Loan Status Prediction Model

By Parvathi Rajesh

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

- **Importing all the necessary libraries which might be required for the project.**

In [2]:
```
data = pd.read_csv(r"C:\Users\HP\Desktop\My works\DATA SCIENCE\Loan Pred Dataset for
```

In [3]:
```
data.head()
```

Out[3]:

	Loan ID	Customer ID	Loan Status	Current Loan Amount	Term	Credit Score	Annual Income	Years in current job	Home Ownership	
0	14dd8831-6af5-400b-83ec-68e61888a048	981165ec-3274-42f5-a3b4-d104041a9ca9	Fully Paid	445412.0	Short Term	709.0	1167493.0	8 years	Home Mortgage	I
1	4771cc26-131a-45db-b5aa-537ea4ba5342	2de017a3-2e01-49cb-a581-08169e83be29	Fully Paid	262328.0	Short Term	NaN	NaN	10+ years	Home Mortgage	
2	4eed4e6a-aa2f-4c91-8651-ce984ee8fb26	5efb2b2b-bf11-4dfd-a572-3761a2694725	Fully Paid	99999999.0	Short Term	741.0	2231892.0	8 years	Own Home	
3	77598f7b-32e7-4e3b-a6e5-06ba0d98fe8a	e777faab-98ae-45af-9a86-7ce5b33b1011	Fully Paid	347666.0	Long Term	721.0	806949.0	3 years	Own Home	
4	d4062e70-befa-4995-8643-a0de73938182	81536ad9-5ccf-4eb8-befb-47a4d608658e	Fully Paid	176220.0	Short Term	NaN	NaN	5 years	Rent	

In [4]:
```
data.describe()
```

Out[4]:

	Current Loan Amount	Credit Score	Annual Income	Monthly Debt	Years of Credit History	Months since last delinquent	Nu
count	1.000000e+05	80846.000000	8.084600e+04	100000.000000	100000.000000	46859.000000	1000
mean	1.176045e+07	1076.456089	1.378277e+06	18472.412336	18.199141	34.901321	
std	3.178394e+07	1475.403791	1.081360e+06	12174.992609	7.015324	21.997829	
min	1.080200e+04	585.000000	7.662700e+04	0.000000	3.600000	0.000000	
25%	1.796520e+05	705.000000	8.488440e+05	10214.162500	13.500000	16.000000	
50%	3.122460e+05	724.000000	1.174162e+06	16220.300000	16.900000	32.000000	
75%	5.249420e+05	741.000000	1.650663e+06	24012.057500	21.700000	51.000000	
max	1.000000e+08	7510.000000	1.655574e+08	435843.280000	70.500000	176.000000	

