.85     29649

[[7228 1547 1108]
 [ 118 9746   19]
 [1286  232 8365]]
20
              precision    recall  f1-score   support

           0       0.84      0.73      0.78      9883
           1       0.85      0.99      0.91      9883
           2       0.88      0.85      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.85     29649
weighted avg       0.86      0.86      0.85     29649

[[7255 1538 1090]
 [ 121 9744   18]
 [1245  229 8409]]
21
              precision    recall  f1-score   support

           0       0.84      0.73      0.78      9883
           1       0.85      0.99      0.91      9883
           2       0.88      0.85      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.85     29649
weighted avg       0.86      0.86      0.85     29649

[[7243 1534 1106]
 [ 119 9743   21]
 [1235  225 8423]]
22
              precision    recall  f1-score   support

           0       0.85      0.73      0.79      9883
           1       0.85      0.99      0.91      9883
           2       0.88      0.86      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.86     29649
weighted avg       0.86      0.86      0.86     29649

[[7247 1523 1113]
 [ 121 9741   21]
 [1196  222 8465]]
23
              precision    recall  f1-score   support

           0       0.85      0.73      0.79      9883
           1       0.85      0.99      0.91      9883
           2       0.88      0.86      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.86     29649
weighted avg       0.86      0.86      0.86     29649
```

```
[[7259 1513 1111]
 [ 123 9739   21]
 [1166  218 8499]]
24
              precision    recall  f1-score   support

           0       0.85      0.74      0.79      9883
           1       0.85      0.98      0.91      9883
           2       0.88      0.86      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.86     29649
weighted avg       0.86      0.86      0.86     29649

[[7291 1487 1105]
 [ 131 9730   22]
 [1143  215 8525]]
25
              precision    recall  f1-score   support

           0       0.85      0.74      0.79      9883
           1       0.85      0.98      0.91      9883
           2       0.88      0.86      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.86     29649
weighted avg       0.86      0.86      0.86     29649

[[7320 1465 1098]
 [ 143 9718   22]
 [1142  206 8535]]
26
              precision    recall  f1-score   support

           0       0.85      0.74      0.79      9883
           1       0.85      0.98      0.91      9883
           2       0.88      0.87      0.87      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.86     29649
weighted avg       0.86      0.86      0.86     29649

[[7313 1459 1111]
 [ 143 9718   22]
 [1116  205 8562]]
27
              precision    recall  f1-score   support

           0       0.86      0.74      0.79      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.87      0.88      9883

    accuracy                           0.86     29649
   macro avg       0.86      0.86      0.86     29649
weighted avg       0.86      0.86      0.86     29649

[[7332 1442 1109]
 [ 143 9719   21]
 [1090  206 8587]]
28
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
```

```
           1       0.86      0.98      0.91      9883
           2       0.88      0.87      0.88      9883

    accuracy                           0.86     29649
   macro avg       0.87      0.86      0.86     29649
weighted avg       0.87      0.86      0.86     29649

[[7341 1436 1106]
 [ 143 9719   21]
 [1092  206 8585]]
29
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
           1       0.86      0.98      0.92      9883
           2       0.88      0.87      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7343 1436 1104]
 [ 147 9714   22]
 [1077  198 8608]]
30
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
           1       0.86      0.98      0.92      9883
           2       0.88      0.87      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7342 1424 1117]
 [ 148 9713   22]
 [1074  191 8618]]
31
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.87      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7341 1424 1118]
 [ 171 9690   22]
 [1066  189 8628]]
32
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.88      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7346 1411 1126]
```

```
 [ 194 9666   23]
 [1051  182 8650]]
33
              precision    recall  f1-score   support

           0       0.85      0.74      0.80      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.88      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7353 1405 1125]
 [ 205 9655   23]
 [1044  180 8659]]
34
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.88      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7362 1397 1124]
 [ 205 9655   23]
 [1032  182 8669]]
35
              precision    recall  f1-score   support

           0       0.86      0.74      0.80      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.88      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7340 1401 1142]
 [ 213 9646   24]
 [1017  182 8684]]
36
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.86      0.98      0.91      9883
           2       0.88      0.88      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.86     29649
weighted avg       0.87      0.87      0.86     29649

[[7363 1390 1130]
 [ 221 9638   24]
 [1012  175 8696]]
37
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.86      0.97      0.91      9883
           2       0.88      0.88      0.88      9883
```

```
    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7392 1378 1113]
 [ 243 9616   24]
 [ 988  174 8721]]
38
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.86      0.97      0.91      9883
           2       0.89      0.88      0.88      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7404 1373 1106]
 [ 247 9613   23]
 [ 985  173 8725]]
39
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.86      0.97      0.91      9883
           2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7405 1370 1108]
 [ 246 9615   22]
 [ 959  169 8755]]
40
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.86      0.97      0.92      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7422 1341 1120]
 [ 250 9611   22]
 [ 950  171 8762]]
41
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.86      0.97      0.92      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7430 1331 1122]
 [ 259 9602   22]
 [ 946  170 8767]]
```

```
42
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.92      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7440 1319 1124]
 [ 262 9599   22]
 [ 936  169 8778]]
43
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.92      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7427 1320 1136]
 [ 268 9593   22]
 [ 930  167 8786]]
44
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.92      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7435 1320 1128]
 [ 272 9589   22]
 [ 921  167 8795]]
45
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.91      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7442 1315 1126]
 [ 281 9580   22]
 [ 919  167 8797]]
46
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.92      9883
           2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
```

```
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7445 1315 1123]
 [ 279 9582   22]
 [ 910  164 8809]]
47
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.91      9883
           2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7450 1310 1123]
 [ 295 9566   22]
 [ 905  165 8813]]
48
              precision    recall  f1-score   support

           0       0.86      0.75      0.80      9883
           1       0.87      0.97      0.91      9883
           2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7453 1311 1119]
 [ 301 9560   22]
 [ 905  162 8816]]
49
              precision    recall  f1-score   support

           0       0.86      0.76      0.81      9883
           1       0.87      0.97      0.91      9883
           2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7474 1304 1105]
 [ 308 9553   22]
 [ 901  160 8822]]
50
              precision    recall  f1-score   support

           0       0.86      0.76      0.81      9883
           1       0.87      0.97      0.91      9883
           2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7488 1292 1103]
 [ 315 9545   23]
 [ 902  156 8825]]
51
              precision    recall  f1-score   support
```

```
              0       0.86      0.76      0.81      9883
              1       0.87      0.96      0.91      9883
              2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7491 1282 1110]
 [ 333 9527   23]
 [ 887  155 8841]]
52
              precision    recall  f1-score   support

              0       0.86      0.76      0.81      9883
              1       0.87      0.96      0.91      9883
              2       0.89      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7488 1282 1113]
 [ 338 9523   22]
 [ 888  155 8840]]
53
              precision    recall  f1-score   support

              0       0.86      0.76      0.81      9883
              1       0.87      0.96      0.91      9883
              2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7495 1269 1119]
 [ 344 9516   23]
 [ 885  151 8847]]
54
              precision    recall  f1-score   support

              0       0.86      0.76      0.80      9883
              1       0.87      0.96      0.91      9883
              2       0.88      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7489 1263 1131]
 [ 355 9505   23]
 [ 885  148 8850]]
55
              precision    recall  f1-score   support

              0       0.86      0.76      0.80      9883
              1       0.87      0.96      0.91      9883
              2       0.88      0.89      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649
```

```
[[7495 1256 1132]
 [ 362 9498   23]
 [ 893  145 8845]]
56
              precision    recall  f1-score   support

           0       0.86      0.76      0.80      9883
           1       0.87      0.96      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7498 1258 1127]
 [ 376 9484   23]
 [ 885  145 8853]]
57
              precision    recall  f1-score   support

           0       0.86      0.76      0.80      9883
           1       0.87      0.96      0.91      9883
           2       0.88      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7504 1248 1131]
 [ 372 9487   24]
 [ 885  141 8857]]
58
              precision    recall  f1-score   support

           0       0.86      0.76      0.81      9883
           1       0.87      0.96      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7516 1241 1126]
 [ 391 9469   23]
 [ 876  137 8870]]
59
              precision    recall  f1-score   support