In [5]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100514 entries, 0 to 100513
Data columns (total 19 columns):
 #   Column                        Non-Null Count   Dtype  
---  ------                        --------------   -----  
 0   Loan ID                       100000 non-null  object 
 1   Customer ID                   100000 non-null  object 
 2   Loan Status                   100000 non-null  object 
 3   Current Loan Amount           100000 non-null  float64
 4   Term                          100000 non-null  object 
 5   Credit Score                  80846 non-null   float64
 6   Annual Income                 80846 non-null   float64
 7   Years in current job          95778 non-null   object 
 8   Home Ownership                100000 non-null  object 
 9   Purpose                       100000 non-null  object 
 10  Monthly Debt                  100000 non-null  float64
 11  Years of Credit History       100000 non-null  float64
 12  Months since last delinquent  46859 non-null   float64
 13  Number of Open Accounts       100000 non-null  float64
 14  Number of Credit Problems     100000 non-null  float64
 15  Current Credit Balance        100000 non-null  float64
 16  Maximum Open Credit           99998 non-null   float64
 17  Bankruptcies                  99796 non-null   float64
 18  Tax Liens                     99990 non-null   float64
dtypes: float64(12), object(7)
memory usage: 11.9+ MB
```

In [6]:
```
data.shape
```

Out[6]: (100514, 19)

- **As we can clearly see it is a really huge dataset with 19 columns. All the columns are necessary, but for our purpose we can cut short the data by eliminating few columns that I personally feel will not make much difference to the prediction. Also from data info we see there are lots of null values which also needs to be sorted.**

In [7]:
```
df=data.filter(['Loan Status','Current Loan Amount','Term','Credit Score','Annual In
```

- **Just starting to explore the data and clean the data along with it.**

In [8]:
```
df.head()
```

Out[8]:

	Loan Status	Current Loan Amount	Term	Credit Score	Annual Income	Monthly Debt	Bankruptcies	Tax Liens
0	Fully Paid	445412.0	Short Term	709.0	1167493.0	5214.74	1.0	0.0
1	Fully Paid	262328.0	Short Term	NaN	NaN	33295.98	0.0	0.0
2	Fully Paid	99999999.0	Short Term	741.0	2231892.0	29200.53	0.0	0.0
3	Fully Paid	347666.0	Long Term	721.0	806949.0	8741.90	0.0	0.0
4	Fully Paid	176220.0	Short Term	NaN	NaN	20639.70	0.0	0.0

In [9]:
```
pd.crosstab(df['Credit Score'],df['Loan Status'],margins=True)
```

Out[9]:

Loan Status	Charged Off	Fully Paid	All
Credit Score			
585.0	5	7	12
586.0	4	3	7
587.0	4	7	11
588.0	5	15	20
589.0	4	2	6
...	...	...	...
7480.0	43	0	43
7490.0	23	0	23
7500.0	24	0	24
7510.0	9	0	9
All	17210	63636	80846

325 rows × 3 columns

- **From my research, I found that Credit score values lie between 300 to 850. So we need to eliminate the error values. Later we can replace null and 0 values with the mean value.**

In [10]:
```
df['Credit Score'].values[df['Credit Score'].values>850]=0
df['Credit Score'].replace(0, np.nan)
```

Out[10]:
```
0         709.0
1           NaN
2         741.0
```

```
3         721.0
4           NaN
          ...
100509      NaN
100510      NaN
100511      NaN
100512      NaN
100513      NaN
Name: Credit Score, Length: 100514, dtype: float64
```

In [11]:
```
pd.crosstab(df['Credit Score'],df['Loan Status'],margins=True)
```

Out[11]:

Loan Status Credit Score	Charged Off	Fully Paid	All
0.0	4551	0	4551
585.0	5	7	12
586.0	4	3	7
587.0	4	7	11
588.0	5	15	20
...	...	...	...
748.0	123	1475	1598
749.0	57	770	827
750.0	53	1181	1234
751.0	33	690	723
All	17210	63636	80846

169 rows × 3 columns

- **We have successfully replaced all the values of Credit score above 850 with 0**
- **From the crosstab we see that higher the credit score, greater are the chances of getting approved for a loan.**

In [12]:
```
pd.crosstab(df['Term'],df['Loan Status'],margins=True)
```

Out[12]:

Loan Status Term	Charged Off	Fully Paid	All
Long Term	8366	19426	27792
Short Term	14273	57935	72208
All	22639	77361	100000

- **Most people have opted for short term loans.**

In [13]:
```
pd.crosstab(df['Bankruptcies'],df['Loan Status'],margins=True)
```

Out[13]:

Loan Status	Charged Off	Fully Paid	All
Bankruptcies			
0.0	20183	68591	88774
1.0	2287	8188	10475
2.0	92	325	417
3.0	18	75	93
4.0	7	20	27
5.0	2	5	7
6.0	0	2	2
7.0	0	1	1
All	22589	77207	99796

- **We can see that and is obvious that lower the bankruptcies, higher are the chances of loan approval. Bank doesn't want to take risks and therefore having a low bankruptcy value will help the person getting approved for a loan.**

In [14]:
```
pd.crosstab(df['Tax Liens'],df['Loan Status'],margins=True)
```

Out[14]:

Loan Status	Charged Off	Fully Paid	All
Tax Liens			
0.0	22150	75912	98062
1.0	330	1013	1343
2.0	90	284	374
3.0	36	75	111
4.0	21	37	58
5.0	6	10	16
6.0	2	10	12
7.0	3	4	7
9.0	1	2	3
10.0	0	1	1
11.0	0	2	2
15.0	0	1	1
All	22639	77351	99990

- **A tax lien is a lien imposed by law upon a property to secure the payment of taxes. A tax lien may be imposed for delinquent taxes owed on real property or personal property, or as a result of failure to pay income taxes or other taxes.**
- **From the table, we see that lower the tax lien value higher are the chances of loan approval.**

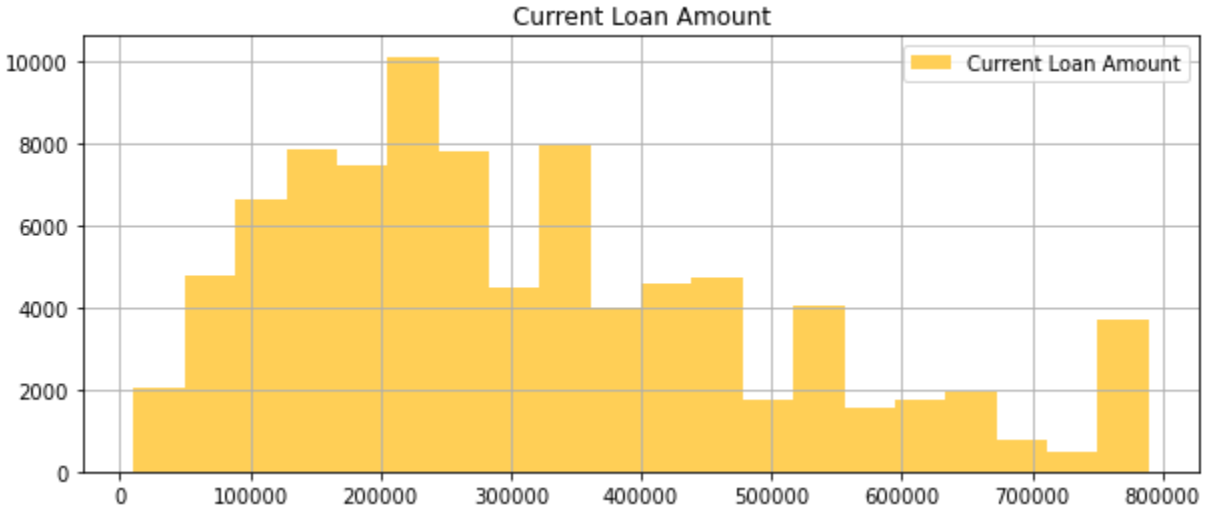
In [15]:
```
df['Current Loan Amount']
```

Out[15]:
```
0          445412.0
1          262328.0
2         99999999.0
3          347666.0
4          176220.0
              ...
100509         NaN
100510         NaN
100511         NaN
100512         NaN
100513         NaN
Name: Current Loan Amount, Length: 100514, dtype: float64
```

- **While going through the dataset, I found repeated use of '99999999.0' value in the 'Current Loan Amount' column. So we need to replace those values with null value and later we can replace it with the mean column value.**

In [16]:
```
df['Current Loan Amount']=df['Current Loan Amount'].replace(99999999.0, np.nan)
```

In [17]:
```
df.hist(column='Current Loan Amount',
        grid=True,
        figsize=(10, 4),
        legend=True,
        bins=20,
        orientation='vertical',
        color='#FFCF56');
```



- **The plot looks standard and almost stable. We can see from the plot that most people have applied for a loan amount in between 200k to 250k.**

In [18]:
```
df.isnull().sum()
```

Out[18]:
```
Loan Status              514
Current Loan Amount    11998
Term                     514
Credit Score           19668
Annual Income          19668
Monthly Debt             514
```

```
Bankruptcies               718
Tax Liens                  524
dtype: int64
```

- **We have to sort all the null values in the dataset with mean and mode values according to the type of data.**

- **Since 'Loan Status', 'Term', 'Bankruptcies' and 'Tax Liens' values are categorical, we replace such null values with mode values.**

In [19]:
```
df['Loan Status'].fillna(df['Loan Status'].mode()[0],inplace=True)
df['Current Loan Amount'].fillna(df['Current Loan Amount'].mean(),inplace=True)
df['Term'].fillna(df['Term'].mode()[0],inplace=True)
df['Credit Score'].fillna(df['Credit Score'].mean(),inplace=True)
df['Annual Income'].fillna(df['Annual Income'].mean(),inplace=True)
df['Monthly Debt'].fillna(df['Monthly Debt'].mean(),inplace=True)
df['Bankruptcies'].fillna(df['Bankruptcies'].mode()[0],inplace=True)
df['Tax Liens'].fillna(df['Tax Liens'].mode()[0],inplace=True)
```

In [20]:
```
df.isnull().sum()
```

Out[20]:
```
Loan Status              0
Current Loan Amount      0
Term                     0
Credit Score             0
Annual Income            0
Monthly Debt             0
Bankruptcies             0
Tax Liens                0
dtype: int64
```

- **We cleared all the null values. :>**

In [21]:
```
df.head()
```

Out[21]:

	Loan Status	Current Loan Amount	Term	Credit Score	Annual Income	Monthly Debt	Bankruptcies	Tax Liens
0	Fully Paid	445412.000000	Short Term	709.000000	1.167493e+06	5214.74	1.0	0.0
1	Fully Paid	262328.000000	Short Term	676.275375	1.378277e+06	33295.98	0.0	0.0
2	Fully Paid	312313.597881	Short Term	741.000000	2.231892e+06	29200.53	0.0	0.0
3	Fully Paid	347666.000000	Long Term	721.000000	8.069490e+05	8741.90	0.0	0.0
4	Fully Paid	176220.000000	Short Term	676.275375	1.378277e+06	20639.70	0.0	0.0

- **Now since we have cleaned and explored our dataset, we are good to do the maths part and applying different algorithms and finding the perfect algorithm for our project based on accuracy.**

In [22]:
```
x=df.iloc[:,np.r_[1:8]].values
```

```
y=df.iloc[:,0].values
```

In [23]:
```
x
```

Out[23]:
```
array([[445412.0, 'Short Term', 709.0, ..., 5214.74, 1.0, 0.0],
       [262328.0, 'Short Term', 676.2753754050912, ..., 33295.98, 0.0,
        0.0],
       [312313.59788060916, 'Short Term', 741.0, ..., 29200.53, 0.0, 0.0],
       ...,
       [312313.59788060916, 'Short Term', 676.2753754050912, ...,
        18472.412335799687, 0.0, 0.0],
       [312313.59788060916, 'Short Term', 676.2753754050912, ...,
        18472.412335799687, 0.0, 0.0],
       [312313.59788060916, 'Short Term', 676.2753754050912, ...,
        18472.412335799687, 0.0, 0.0]], dtype=object)
```

In [24]:
```
y
```

Out[24]:
```
array(['Fully Paid', 'Fully Paid', 'Fully Paid', ..., 'Fully Paid',
       'Fully Paid', 'Fully Paid'], dtype=object)
```

In [25]:
```
x=df.iloc[:,np.r_[1:8]].values
y=df.iloc[:,0].values
```

In [26]:
```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.2,random_state=0)
```

In [27]:
```
x_train
```

Out[27]:
```
array([[131736.0, 'Short Term', 713.0, ..., 8798.9, 0.0, 0.0],
       [182710.0, 'Short Term', 705.0, ..., 21697.05, 1.0, 0.0],
       [153626.0, 'Short Term', 676.2753754050912, ..., 20342.35, 0.0,
        0.0],
       ...,
       [127930.0, 'Short Term', 718.0, ..., 10425.87, 0.0, 0.0],
       [130856.0, 'Short Term', 719.0, ..., 11347.94, 0.0, 0.0],
       [138490.0, 'Short Term', 721.0, ..., 4448.28, 0.0, 0.0]],
      dtype=object)
```

In [28]:
```
from sklearn.preprocessing import LabelEncoder
Label_Encoder_X=LabelEncoder()
```

- **Label Encoder will assign numerical values for non-numerical ones. This is done because machine and most algorithms understand/prefer numericl values.**

In [29]:
```
x_train[:,1]=Label_Encoder_X.fit_transform(x_train[:,1])
```

In [30]:
```
x_train
```

Out[30]:
```
array([[131736.0, 1, 713.0, ..., 8798.9, 0.0, 0.0],
       [182710.0, 1, 705.0, ..., 21697.05, 1.0, 0.0],
       [153626.0, 1, 676.2753754050912, ..., 20342.35, 0.0, 0.0],
       ...,
       [127930.0, 1, 718.0, ..., 10425.87, 0.0, 0.0],
```

```
       [130856.0, 1, 719.0, ..., 11347.94, 0.0, 0.0],
       [138490.0, 1, 721.0, ..., 4448.28, 0.0, 0.0]], dtype=object)
```

- **Here, for the 'Term' column, '1' implies 'Short Term' and '0' implies 'Long Term' loans.**

In [31]:
```
y_train
```

Out[31]:
```
array(['Fully Paid', 'Charged Off', 'Fully Paid', ..., 'Charged Off',
       'Fully Paid', 'Fully Paid'], dtype=object)
```

In [32]:
```
Label_Encoder_Y=LabelEncoder()
y_train=Label_Encoder_Y.fit_transform(y_train)
```

In [33]:
```
y_train
```

Out[33]:
```
array([1, 0, 1, ..., 0, 1, 1])
```

- **Here, '1' implies 'FullyPaid' and '0' implies 'Charged off' loans.**

In [34]:
```
x_test[:,1]=Label_Encoder_X.fit_transform(x_test[:,1])
```

In [35]:
```
y_test=Label_Encoder_Y.fit_transform(y_test)
```

In [36]:
```
x_test
```

Out[36]:
```
array([[123024.0, 1, 724.0, ..., 9414.88, 0.0, 0.0],
       [346346.0, 1, 699.0, ..., 3940.03, 0.0, 0.0],
       [223234.0, 0, 720.0, ..., 15760.88, 0.0, 0.0],
       ...,
       [521554.0, 1, 676.2753754050912, ..., 10078.55, 0.0, 0.0],
       [559174.0, 0, 689.0, ..., 23715.8, 0.0, 0.0],
       [306196.0, 1, 712.0, ..., 21203.05, 0.0, 0.0]], dtype=object)
```

In [37]:
```
y_test
```

Out[37]:
```
array([0, 1, 1, ..., 0, 1, 1])
```

In [38]:
```
from sklearn.preprocessing import StandardScaler
S_S=StandardScaler()
x_train-S_S.fit_transform(x_train)
x_test-S_S.fit_transform(x_test)
```

Out[38]:
```
array([[123025.07922893342, 0.3815304032964587, 723.6830225514444, ...,
        9415.632942325406, 0.3381528235406028, 0.11922475612620129],
       [346345.80136489525, 0.3815304032964587, 698.8519074689239, ...,
        3941.237197049049, 0.3381528235406028, 0.11922475612620129],
       [223234.50582033387, 1.6168943555674564, 719.7100441382411, ...,
        15761.10640726486, 0.3381528235406028, 0.11922475612620129],
       ...,
       [521552.79881251615, 0.3815304032964587, 676.2807967279936, ...,
        10079.247876847368, 0.3381528235406028, 0.11922475612620129],
       [559172.583548256, 1.6168943555674564, 688.9194614359157, ...,
        23715.36637822549, 0.3381528235406028, 0.11922475612620129],
       [306196.0311059917, 0.3815304032964587, 711.7640873118346, ...,
```

```
       21202.824864039136, 0.3381528235406028, 0.11922475612620129]],
      dtype=object)
```

In [39]:
```
from sklearn.tree import DecisionTreeClassifier
DTC=DecisionTreeClassifier(criterion='entropy', random_state=0)
DTC.fit(x_train,y_train)
```

Out[39]:
```
DecisionTreeClassifier(criterion='entropy', random_state=0)
```

In [40]:
```
Predict_Y=DTC.predict(x_test)
Predict_Y
```

Out[40]:
```
array([1, 1, 1, ..., 1, 1, 1])
```

In [41]:
```
from sklearn import metrics
print('Acuracy of Decision Tree Prediction: ',metrics.accuracy_score(Predict_Y,y_tes
```

```
Acuracy of Decision Tree Prediction:  0.7576978560413868
```

- **Applying Decision Tree algorithm, we got an accuracy of about 76% which is not so good. So let's try applying an alternative algorithm i.e. Naive Bayes alogorithm.**

In [42]:
```
from sklearn.naive_bayes import GaussianNB
NBC=GaussianNB()
NBC.fit(x_train,y_train)
```

Out[42]:
```
GaussianNB()
```

In [43]:
```
Predict_Y=NBC.predict(x_test)
Predict_Y
```

Out[43]:
```
array([1, 1, 1, ..., 1, 1, 1])
```

In [44]:
```
print('Acuracy of Naive Bayes Prediction: ',metrics.accuracy_score(Predict_Y,y_test)
```

```
Acuracy of Naive Bayes Prediction:  0.8120181067502363
```

- **As it is clearly visible that Naive Bayes has a higher accuracy rate than Decision tree, we will use Naive Bayes algorithm for our project.**

In [45]:
```
test_data=pd.read_csv(r"C:\Users\HP\Desktop\My works\DATA SCIENCE\Loan Pred Dataset
```

In [46]:
```
test_data.head()
```

Out[46]:

	Loan ID	Customer ID	Current Loan Amount	Term	Credit Score	Annual Income	Years in current job	Home Ownership	Purpos
0	f738779f-c726-40dc-92cf-689d73af533d	ded0b3c3-6bf4-4091-8726-47039f2c1b90	611314.0	Short Term	747.0	2074116.0	10+ years	Home Mortgage	Del Consolidatic

	Loan ID	Customer ID	Current Loan Amount	Term	Credit Score	Annual Income	Years in current job	Home Ownership	Purpos
1	6dcc0947-164d-476c-a1de-3ae7283dde0a	1630e6e3-34e3-461a-8fda-09297d3140c8	266662.0	Short Term	734.0	1919190.0	10+ years	Home Mortgage	Del Consolidatic
2	f7744d01-894b-49c3-8777-fc6431a2cff1	2c60938b-ad2b-4702-804d-eeca43949c52	153494.0	Short Term	709.0	871112.0	2 years	Rent	Del Consolidatic
3	83721ffb-b99a-4a0f-aea5-ef472a138b41	12116614-2f3c-4d16-ad34-d92883718806	176242.0	Short Term	727.0	780083.0	10+ years	Rent	Del Consolidatic
4	08f3789f-5714-4b10-929d-e1527ab5e5a3	39888105-fd5f-4023-860a-30a3e6f5ccb7	321992.0	Short Term	744.0	1761148.0	10+ years	Home Mortgage	Del Consolidatic

In [47]:
```
test_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10353 entries, 0 to 10352
Data columns (total 18 columns):
 #   Column                         Non-Null Count  Dtype
---  ------                         --------------  -----
 0   Loan ID                        10000 non-null  object
 1   Customer ID                    10000 non-null  object
 2   Current Loan Amount            10000 non-null  float64
 3   Term                           10000 non-null  object
 4   Credit Score                   8019 non-null   float64
 5   Annual Income                  8019 non-null   float64
 6   Years in current job           9573 non-null   object
 7   Home Ownership                 10000 non-null  object
 8   Purpose                        10000 non-null  object
 9   Monthly Debt                   10000 non-null  float64
 10  Years of Credit History        10000 non-null  float64
 11  Months since last delinquent   4694 non-null   float64
 12  Number of Open Accounts        10000 non-null  float64
 13  Number of Credit Problems      10000 non-null  float64
 14  Current Credit Balance         10000 non-null  float64
 15  Maximum Open Credit            10000 non-null  float64
 16  Bankruptcies                   9978 non-null   float64
 17  Tax Liens                      9999 non-null   float64
dtypes: float64(12), object(6)
memory usage: 1.2+ MB
```

In [48]:
```
test_data.shape
```

Out[48]: (10353, 18)

In [49]:
```
df_test=test_data.filter(['Current Loan Amount','Term','Credit Score','Annual Income
```

In [50]:
```
df_test.head()
```

Out[50]:

	Current Loan Amount	Term	Credit Score	Annual Income	Monthly Debt	Bankruptcies	Tax Liens
0	611314.0	Short Term	747.0	2074116.0	42000.83	0.0	0.0
1	266662.0	Short Term	734.0	1919190.0	36624.40	0.0	0.0
2	153494.0	Short Term	709.0	871112.0	8391.73	0.0	0.0
3	176242.0	Short Term	727.0	780083.0	16771.87	1.0	0.0
4	321992.0	Short Term	744.0	1761148.0	39478.77	0.0	0.0

- **Cleaning our test dataset similar to our train dataset**

In [51]:
```
df_test['Current Loan Amount']
```

Out[51]:
```
0        611314.0
1        266662.0
2        153494.0
3        176242.0
4        321992.0
           ...
10348         NaN
10349         NaN
10350         NaN
10351         NaN
10352         NaN
Name: Current Loan Amount, Length: 10353, dtype: float64
```

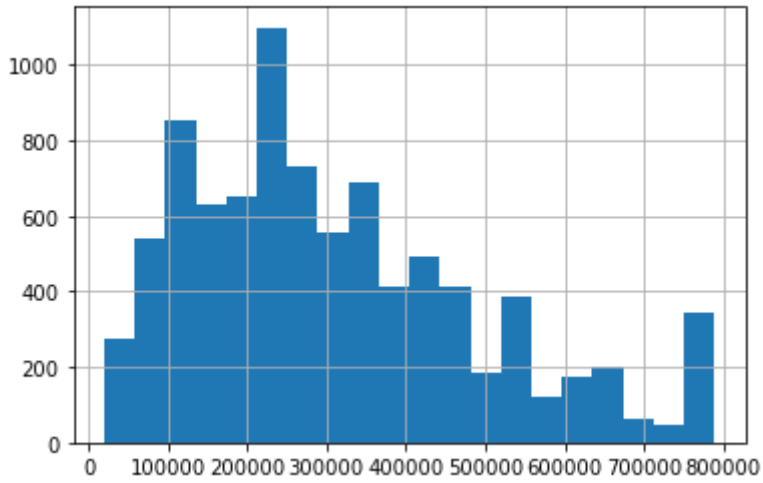
In [52]:
```
df_test['Current Loan Amount']=df_test['Current Loan Amount'].replace(99999999.0, np
```

In [53]:
```
df_test['Current Loan Amount']
```

Out[53]:
```
0        611314.0
1        266662.0
2        153494.0
3        176242.0
4        321992.0
           ...
10348         NaN
10349         NaN
10350         NaN
10351         NaN
10352         NaN
Name: Current Loan Amount, Length: 10353, dtype: float64
```

In [54]:
```
df_test['Current Loan Amount'].hist(bins=20)
```

Out[54]:
```
<AxesSubplot:>
```



In [55]:
```
df_test['Credit Score']
```

Out[55]:
```
0        747.0
1        734.0
2        709.0
3        727.0
4        744.0
         ...
10348      NaN
10349      NaN
10350      NaN
10351      NaN
10352      NaN
Name: Credit Score, Length: 10353, dtype: float64
```

In [56]:
```
pd.crosstab(df_test['Credit Score'],df['Term'],margins=True)
```

Out[56]:

Term	Long Term	Short Term	All
Credit Score			
585.0	0	1	1
586.0	0	1	1
587.0	1	0	1
588.0	1	0	1
594.0	0	1	1
...	...	...	...
7480.0	1	4	5
7490.0	1	0	1
7500.0	0	3	3
7510.0	1	0	1
All	2255	5764	8019

273 rows × 3 columns

In [57]:
```
df_test['Credit Score'].values[df_test['Credit Score'].values>850]=0
df_test['Credit Score'].replace(0, np.nan)
```

Out[57]:
```
0        747.0
1        734.0
2        709.0
3        727.0
4        744.0
         ...
10348      NaN
10349      NaN
10350      NaN
10351      NaN
10352      NaN
Name: Credit Score, Length: 10353, dtype: float64
```

In [58]:
```
df_test.isnull().sum()
```

Out[58]:
```
Current Loan Amount    1486
Term                    353
Credit Score           2334
Annual Income          2334
Monthly Debt            353
Bankruptcies            375
Tax Liens               354
dtype: int64
```

In [59]:
```
df_test['Current Loan Amount'].fillna(df_test['Current Loan Amount'].mean(),inplace=
df_test['Term'].fillna(df_test['Term'].mode()[0],inplace=True)
df_test['Credit Score'].fillna(df_test['Credit Score'].mean(),inplace=True)
df_test['Annual Income'].fillna(df_test['Annual Income'].mean(),inplace=True)
df_test['Monthly Debt'].fillna(df_test['Monthly Debt'].mean(),inplace=True)
df_test['Bankruptcies'].fillna(df_test['Bankruptcies'].mode()[0],inplace=True)
df_test['Tax Liens'].fillna(df_test['Tax Liens'].mode()[0],inplace=True)
```

In [60]:
```
df_test.isnull().sum()
```

Out[60]:
```
Current Loan Amount    0
Term                   0
Credit Score           0
Annual Income          0
Monthly Debt           0
Bankruptcies           0
Tax Liens              0
dtype: int64
```

- **We successfully cleaned our test data also and now we are good to apply our model to the data and predict values.**

In [61]:
```
df_test.head()
```

Out[61]:

	Current Loan Amount	Term	Credit Score	Annual Income	Monthly Debt	Bankruptcies	Tax Liens
0	611314.0	Short Term	747.0	2074116.0	42000.83	0.0	0.0
1	266662.0	Short Term	734.0	1919190.0	36624.40	0.0	0.0
2	153494.0	Short Term	709.0	871112.0	8391.73	0.0	0.0
3	176242.0	Short Term	727.0	780083.0	16771.87	1.0	0.0

	Current Loan Amount	Term	Credit Score	Annual Income	Monthly Debt	Bankruptcies	Tax Liens
4	321992.0	Short Term	744.0	1761148.0	39478.77	0.0	0.0

In [62]:
```
test=df_test.iloc[:,np.r_[0:7]].values
```

In [63]:
```
test[:,1]=Label_Encoder_X.fit_transform(test[:,1])
test
```

Out[63]:
```
array([[611314.0, 1, 747.0, ..., 42000.83, 0.0, 0.0],
       [266662.0, 1, 734.0, ..., 36624.4, 0.0, 0.0],
       [153494.0, 1, 709.0, ..., 8391.73, 0.0, 0.0],
       ...,
       [308786.8789895117, 1, 676.480109739369, ..., 18429.671698999955,
        0.0, 0.0],
       [308786.8789895117, 1, 676.480109739369, ..., 18429.671698999955,
        0.0, 0.0],
       [308786.8789895117, 1, 676.480109739369, ..., 18429.671698999955,
        0.0, 0.0]], dtype=object)
```

In [64]:
```
test-S_S.fit_transform(test)
```

Out[64]:
```
array([[611312.2216617999, 0.40528390092942335, 746.522358574444, ...,
        41998.89573667871, 0.32577034820188777, 0.10501701782435616],
       [266662.2476217049, 0.40528390092942335, 733.6104094563906, ...,
        36622.90692973404, 0.32577034820188777, 0.10501701782435616],
       [153494.91285454997, 0.40528390092942335, 708.7797380755187, ...,
        8392.553719488102, 0.32577034820188777, 0.10501701782435616],
       ...,
       [308786.8789895117, 0.40528390092942335, 676.480109739369, ...,
        18429.671698999955, 0.32577034820188777, 0.10501701782435616],
       [308786.8789895117, 0.40528390092942335, 676.480109739369, ...,
        18429.671698999955, 0.32577034820188777, 0.10501701782435616],
       [308786.8789895117, 0.40528390092942335, 676.480109739369, ...,
        18429.671698999955, 0.32577034820188777, 0.10501701782435616]],
      dtype=object)
```

In [65]:
```
prediction=NBC.predict(test)
```

In [66]:
```
prediction
```

Out[66]:
```
array([1, 1, 1, ..., 1, 1, 1])
```

In [67]:
```
np.set_printoptions(threshold=np.inf)
prediction
```

Out[67]:
```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
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       1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0,
```

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- **From my prediction, my model has predicted the 'Loan Status' of the 'Test Data' where '1' implies the loan is most likely to get 'Fully paid' and '0' implies that the loan amount is likely to be 'Charged Off' and hence it is better not to approve their Loan application.**

- **For my project, I have used dataset from Kaggle. The Link for the dataset is given below.**

- **(https://www.kaggle.com/zaurbegiev/my-dataset)**