           0       0.86      0.76      0.81      9883
           1       0.87      0.96      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7531 1241 1111]
 [ 402 9458   23]
 [ 864  137 8882]]
60
              precision    recall  f1-score   support

           0       0.86      0.76      0.81      9883
```

```
           1       0.87      0.96      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7533 1239 1111]
 [ 412 9447   24]
 [ 865  135 8883]]
61
              precision    recall  f1-score   support

           0       0.85      0.76      0.81      9883
           1       0.87      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7546 1229 1108]
 [ 424 9435   24]
 [ 866  133 8884]]
62
              precision    recall  f1-score   support

           0       0.85      0.76      0.81      9883
           1       0.87      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7557 1218 1108]
 [ 429 9429   25]
 [ 856  134 8893]]
63
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.87      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7561 1216 1106]
 [ 441 9419   23]
 [ 851  132 8900]]
64
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7571 1206 1106]
```

```
 [ 444 9415   24]
 [ 843  131 8909]]
65
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7573 1200 1110]
 [ 447 9413   23]
 [ 839  130 8914]]
66
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7573 1194 1116]
 [ 467 9392   24]
 [ 837  130 8916]]
67
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7576 1191 1116]
 [ 472 9388   23]
 [ 829  128 8926]]
68
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.90      0.89      9883

    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7587 1179 1117]
 [ 474 9386   23]
 [ 830  127 8926]]
69
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.90      0.90      9883
```

```
    accuracy                           0.87     29649
   macro avg       0.87      0.87      0.87     29649
weighted avg       0.87      0.87      0.87     29649

[[7585 1177 1121]
 [ 472 9386   25]
 [ 821  125 8937]]
70
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7619 1177 1087]
 [ 473 9387   23]
 [ 811  123 8949]]
71
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.87     29649
weighted avg       0.88      0.88      0.87     29649

[[7618 1175 1090]
 [ 481 9380   22]
 [ 789  121 8973]]
72
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.87     29649
weighted avg       0.88      0.88      0.87     29649

[[7622 1175 1086]
 [ 477 9381   25]
 [ 780  117 8986]]
73
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.87     29649
weighted avg       0.88      0.88      0.87     29649

[[7622 1168 1093]
 [ 491 9367   25]
 [ 781  119 8983]]
```

```
74
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7618 1167 1098]
 [ 516 9341   26]
 [ 772  112 8999]]
75
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.87     29649
weighted avg       0.88      0.88      0.87     29649

[[7629 1165 1089]
 [ 517 9340   26]
 [ 766  109 9008]]
76
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.87     29649
weighted avg       0.88      0.88      0.87     29649

[[7634 1166 1083]
 [ 516 9340   27]
 [ 769  105 9009]]
77
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7631 1165 1087]
 [ 532 9325   26]
 [ 772  104 9007]]
78
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
```

```
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7625 1160 1098]
 [ 540 9316   27]
 [ 768  103 9012]]
79
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7630 1153 1100]
 [ 542 9314   27]
 [ 771  103 9009]]
80
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7627 1151 1105]
 [ 552 9307   24]
 [ 765  100 9018]]
81
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7651 1144 1088]
 [ 557 9300   26]
 [ 765  100 9018]]
82
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7646 1139 1098]
 [ 561 9294   28]
 [ 767   99 9017]]
83
              precision    recall  f1-score   support
```

```
           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7644 1134 1105]
 [ 558 9297   28]
 [ 761   98 9024]]
84
              precision    recall  f1-score   support

           0       0.85      0.77      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.87     29649
weighted avg       0.88      0.88      0.87     29649

[[7657 1130 1096]
 [ 564 9292   27]
 [ 760   93 9030]]
85
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7675 1125 1083]
 [ 568 9288   27]
 [ 745   94 9044]]
86
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7673 1125 1085]
 [ 566 9290   27]
 [ 742   95 9046]]
87
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649
```

```
[[7676 1123 1084]
 [ 563 9294   26]
 [ 740   92 9051]]
88
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7679 1118 1086]
 [ 566 9291   26]
 [ 740   91 9052]]
89
              precision    recall  f1-score   support

           0       0.86      0.78      0.81      9883
           1       0.88      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7683 1118 1082]
 [ 569 9288   26]
 [ 730   91 9062]]
90
              precision    recall  f1-score   support

           0       0.86      0.78      0.82      9883
           1       0.89      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7706 1094 1083]
 [ 575 9282   26]
 [ 729   91 9063]]
91
              precision    recall  f1-score   support

           0       0.86      0.78      0.82      9883
           1       0.89      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7717 1092 1074]
 [ 577 9280   26]
 [ 727   90 9066]]
92
              precision    recall  f1-score   support

           0       0.85      0.78      0.82      9883
```

```
           1       0.89      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7719 1090 1074]
 [ 587 9271   25]
 [ 725   90 9068]]
93
              precision    recall  f1-score   support

           0       0.85      0.78      0.82      9883
           1       0.89      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7715 1090 1078]
 [ 589 9269   25]
 [ 720   89 9074]]
94
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.89      0.93      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7720 1089 1074]
 [ 619 9240   24]
 [ 726   89 9068]]
95
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.89      0.93      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7716 1081 1086]
 [ 620 9239   24]
 [ 727   87 9069]]
96
              precision    recall  f1-score   support

           0       0.85      0.78      0.82      9883
           1       0.89      0.93      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7722 1079 1082]
```

```
 [ 619 9238   26]
 [ 723   87 9073]]
97
              precision    recall  f1-score   support

           0       0.85      0.78      0.81      9883
           1       0.89      0.93      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7713 1084 1086]
 [ 623 9235   25]
 [ 724   88 9071]]
98
              precision    recall  f1-score   support

           0       0.85      0.78      0.82      9883
           1       0.89      0.94      0.91      9883
           2       0.89      0.92      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7729 1074 1080]
 [ 617 9242   24]
 [ 719   86 9078]]
99
              precision    recall  f1-score   support

           0       0.85      0.78      0.82      9883
           1       0.89      0.93      0.91      9883
           2       0.89      0.92      0.91      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7736 1074 1073]
 [ 622 9237   24]
 [ 715   87 9081]]
100
              precision    recall  f1-score   support

           0       0.85      0.78      0.82      9883
           1       0.89      0.93      0.91      9883
           2       0.89      0.92      0.91      9883

    accuracy                           0.88     29649
   macro avg       0.88      0.88      0.88     29649
weighted avg       0.88      0.88      0.88     29649

[[7744 1071 1068]
 [ 637 9220   26]
 [ 704   88 9091]]
```

In [101…

```
xgb=XGBClassifier(n_estimators=70,reg_alpha=1)
xgb=create_model(xgb)
```

```
              precision    recall  f1-score   support

           0       0.86      0.77      0.81      9883
           1       0.88      0.95      0.91      9883
           2       0.89      0.91      0.90      9883

    accuracy                           0.88     29649
   macro avg       0.87      0.88      0.87     29649
weighted avg       0.87      0.88      0.87     29649

[[7619 1177 1087]
 [ 473 9387   23]
 [ 811  123 8949]]
```

In [102…

```
#check impotant features
dict={'Input':X.columns,'IG':xgb.feature_importances_}
df1=pd.DataFrame(dict)
df1.sort_values('IG',ascending=False)
```

Out[102]:

	Input	IG
0	term	0.695241
14	last_pymnt_amnt	0.079807
3	home_ownership	0.038092
1	int_rate	0.036447
2	grade	0.034768
10	funded_amnt	0.019024
12	installment	0.018983
9	loan_amnt	0.016324
5	issue_d	0.014157
7	purpose	0.014068
4	verification_status	0.013653
11	funded_amnt_inv	0.009838
13	annual_inc	0.009598
6	pymnt_plan	0.000000
8	application_type	0.000000

In the above all algos applied we got the result best on XGBClassifier i.e of 88% accuracy whcih is highest in the range of all algos This dataset might give results below ecpectation i.e non optimistic results as this dataset is unblanced and may get the chances more of data duplicacy in every terms. The results we got in all algorithms are #dtc=82% #svc=82% #rfc=85% #rfc min sample leaf=86% #ada boost=85% #xgboost=88%

In [ ]: