# Exploratory Data Analysis

## Problem Statement

- This dataset contains loan records for various customers, including details such as loan amounts, credit scores, loan statuses (whether fully paid or charged off), and customer financial data.
- Dataset include information about the customer's income, credit history, homeownership, and any credit problems or bankruptcies.
- The dataset aims to provide insight into customer behavior related to loans and credit, which could be useful for financial risk analysis, predicting loan defaults, or understanding customer creditworthines

## Column Definition

- **Loan ID**: A unique identifier for each loan.
- **Customer ID**: A unique identifier for each customer.
- **Loan Status**: Indicates whether the loan is "Fully Paid" or "Charged Off."
- **Current Loan Amount**: The loan amount provided to the customer.
- **Term**: The loan term, e.g., "Short Term" or "Long Term."
- **Credit Score**: The customer's credit score at the time of loan application.
- **Years in current job**: The number of years the customer has held their current job.
- **Home Ownership**: Whether the customer owns a home or rents.
- **Annual Income**: The customer's annual income.
- **Purpose**: The reason for taking out the loan (e.g., "Debt Consolidation," "Home Improvement").
- **Monthly Debt**: The customer's monthly debt payment obligations.
- **Years of Credit History**: The number of years the customer has had credit.
- **Months since last delinquent**: Number of months since the customer’s last fail to complete obligation.
- **Number of Open Accounts**: The number of open credit accounts.
- **Number of Credit Problems**: The number of credit issues the customer has encountered.
- **Current Credit Balance**: The current credit balance held by the customer.
- **Maximum Open Credit**: The highest amount of credit ever open for the customer.
- **Bankruptcies**: The number of bankruptcies filed by the customer.
- **Tax Liens**: The number of tax liens filed against the customer(**Claims**).

## Import Library

```
import numpy as np    # import numpy library
import pandas as pd   # import pandas library for accessing and
analyzing the data
```

```
from sklearn.impute import KNNImputer
#KNN Iputation library for handaling missing data commented out after processing once and stored the imputed data in new file as it takes 1 hour to process,
from sklearn.preprocessing import LabelEncoder
label_encoder = LabelEncoder()
import matplotlib.pyplot as plt # import matplotlib library for plots and visualization
import seaborn as sns
from sklearn.model_selection import train_test_split   # import train-test split for splitting the data into train and test
from sklearn.preprocessing import MinMaxScaler   #library used for scaling and standardizing the data
%matplotlib inline
#It is used to plot the matplotlib charts just below the code cells
```

# Data Prepration and Descriptive Statistics (Uncleaned and Cleaned Data Both)

## Reading and Understanding the dataset

```
loan = pd.read_csv('255LoansTrainingSet.csv')
```

```
C:\Users\prakhar\AppData\Local\Temp\ipykernel_7348\2481981716.py:1: DtypeWarning: Columns (16) have mixed types. Specify dtype option on import or set low_memory=False.
  loan = pd.read_csv('255LoansTrainingSet.csv')
```

```
df = pd.read_csv('255LoansTrainingSet.csv')  #copy of dataset
```

```
C:\Users\prakhar\AppData\Local\Temp\ipykernel_7348\2957271157.py:1: DtypeWarning: Columns (16) have mixed types. Specify dtype option on import or set low_memory=False.
  df = pd.read_csv('255LoansTrainingSet.csv')  #copy of dataset
```

```
loan.shape
```

```
(256984, 19)
```

```
loan.head(5)
```

```
                                Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-a6eebc401a19
1  00002c49-3a29-4bd4-8f67-c8f8fbc1048c  927b388d-2e01-423f-a8dc-f7e42d668f46
2  00002d89-27f3-409b-aa76-90834f359a65  defce609-c631-447d-aad6-1270615e89c4
```

```
3  00005222-b4d8-45a4-ad8c-186057e24233  070bcecb-aae7-4485-a26a-
e0403e7bb6c5
4  0000757f-a121-41ed-b17b-162e76647c1f  dde79588-12f0-4811-bab0-
e2b07f633fcd

  Loan Status  Current Loan Amount        Term  Credit Score  \
0  Fully Paid                11520  Short Term         741.0
1  Fully Paid                 3441  Short Term         734.0
2  Fully Paid                21029  Short Term         747.0
3  Fully Paid                18743  Short Term         747.0
4  Fully Paid                11731  Short Term         746.0

  Years in current job Home Ownership  Annual Income
Purpose  \
0            10+ years  Home Mortgage        33694.0  Debt
Consolidation
1              4 years  Home Mortgage        42269.0
other
2            10+ years  Home Mortgage        90126.0  Debt
Consolidation
3            10+ years       Own Home        38072.0  Debt
Consolidation
4              4 years           Rent        50025.0  Debt
Consolidation

  Monthly Debt  Years of Credit History  Months since last delinquent
\
0      $584.03                     12.3                          41.0

1   $1,106.04                     26.3                           NaN

2   $1,321.85                     28.8                           NaN

3      $751.92                     26.2                           NaN

4      $355.18                     11.5                           NaN


   Number of Open Accounts  Number of Credit Problems  Current Credit
Balance  \
0                       10                          0
6760
1                       17                          0
6262
2                        5                          0
20967
3                        9                          0
22529
4                       12                          0
17391
```

```
  Maximum Open Credit  Bankruptcies  Tax Liens
0               16056           0.0        0.0
1               19149           0.0        0.0
2               28335           0.0        0.0
3               43915           0.0        0.0
4               37081           0.0        0.0
```

```
loan.tail(5)
```

```
                                      Loan ID  \
256979  fffef5b7-be99-4666-ac70-2a397d2ee435
256980  ffffca93-aa8c-4123-b8ff-7852f6df889a
256981  ffffcb2e-e48e-4d2c-a0d6-ed6bce5bfdbe
256982  ffffcb2e-e48e-4d2c-a0d6-ed6bce5bfdbe
256983  ffffe32e-ed17-459f-9cfd-7b9ee7972933

                                   Customer ID  Loan Status  \
256979  7211a8e3-cba4-4132-b939-222eed8a662c   Fully Paid
256980  616fef0c-8f09-4327-9b5c-48fcfaa52934   Fully Paid
256981  971a6682-183b-4a52-8bce-1d3429ade295  Charged Off
256982  971a6682-183b-4a52-8bce-1d3429ade295  Charged Off
256983  97281336-1e45-41d2-acb2-263ce56a590e   Fully Paid

        Current Loan Amount        Term  Credit Score Years in current
job  \
256979                 3911  Short Term           NaN               2
years
256980                 5078  Short Term         737.0             10+
years
256981                12116  Short Term        7460.0               9
years
256982                12116  Short Term         746.0               9
years
256983                27902   Long Term         678.0             10+
years

       Home Ownership  Annual Income             Purpose Monthly Debt
\
256979           Rent            NaN  Debt Consolidation   $1,706.58

256980       Own Home        77186.0  Debt Consolidation   $1,376.47

256981  Home Mortgage        52504.0  Debt Consolidation      $297.96

256982  Home Mortgage        52504.0  Debt Consolidation      $297.96

256983  Home Mortgage       117480.0  Debt Consolidation   $2,525.82


        Years of Credit History  Months since last delinquent  \
```

```
256979                      19.9                             NaN
256980                      19.1                            47.0
256981                      15.1                            82.0
256982                      15.1                            82.0
256983                      18.0                            11.0

        Number of Open Accounts  Number of Credit Problems  \
256979                       16                           0
256980                        9                           0
256981                        8                           0
256982                        8                           0
256983                       10                           0

        Current Credit Balance Maximum Open Credit  Bankruptcies  Tax
Liens
256979                  43992               44080          0.0
0.0
256980                   1717                9758          0.0
0.0
256981                   3315               20090          0.0
0.0
256982                   3315               20090          0.0
0.0
256983                  28317               62371          0.0
0.0

loan.sample(5,random_state=42)

                                      Loan ID  \
70992   4680a93d-437d-429d-82d7-b26978845d84
97602   611323fc-7ee7-44eb-a67b-6830a2a16e66
5902    05ea8774-4dda-4e39-9ed6-2968ce705d2c
160249  9f673510-2135-4569-8fa9-19977deb4f60
16261   102ee141-198e-415b-a14b-5eb90b379faf

                                   Customer ID  Loan Status  \
70992   e9c9812a-5d01-4cc6-b695-ba2a282d4f90   Fully Paid
97602   30b2f825-9f10-4c80-966e-7cfb2d4c77f6  Charged Off
5902    91abff04-9265-4fdb-819b-9ba2779ad5d1   Fully Paid
160249  c4f3d4d5-112d-4307-aba4-607550815ead  Charged Off
16261   20548661-e4ba-4853-ad03-2cb94e95d3de   Fully Paid

        Current Loan Amount        Term  Credit Score Years in current
job  \
70992                  8987  Short Term         748.0                1
year
97602                 23846   Long Term         651.0                6
years
5902                  15332  Short Term         747.0                4
years
```

```
160249                17414  Short Term        6950.0              5
years
16261              99999999  Short Term         742.0              2
years

       Home Ownership  Annual Income             Purpose Monthly Debt
\
70992   Home Mortgage       119832.0  Debt Consolidation   $1,378.07

97602            Rent        59843.0  Debt Consolidation   $1,077.18

5902             Rent        58260.0  Debt Consolidation   $1,437.07

160249  Home Mortgage        48528.0  Debt Consolidation   $1,548.85

16261            Rent       187785.0  Debt Consolidation   $1,359.88


        Years of Credit History  Months since last delinquent  \
70992                      16.5                           NaN
97602                      17.0                           NaN
5902                       15.9                           NaN
160249                     15.6                           NaN
16261                      11.2                          30.0

        Number of Open Accounts  Number of Credit Problems  \
70992                        11                          0
97602                        15                          2
5902                         13                          0
160249                       17                          0
16261                        16                          0

        Current Credit Balance Maximum Open Credit  Bankruptcies  Tax
Liens
70992                    28354               58103           0.0
0.0
97602                    30509               57240           1.0
0.0
5902                     18050               48392           0.0
0.0
160249                   28345               42947           0.0
0.0
16261                    17515               28159           0.0
0.0

loan.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 256984 entries, 0 to 256983
Data columns (total 19 columns):
 #   Column                        Non-Null Count   Dtype
```

```
---  ------                          --------------   -----
 0   Loan ID                         256984 non-null  object
 1   Customer ID                     256984 non-null  object
 2   Loan Status                     256984 non-null  object
 3   Current Loan Amount             256984 non-null  int64
 4   Term                            256984 non-null  object
 5   Credit Score                    195308 non-null  float64
 6   Years in current job            245508 non-null  object
 7   Home Ownership                  256984 non-null  object
 8   Annual Income                   195308 non-null  float64
 9   Purpose                         256984 non-null  object
 10  Monthly Debt                    256984 non-null  object
 11  Years of Credit History         256984 non-null  float64
 12  Months since last delinquent    116601 non-null  float64
 13  Number of Open Accounts         256984 non-null  int64
 14  Number of Credit Problems       256984 non-null  int64
 15  Current Credit Balance          256984 non-null  int64
 16  Maximum Open Credit             256984 non-null  object
 17  Bankruptcies                    256455 non-null  float64
 18  Tax Liens                       256961 non-null  float64
dtypes: float64(6), int64(4), object(9)
memory usage: 37.3+ MB
```

```
loan.info(verbose=False)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 256984 entries, 0 to 256983
Columns: 19 entries, Loan ID to Tax Liens
dtypes: float64(6), int64(4), object(9)
memory usage: 37.3+ MB
```

```
loan.describe()
```

```
       Current Loan Amount   Credit Score  Annual Income  \
count         2.569840e+05  195308.000000   1.953080e+05
mean          1.371331e+07    1251.116099   7.195272e+04
std           3.438131e+07    1762.016848   5.887757e+04
min           5.050000e+02     585.000000   0.000000e+00
25%           8.299000e+03     714.000000   4.432100e+04
50%           1.429800e+04     733.000000   6.124200e+04
75%           2.436700e+04     744.000000   8.646200e+04
max           1.000000e+08    7510.000000   8.713547e+06

       Years of Credit History  Months since last delinquent  \
count            256984.000000                 116601.000000
mean                 18.290195                     34.881450
std                   7.075747                     21.854165
min                   3.400000                      0.000000
25%                  13.500000                     16.000000
50%                  17.000000                     32.000000
```

```
75%                   21.700000                    51.000000
max                   70.500000                   176.000000

       Number of Open Accounts  Number of Credit Problems  \
count             256984.000000              256984.000000
mean                  11.106267                   0.156628
std                    4.982982                   0.460731
min                    0.000000                   0.000000
25%                    8.000000                   0.000000
50%                   10.000000                   0.000000
75%                   14.000000                   0.000000
max                   76.000000                  11.000000

       Current Credit Balance   Bankruptcies      Tax Liens
count            2.569840e+05  256455.000000  256961.000000
mean             1.540656e+04       0.110316       0.027203
std              1.966506e+04       0.336229       0.245950
min              0.000000e+00       0.000000       0.000000
25%              5.974000e+03       0.000000       0.000000
50%              1.107800e+04       0.000000       0.000000
75%              1.931900e+04       0.000000       0.000000
max              1.731412e+06       7.000000      11.000000
```

```
loan.describe(include='object')
```

```
                                       Loan ID  \
count                                   256984
unique                                  215700
top     3f6bd37a-b0bc-4d85-93c7-eea53df601fb
freq                                         4

                                  Customer ID Loan Status
Term  \
count                                 256984      256984      256984

unique                                215700           2           2

top     a96104f4-2f44-4112-82b9-75605d44dac3  Fully Paid  Short Term

freq                                       4      176191      192632


       Years in current job Home Ownership             Purpose Monthly
Debt  \
count                245508         256984              256984
256984
unique                   11              4                  10
129115
top              10+ years  Home Mortgage  Debt Consolidation
$0.00
```

```
freq                   78896          124477                203911
254

        Maximum Open Credit
count                256984
unique                87188
top                       0
freq                   1597
```

Null Values

```
loan.isna().sum()
```

```
Loan ID                             0
Customer ID                         0
Loan Status                         0
Current Loan Amount                 0
Term                                0
Credit Score                    61676
Years in current job            11476
Home Ownership                      0
Annual Income                   61676
Purpose                             0
Monthly Debt                        0
Years of Credit History             0
Months since last delinquent    140383
Number of Open Accounts             0
Number of Credit Problems           0
Current Credit Balance              0
Maximum Open Credit                 0
Bankruptcies                      529
Tax Liens                          23
dtype: int64
```

```
(loan.isna().sum()/loan.shape[0])*100
```

```
Loan ID                          0.000000
Customer ID                      0.000000
Loan Status                      0.000000
Current Loan Amount              0.000000
Term                             0.000000
Credit Score                    23.999938
Years in current job             4.465648
Home Ownership                   0.000000
Annual Income                   23.999938
Purpose                          0.000000
Monthly Debt                     0.000000
Years of Credit History          0.000000
Months since last delinquent    54.627136
Number of Open Accounts          0.000000
```

```
Number of Credit Problems         0.000000
Current Credit Balance            0.000000
Maximum Open Credit               0.000000
Bankruptcies                      0.205849
Tax Liens                         0.008950
dtype: float64
```

Duplicate Values

```
loan.duplicated().sum()
```

```
16610
```

```
loan.nunique()
```

```
Loan ID                         215700
Customer ID                     215700
Loan Status                          2
Current Loan Amount              27347
Term                                 2
Credit Score                       334
Years in current job                11
Home Ownership                       4
Annual Income                    60558
Purpose                             10
Monthly Debt                    129115
Years of Credit History            541
Months since last delinquent       131
Number of Open Accounts             59
Number of Credit Problems           12
Current Credit Balance           45704
Maximum Open Credit              87188
Bankruptcies                         8
Tax Liens                           12
dtype: int64
```

```
loan.shape
```

```
(256984, 19)
```

```
loan.columns
```

```
Index(['Loan ID', 'Customer ID', 'Loan Status', 'Current Loan Amount',
'Term',
       'Credit Score', 'Years in current job', 'Home Ownership',
       'Annual Income', 'Purpose', 'Monthly Debt', 'Years of Credit
History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

## Assessing Datatypes

```
loan.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 256984 entries, 0 to 256983
Data columns (total 19 columns):
 #   Column                         Non-Null Count   Dtype
---  ------                         --------------   -----
 0   Loan ID                        256984 non-null  object
 1   Customer ID                    256984 non-null  object
 2   Loan Status                    256984 non-null  object
 3   Current Loan Amount            256984 non-null  int64
 4   Term                           256984 non-null  object
 5   Credit Score                   195308 non-null  float64
 6   Years in current job           245508 non-null  object
 7   Home Ownership                 256984 non-null  object
 8   Annual Income                  195308 non-null  float64
 9   Purpose                        256984 non-null  object
 10  Monthly Debt                   256984 non-null  object
 11  Years of Credit History        256984 non-null  float64
 12  Months since last delinquent   116601 non-null  float64
 13  Number of Open Accounts        256984 non-null  int64
 14  Number of Credit Problems      256984 non-null  int64
 15  Current Credit Balance         256984 non-null  int64
 16  Maximum Open Credit            256984 non-null  object
 17  Bankruptcies                   256455 non-null  float64
 18  Tax Liens                      256961 non-null  float64
dtypes: float64(6), int64(4), object(9)
memory usage: 37.3+ MB
```

### Loan ID

```
loan['Loan ID'].info()

<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Loan ID
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB

loan['Loan ID'].isna().sum()

0
```

### Customer ID

```
loan['Customer ID'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Customer ID
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan['Customer ID'].isna().sum()
```

```
0
```

Loan Status

```
loan['Loan Status'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Loan Status
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan['Loan Status'].nunique()
```

```
2
```

```
#since loan status has only 2 unique values it can be used as a
catogical data with category as dtype
loan['Loan Status'] = loan['Loan Status'].astype('category')
```

```
loan['Loan Status'].value_counts()
```

```
Loan Status
Fully Paid     176191
Charged Off     80793
Name: count, dtype: int64
```

```
loan['Loan Status'].isna().sum()
```

```
0
```

Current Loan Amount

```
loan['Current Loan Amount'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Current Loan Amount
```

```
Non-Null Count   Dtype
--------------   -----
256984 non-null  int64
dtypes: int64(1)
memory usage: 2.0 MB
```

```
loan['Current Loan Amount'].nunique()
```

```
27347
```

```
loan['Current Loan Amount'].isna().sum()
```

```
0
```

Term

```
loan['Term'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Term
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan['Term'].nunique()
```

```
2
```

```
loan['Term'].unique()
```

```
array(['Short Term', 'Long Term'], dtype=object)
```

```
# It can also treated as Catagorical Column
loan['Term'] = loan['Term'].astype('category')
```

```
loan['Term'].value_counts()
```

```
Term
Short Term    192632
Long Term      64352
Name: count, dtype: int64
```

Credit Score

```
loan['Credit Score'] #some values >900 is seen
```

```
0          741.0
1          734.0
2          747.0
3          747.0
```

```
4          746.0
           ...
256979       NaN
256980     737.0
256981    7460.0
256982     746.0
256983     678.0
Name: Credit Score, Length: 256984, dtype: float64
```

```
a1 = loan[loan['Credit Score']>900]['Credit Score']
a1
#This can be a typo error in last 0 is present for all the credit
score
# Solution is to remove the 0 from the tail of all these values.
```

```
6         6640.0
55        7320.0
71        7180.0
73        6670.0
79        7270.0
           ...
256946    7450.0
256948    7220.0
256952    7410.0
256977    7170.0
256981    7460.0
Name: Credit Score, Length: 16187, dtype: float64
```

```
loan['Credit Score']=loan['Credit Score'].apply(lambda x: x//10 if
x>900 else x)
```

```
a2 = loan[loan['Credit Score']>900]['Credit Score']
a2
```

```
Series([], Name: Credit Score, dtype: float64)
```

**Need to clear nan values then we'll change its dtype to int**

Years in current job

```
loan['Years in current job'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Years in current job
Non-Null Count   Dtype
--------------   -----
245508 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan['Years in current job'].nunique()
```

```
11
```

```
loan['Years in current job']=loan['Years in current
job'].str.replace('+ years','')
loan['Years in current job']=loan['Years in current
job'].str.replace('years','')
loan['Years in current job']=loan['Years in current
job'].str.replace('< 1 year','0')
loan['Years in current job']=loan['Years in current
job'].str.replace('1 year','1')
loan['Years in current job'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Years in current job
Non-Null Count   Dtype
--------------   -----
245508 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
df['Years in current job']=df['Years in current job'].str.replace('+
years','')
df['Years in current job']=df['Years in current
job'].str.replace('years','')
df['Years in current job']=df['Years in current job'].str.replace('< 1
year','0')
df['Years in current job']=df['Years in current job'].str.replace('1
year','1')
```

```
#Missing Values
loan['Years in current job']=loan['Years in current
job'].fillna(np.nan)
```

```
loan['Years in current job'].unique()
```

```
array(['10', '4 ', '6 ', '5 ', nan, '3 ', '2 ', '0', '1', '7 ', '9 ',
       '8 '], dtype=object)
```

```
loan['Years in current job']=loan['Years in current
job'].astype(float)
```

```
loan['Years in current job'].unique()
```

```
array([10.,  4.,  6.,  5., nan,  3.,  2.,  0.,  1.,  7.,  9.,  8.])
```

```
loan['Years in current job'].describe()
```

```
count    245508.000000
mean          5.869401
std           3.626767
min           0.000000
25%           3.000000
50%           6.000000
75%          10.000000
max          10.000000
Name: Years in current job, dtype: float64
```

```
loan['Years in current job']
```

```
0         10.0
1          4.0
2         10.0
3         10.0
4          4.0
          ...
256979     2.0
256980    10.0
256981     9.0
256982     9.0
256983    10.0
Name: Years in current job, Length: 256984, dtype: float64
```

Home Ownership

```
loan['Home Ownership'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Home Ownership
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan['Home Ownership'].nunique()
```

```
4
```

```
loan['Home Ownership'].unique()
#Here we can see that Redundant value is seen we can merge HaveMortage
to Home Mortgage but says that person is getting income from Mortgage
```

```
array(['Home Mortgage', 'Own Home', 'Rent', 'HaveMortgage'],
dtype=object)
```

```
loan['Home Ownership'].value_counts()
#Here we can see that Redundant value is seen we can merge HaveMortage
to Home Mortgage but says that person is getting income from Mortgage
```

```
Home Ownership
Home Mortgage    124477
Rent             109010
Own Home          22923
HaveMortgage        574
Name: count, dtype: int64
```

```
loan['Home Ownership'] = loan['Home
Ownership'].str.replace('HaveMortgage','Home Mortgage')
```

```
loan['Home Ownership'].value_counts()
```

```
Home Ownership
Home Mortgage    125051
Rent             109010
Own Home          22923
Name: count, dtype: int64
```

```
loan['Home Ownership']=loan['Home Ownership'].astype('category')
```

Annual Income

```
loan['Annual Income'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Annual Income
Non-Null Count   Dtype
--------------   -----
195308 non-null  float64
dtypes: float64(1)
memory usage: 2.0 MB
```

```
loan['Annual Income'].isna().sum()
```

```
61676
```

```
loan['Annual Income'].nunique()
```

```
60558
```

Purpose

```
loan['Purpose'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Purpose
```

```
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan['Purpose'].nunique()
```

```
10
```

```
loan['Purpose'].unique()
```

```
array(['Debt Consolidation', 'other', 'Business Loan',
       'Home Improvements', 'Buy House', 'Other', 'Buy a Car',
       'Medical Bills', 'Take a Trip', 'Educational Expenses'],
      dtype=object)
```

```
loan['Purpose'] = loan['Purpose'].astype('category')
```

```
loan['Purpose'].isna().sum()
```

```
0
```

```
loan['Purpose'].value_counts()
```

```
Purpose
Debt Consolidation      203911
Home Improvements        14915
other                    14268
Other                     9667
Business Loan             4712
Buy a Car                 3276
Medical Bills             2868
Take a Trip               1570
Buy House                 1530
Educational Expenses       267
Name: count, dtype: int64
```

Monthly Debt

```
loan['Monthly Debt']=loan['Monthly Debt'].str.replace('$','')
loan['Monthly Debt']=loan['Monthly Debt'].str.replace(',','')
```

```
loan['Monthly Debt']=loan['Monthly Debt'].astype(float)
loan['Monthly Debt']
```

```
0          584.03
1         1106.04
2         1321.85
```

```
3          751.92
4          355.18
           ...
256979    1706.58
256980    1376.47
256981     297.96
256982     297.96
256983    2525.82
Name: Monthly Debt, Length: 256984, dtype: float64
```

Year of credit history

```
loan['Years of Credit History']
```

```
0         12.3
1         26.3
2         28.8
3         26.2
4         11.5
          ...
256979    19.9
256980    19.1
256981    15.1
256982    15.1
256983    18.0
Name: Years of Credit History, Length: 256984, dtype: float64
```

```
loan['Years of Credit History'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Years of Credit History
Non-Null Count   Dtype
--------------   -----
256984 non-null  float64
dtypes: float64(1)
memory usage: 2.0 MB
```

```
loan['Years of Credit History'].isna().sum()
```

```
0
```

```
loan['Years of Credit History'].value_counts()
```

```
Years of Credit History
16.0    3563
15.0    3379
17.0    3080
16.5    2963
14.0    2954
        ...
```

```
52.8       1
54.6       1
3.7        1
65.8       1
60.7       1
Name: count, Length: 541, dtype: int64
```

Months since last delinquent

```
loan['Months since last delinquent']
```

```
0         41.0
1          NaN
2          NaN
3          NaN
4          NaN
          ...
256979     NaN
256980    47.0
256981    82.0
256982    82.0
256983    11.0
Name: Months since last delinquent, Length: 256984, dtype: float64
```

```
loan['Months since last delinquent'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Months since last delinquent
Non-Null Count   Dtype
--------------   -----
116601 non-null  float64
dtypes: float64(1)
memory usage: 2.0 MB
```

```
loan['Months since last delinquent'].isna().sum()
```

```
140383
```

```
loan['Months since last delinquent'].nunique()
```

```
131
```

```
loan['Months since last delinquent'].value_counts()
```

```
Months since last delinquent
12.0     2224
14.0     2196
15.0     2189
8.0      2164
9.0      2127
         ...
```

```
122.0       1
98.0        1
143.0       1
140.0       1
119.0       1
Name: count, Length: 131, dtype: int64
```

Number of Open Accounts

```
loan['Number of Open Accounts'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Number of Open Accounts
Non-Null Count   Dtype
--------------   -----
256984 non-null  int64
dtypes: int64(1)
memory usage: 2.0 MB
```

```
loan['Number of Open Accounts'].isna().sum()
```

```
0
```

```
loan['Number of Open Accounts'].nunique()
```

```
59
```

```
loan['Number of Open Accounts'].value_counts()
```

```
Number of Open Accounts
9     24412
10    23306
8     23140
11    21577
7     20851
12    19056
6     17454
13    15987
14    13649
5     12232
15    10833
16     8982
17     7258
4      7225
18     5801
19     4706
20     3612
3      3362
21     2815
22     2207
```

```
23     1725
24     1371
2      1104
25     1011
26      746
27      580
28      404
29      303
30      236
31      207
32      181
33      113
34      104
35       79
36       61
37       58
38       41
1        37
39       33
40       26
41       24
42       14
45        9
43        9
47        7
0         5
44        5
76        4
50        3
53        3
46        3
48        3
55        2
52        2
58        2
56        1
49        1
51        1
54        1
Name: count, dtype: int64
```

```
loan.columns
```

```
Index(['Loan ID', 'Customer ID', 'Loan Status', 'Current Loan Amount',
'Term',
       'Credit Score', 'Years in current job', 'Home Ownership',
       'Annual Income', 'Purpose', 'Monthly Debt', 'Years of Credit
History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
```

```
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

Number of Credit Problems

```
loan['Number of Credit Problems'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Number of Credit Problems
Non-Null Count   Dtype
--------------   -----
256984 non-null  int64
dtypes: int64(1)
memory usage: 2.0 MB
```

```
loan['Number of Credit Problems'].isna().sum()
```

```
0
```

```
loan['Number of Credit Problems'].unique()
```

```
array([ 0,  1,  2,  5,  3,  4,  6,  7,  9, 10,  8, 11], dtype=int64)
```

```
loan['Number of Credit Problems'].nunique()
```

```
12
```

```
loan['Number of Credit Problems'].value_counts()   #binning possible
```

```
Number of Credit Problems
0     223171
1      29547
2       2987
3        791
4        275
5        125
6         42
7         16
8         12
9         10
10         6
11         2
Name: count, dtype: int64
```

Current Credit Balance

```
loan['Current Credit Balance'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Current Credit Balance
Non-Null Count   Dtype
--------------   -----
256984 non-null  int64
dtypes: int64(1)
memory usage: 2.0 MB
```

```
loan['Current Credit Balance'].isna().sum()
```

```
0
```

```
loan['Current Credit Balance'].nunique()
```

```
45704
```

```
loan['Current Credit Balance'].value_counts()
```

```
Current Credit Balance
0         1565
6746        32
3420        32
6259        30
6539        29
          ...
34123        1
132138       1
77778        1
52618        1
35089        1
Name: count, Length: 45704, dtype: int64
```

Maximum Open Credit

```
loan['Maximum Open Credit'].info()  #some #VALUE is present in the
column
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Maximum Open Credit
Non-Null Count   Dtype
--------------   -----
256984 non-null  object
dtypes: object(1)
memory usage: 2.0+ MB
```

```
loan[loan['Maximum Open Credit']=='#VALUE!']['Maximum Open
Credit'].count()
```

```
4
```

```
#since it is a very small number so dropping the particular row is a
good option
df_drop=loan[loan['Maximum Open Credit']=='#VALUE!'].index
loan = loan.drop(df_drop)
```

```
loan[loan['Maximum Open Credit']=='#VALUE!']['Maximum Open
Credit'].count()
```

```
0
```

```
loan['Maximum Open Credit'].isna().sum()
```

```
0
```

```
loan['Maximum Open Credit']=loan['Maximum Open Credit'].astype(int)
```

```
loan['Maximum Open Credit'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 256980 entries, 0 to 256983
Series name: Maximum Open Credit
Non-Null Count   Dtype
--------------   -----
256980 non-null  int32
dtypes: int32(1)
memory usage: 2.9 MB
```

Bankruptcies

```
loan['Bankruptcies'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 256980 entries, 0 to 256983
Series name: Bankruptcies
Non-Null Count   Dtype
--------------   -----
256451 non-null  float64
dtypes: float64(1)
memory usage: 3.9 MB
```

```
loan['Bankruptcies'].unique()
```

```
array([ 0.,  1.,  2., nan,  3.,  4.,  5.,  7.,  6.])
```

```
loan['Bankruptcies'].isna().sum()  #it is a small number as compared
to total number of rows we can drop the column
```

```
529
```

```
Bankna_ind=loan[loan['Bankruptcies'].isna()].index
```

```
loan=loan.drop(Bankna_ind)
```

```
loan['Bankruptcies'].isna().sum()
```

```
0
```

```
loan['Bankruptcies']=loan['Bankruptcies'].astype(int)
```

```
loan['Bankruptcies'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 256451 entries, 0 to 256983
Series name: Bankruptcies
Non-Null Count   Dtype
--------------   -----
256451 non-null  int32
dtypes: int32(1)
memory usage: 2.9 MB
```

Tax Liens

```
loan['Tax Liens'].info()
```

```
<class 'pandas.core.series.Series'>
Index: 256451 entries, 0 to 256983
Series name: Tax Liens
Non-Null Count   Dtype
--------------   -----
256451 non-null  float64
dtypes: float64(1)
memory usage: 3.9 MB
```

```
loan['Tax Liens'].isna().sum()
```

```
0
```

```
loan['Tax Liens']
```

```
0         0.0
1         0.0
2         0.0
3         0.0
4         0.0
         ...
256979    0.0
256980    0.0
256981    0.0
256982    0.0
256983    0.0
Name: Tax Liens, Length: 256451, dtype: float64
```

```
loan['Tax Liens'].unique()
```

```
array([ 0.,  5.,  1.,  2.,  4.,  3.,  6.,  7.,  9.,  8., 10., 11.])
```

```
loan['Tax Liens'] = loan['Tax Liens'].astype(int)

df['Tax Liens'].info()
```

```
<class 'pandas.core.series.Series'>
RangeIndex: 256984 entries, 0 to 256983
Series name: Tax Liens
Non-Null Count   Dtype
--------------   -----
256961 non-null  float64
dtypes: float64(1)
memory usage: 2.0 MB
```

## Overview of Columns and its dtypes

```
loan.columns
```

```
Index(['Loan ID', 'Customer ID', 'Loan Status', 'Current Loan Amount',
'Term',
       'Credit Score', 'Years in current job', 'Home Ownership',
       'Annual Income', 'Purpose', 'Monthly Debt', 'Years of Credit
History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

```
loan.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 256451 entries, 0 to 256983
Data columns (total 19 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   Loan ID                       256451 non-null  object
 1   Customer ID                   256451 non-null  object
 2   Loan Status                   256451 non-null  category
 3   Current Loan Amount           256451 non-null  int64
 4   Term                          256451 non-null  category
 5   Credit Score                  194892 non-null  float64
 6   Years in current job          244975 non-null  float64
 7   Home Ownership                256451 non-null  category
 8   Annual Income                 194892 non-null  float64
 9   Purpose                       256451 non-null  category
 10  Monthly Debt                  256451 non-null  float64
 11  Years of Credit History       256451 non-null  float64
 12  Months since last delinquent  116074 non-null  float64
 13  Number of Open Accounts       256451 non-null  int64
 14  Number of Credit Problems     256451 non-null  int64
 15  Current Credit Balance        256451 non-null  int64
```

```
 16  Maximum Open Credit           256451 non-null  int32
 17  Bankruptcies                  256451 non-null  int32
 18  Tax Liens                     256451 non-null  int32
dtypes: category(4), float64(6), int32(3), int64(4), object(2)
memory usage: 29.3+ MB
```

```
loan.isna().sum()
```

```
Loan ID                             0
Customer ID                         0
Loan Status                         0
Current Loan Amount                 0
Term                                0
Credit Score                    61559
Years in current job            11476
Home Ownership                      0
Annual Income                   61559
Purpose                             0
Monthly Debt                        0
Years of Credit History             0
Months since last delinquent    140377
Number of Open Accounts             0
Number of Credit Problems           0
Current Credit Balance              0
Maximum Open Credit                 0
Bankruptcies                        0
Tax Liens                           0
dtype: int64
```

```
loan.isna().sum()/loan.isna().shape[0]*100
```

```
Loan ID                          0.000000
Customer ID                      0.000000
Loan Status                      0.000000
Current Loan Amount              0.000000
Term                             0.000000
Credit Score                    24.004196
Years in current job             4.474929
Home Ownership                   0.000000
Annual Income                   24.004196
Purpose                          0.000000
Monthly Debt                     0.000000
Years of Credit History          0.000000
Months since last delinquent    54.738332
Number of Open Accounts          0.000000
Number of Credit Problems        0.000000
Current Credit Balance           0.000000
Maximum Open Credit              0.000000
Bankruptcies                     0.000000
```

```
Tax Liens                       0.000000
dtype: float64
```

```
loan.columns
```

```
Index(['Loan ID', 'Customer ID', 'Loan Status', 'Current Loan Amount',
'Term',
       'Credit Score', 'Years in current job', 'Home Ownership',
       'Annual Income', 'Purpose', 'Monthly Debt', 'Years of Credit
History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

Description

```
loan_num = loan.select_dtypes(include=np.number).columns
len(loan_num)
```

```
13
```

```
loan_obj = loan.select_dtypes(include='object').columns
len(loan_obj)
```

```
2
```

```
loan_cat = loan.select_dtypes(include='category').columns
len(loan_cat)
```

```
4
```

```
len(loan.columns)
```

```
19
```

```
loan_num
```

```
Index(['Current Loan Amount', 'Credit Score', 'Years in current job',
       'Annual Income', 'Monthly Debt', 'Years of Credit History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

```
loan_obj
```

```
Index(['Loan ID', 'Customer ID'], dtype='object')
```

```
loan_cat
```

```
Index(['Loan Status', 'Term', 'Home Ownership', 'Purpose'],
dtype='object')
```

## Descriptive Statistics (Initial)

```
print('============Description For Numerical
Data=========================')
for i in loan_num:
    print(f'Information about {i} is: \n{loan[i].describe()}')
    print('=========================================================')
```

```
============Description For Numerical Data=========================
Information about Current Loan Amount is:
count    2.564510e+05
mean     1.371410e+07
std      3.438214e+07
min      7.010000e+02
25%      8.308000e+03
50%      1.430400e+04
75%      2.437400e+04
max      1.000000e+08
Name: Current Loan Amount, dtype: float64
=========================================================
Information about Credit Score is:
count    194892.000000
mean        721.196047
std          27.724158
min         585.000000
25%         710.000000
50%         730.000000
75%         741.000000
max         751.000000
Name: Credit Score, dtype: float64
=========================================================
Information about Years in current job is:
count    244975.000000
mean          5.873701
std           3.625345
min           0.000000
25%           3.000000
50%           6.000000
75%          10.000000
max          10.000000
Name: Years in current job, dtype: float64
=========================================================
Information about Annual Income is:
count    1.948920e+05
mean     7.195962e+04
std      5.887403e+04
min      0.000000e+00
25%      4.433400e+04
50%      6.125000e+04
75%      8.646950e+04
```

```
max      8.713547e+06
Name: Annual Income, dtype: float64
==========================================================
Information about Monthly Debt is:
count    256451.000000
mean        964.090015
std         634.147005
min           0.000000
25%         532.840000
50%         845.190000
75%        1253.065000
max       22939.120000
Name: Monthly Debt, dtype: float64
==========================================================
Information about Years of Credit History is:
count    256451.000000
mean         18.284988
std           7.076022
min           3.400000
25%          13.500000
50%          17.000000
75%          21.700000
max          70.500000
Name: Years of Credit History, dtype: float64
==========================================================
Information about Months since last delinquent is:
count    116074.000000
mean         34.980831
std          21.809912
min           0.000000
25%          16.000000
50%          32.000000
75%          51.000000
max         176.000000
Name: Months since last delinquent, dtype: float64
==========================================================
Information about Number of Open Accounts is:
count    256451.000000
mean         11.109573
std           4.982242
min           0.000000
25%           8.000000
50%          10.000000
75%          14.000000
max          76.000000
Name: Number of Open Accounts, dtype: float64
==========================================================
Information about Number of Credit Problems is:
count    256451.000000
```

```
mean           0.156884
std            0.461102
min            0.000000
25%            0.000000
50%            0.000000
75%            0.000000
max           11.000000
Name: Number of Credit Problems, dtype: float64
==========================================================
Information about Current Credit Balance is:
count    2.564510e+05
mean     1.540784e+04
std      1.966452e+04
min      0.000000e+00
25%      5.980000e+03
50%      1.108100e+04
75%      1.931900e+04
max      1.731412e+06
Name: Current Credit Balance, dtype: float64
==========================================================
Information about Maximum Open Credit is:
count    2.564510e+05
mean     3.568168e+04
std      5.554836e+05
min      0.000000e+00
25%      1.277900e+04
50%      2.173800e+04
75%      3.616550e+04
max      1.763322e+08
Name: Maximum Open Credit, dtype: float64
==========================================================
Information about Bankruptcies is:
count    256451.000000
mean          0.110317
std           0.336231
min           0.000000
25%           0.000000
50%           0.000000
75%           0.000000
max           7.000000
Name: Bankruptcies, dtype: float64
==========================================================
Information about Tax Liens is:
count    256451.000000
mean          0.027257
std           0.246191
min           0.000000
25%           0.000000
50%           0.000000
```

```
75%           0.000000
max          11.000000
Name: Tax Liens, dtype: float64
====================================================
```

**Inference**-

- The dataset shows a generally low-risk population, with most individuals having good credit scores and manageable debt levels
- There is a presence of significant outliers in features like "Current Loan Amount" and "Annual Income.

```
print('================Description For Object
Data=========================')
for i in loan_obj:
    print(f'Information about {i} is: \n{loan[i].describe()}')

print('============================================================')
```

```
================Description For Object Data=========================
Information about Loan ID is:
count                                    256451
unique                                   215246
top       371ae9d0-245c-4a06-b712-51239379518e
freq                                          4
Name: Loan ID, dtype: object
============================================================
Information about Customer ID is:
count                                    256451
unique                                   215246
top       98b6f7d8-15e4-4434-8da7-b7cd3c392dd5
freq                                          4
Name: Customer ID, dtype: object
============================================================
```

```
print('============Description For Categorical
Data=========================')

for i in loan_cat:
    print(f'Information about {i} is: \n{loan[i].describe()}')

print('============================================================')
```

```
============Description For Categorical Data=========================
Information about Loan Status is:
count         256451
unique             2
top       Fully Paid
freq          175812
Name: Loan Status, dtype: object
```

```
============================================================
Information about Term is:
count         256451
unique             2
top       Short Term
freq          192101
Name: Term, dtype: object
============================================================
Information about Home Ownership is:
count            256451
unique                3
top       Home Mortgage
freq             124850
Name: Home Ownership, dtype: object
============================================================
Information about Purpose is:
count                256451
unique                   10
top       Debt Consolidation
freq                 203605
Name: Purpose, dtype: object
============================================================
```

**Inference**-

- The "Loan Status" feature indicates a binary outcome, with a majority (approximately 68%) categorized as "Fully Paid," suggesting a healthy repayment rate.
- The "Term" variable also shows a preference for "Short Term" loans, which comprise about 75% of the dataset
- "Home Ownership" and "Purpose" categories display more diversity, with "Home Mortgage" and "Debt Consolidation"

## Correlation

```
loan.select_dtypes(include=np.number).corr()
```

```
                              Current Loan Amount  Credit Score  \
Current Loan Amount                      1.000000      0.082170
Credit Score                             0.082170      1.000000
Years in current job                     0.005734     -0.018649
Annual Income                            0.024234      0.012452
Monthly Debt                            -0.001998     -0.092169
Years of Credit History                  0.014591      0.085602
Months since last delinquent             0.003517      0.048560
Number of Open Accounts                 -0.003307     -0.043472
Number of Credit Problems               -0.000009     -0.057477
Current Credit Balance                   0.003106     -0.016452
Maximum Open Credit                      0.006512      0.010491
Bankruptcies                             0.003574     -0.043008
Tax Liens                               -0.003073     -0.027243
```

| | Years in current job | Annual Income |
|---|---|---|
| Current Loan Amount | 0.005734 | 0.024234 |
| Credit Score | -0.018649 | 0.012452 |
| Years in current job | 1.000000 | 0.069892 |
| Annual Income | 0.069892 | 1.000000 |
| Monthly Debt | 0.123182 | 0.454790 |
| Years of Credit History | 0.221941 | 0.146813 |
| Months since last delinquent | -0.009941 | -0.060848 |
| Number of Open Accounts | 0.046991 | 0.140244 |
| Number of Credit Problems | 0.041162 | -0.013735 |
| Current Credit Balance | 0.091100 | 0.291530 |
| Maximum Open Credit | 0.003806 | 0.029871 |
| Bankruptcies | 0.043871 | -0.044840 |
| Tax Liens | 0.007735 | 0.038210 |

| | Monthly Debt | Years of Credit History |
|---|---|---|
| Current Loan Amount | -0.001998 | 0.014591 |
| Credit Score | -0.092169 | 0.085602 |
| Years in current job | 0.123182 | 0.221941 |
| Annual Income | 0.454790 | 0.146813 |
| Monthly Debt | 1.000000 | 0.189187 |
| Years of Credit History | 0.189187 | 1.000000 |
| Months since last delinquent | -0.060263 | -0.039573 |
| Number of Open Accounts | 0.410257 | 0.128082 |
| Number of Credit Problems | -0.053212 | 0.061466 |
| Current Credit Balance | 0.472491 | 0.201086 |
| Maximum Open Credit | 0.026406 | 0.021700 |
| Bankruptcies | -0.078441 | 0.062047 |
| Tax Liens | 0.020447 | 0.021014 |

| | Months since last delinquent |
|---|---|
| Current Loan Amount | 0.003517 |
| Credit Score | 0.048560 |
| Years in current job | -0.009941 |
| Annual Income | -0.060848 |
| Monthly Debt | -0.060263 |
| Years of Credit History | -0.039573 |
| Months since last delinquent | 1.000000 |
| Number of Open Accounts | -0.037930 |
| Number of Credit Problems | 0.087453 |
| Current Credit Balance | -0.023770 |
| Maximum Open Credit | -0.000217 |
| Bankruptcies | 0.112905 |
| Tax Liens | 0.002185 |

| | Number of Open Accounts |
|---|---|
| Current Loan Amount | -0.003307 |
| Credit Score | -0.043472 |
| Years in current job | 0.046991 |

```
Annual Income                                0.140244
Monthly Debt                                 0.410257
Years of Credit History                      0.128082
Months since last delinquent                -0.037930
Number of Open Accounts                      1.000000
Number of Credit Problems                   -0.013890
Current Credit Balance                       0.222531
Maximum Open Credit                          0.019199
Bankruptcies                                -0.022812
Tax Liens                                    0.005688

                             Number of Credit Problems  \
Current Loan Amount                          -0.000009
Credit Score                                 -0.057477
Years in current job                          0.041162
Annual Income                                -0.013735
Monthly Debt                                 -0.053212
Years of Credit History                       0.061466
Months since last delinquent                  0.087453
Number of Open Accounts                      -0.013890
Number of Credit Problems                     1.000000
Current Credit Balance                       -0.103959
Maximum Open Credit                          -0.008305
Bankruptcies                                  0.755866
Tax Liens                                     0.584995

                             Current Credit Balance  Maximum Open
Credit  \
Current Loan Amount                        0.003106
0.006512
Credit Score                              -0.016452
0.010491
Years in current job                       0.091100
0.003806
Annual Income                              0.291530
0.029871
Monthly Debt                               0.472491
0.026406
Years of Credit History                    0.201086
0.021700
Months since last delinquent              -0.023770             -
0.000217
Number of Open Accounts                    0.222531
0.019199
Number of Credit Problems                 -0.103959             -
0.008305
Current Credit Balance                     1.000000
0.111409
Maximum Open Credit                        0.111409
```

```
1.000000
Bankruptcies                                  -0.117999            -
0.009962
Tax Liens                                     -0.011138            -
0.000483
```

| | Bankruptcies | Tax Liens |
|---|---|---|
| Current Loan Amount | 0.003574 | -0.003073 |
| Credit Score | -0.043008 | -0.027243 |
| Years in current job | 0.043871 | 0.007735 |
| Annual Income | -0.044840 | 0.038210 |
| Monthly Debt | -0.078441 | 0.020447 |
| Years of Credit History | 0.062047 | 0.021014 |
| Months since last delinquent | 0.112905 | 0.002185 |
| Number of Open Accounts | -0.022812 | 0.005688 |
| Number of Credit Problems | 0.755866 | 0.584995 |
| Current Credit Balance | -0.117999 | -0.011138 |
| Maximum Open Credit | -0.009962 | -0.000483 |
| Bankruptcies | 1.000000 | 0.046159 |
| Tax Liens | 0.046159 | 1.000000 |

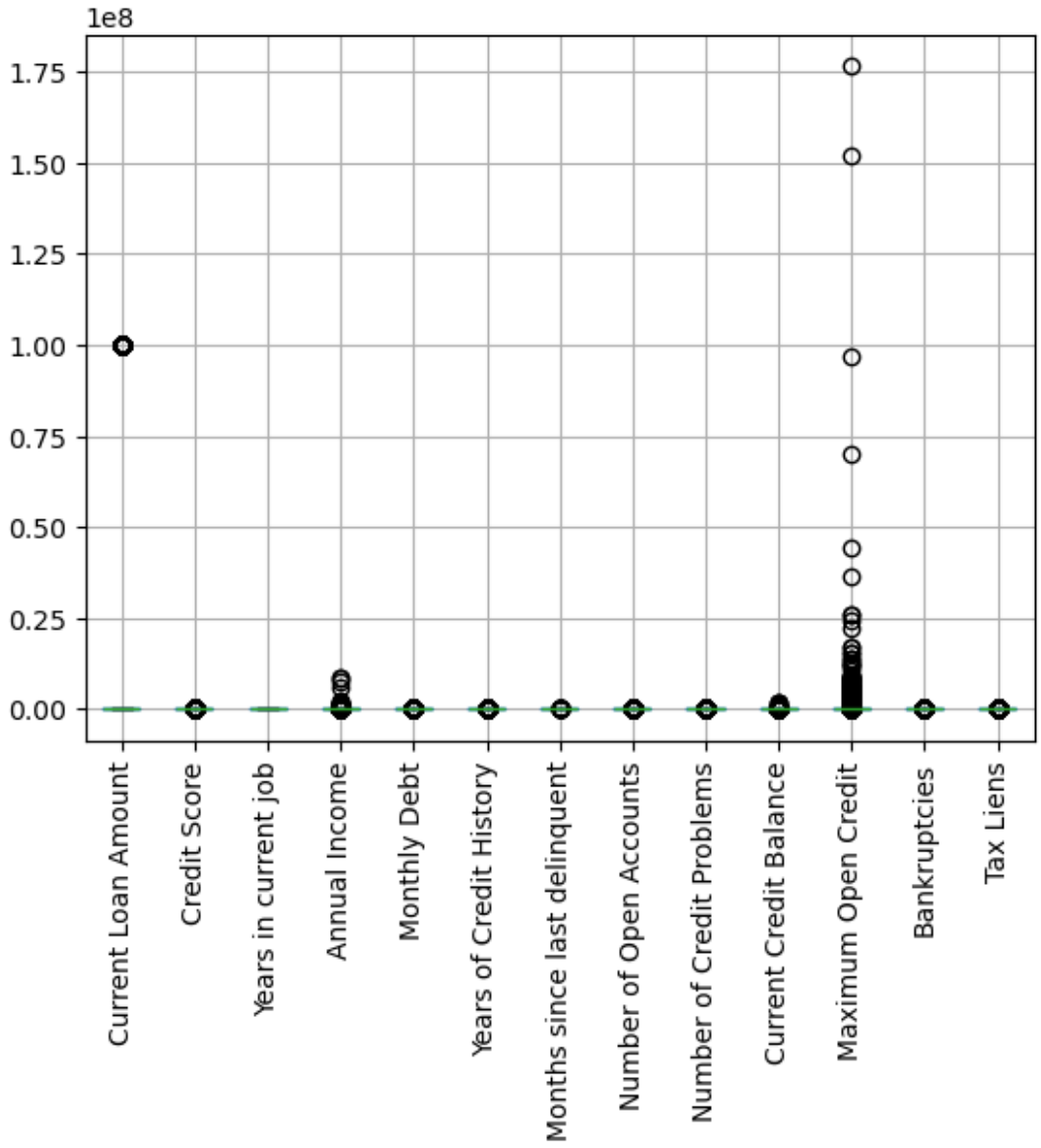
**Inference**-

- The correlation matrix indicates several key relationships among the variables: "Annual Income" has a strong positive correlation with "Monthly Debt" (0.45), suggesting higher incomes tend to be associated with higher debt levels.
- "Number of Credit Problems" is notably correlated with "Bankruptcies" (0.76), highlighting a significant relationship between credit issues and financial distress. Overall, features like "Years in Current Job" and "Years of Credit History" show weak correlations with other variables, suggesting they may have less direct impact on loan status.

## Outliers

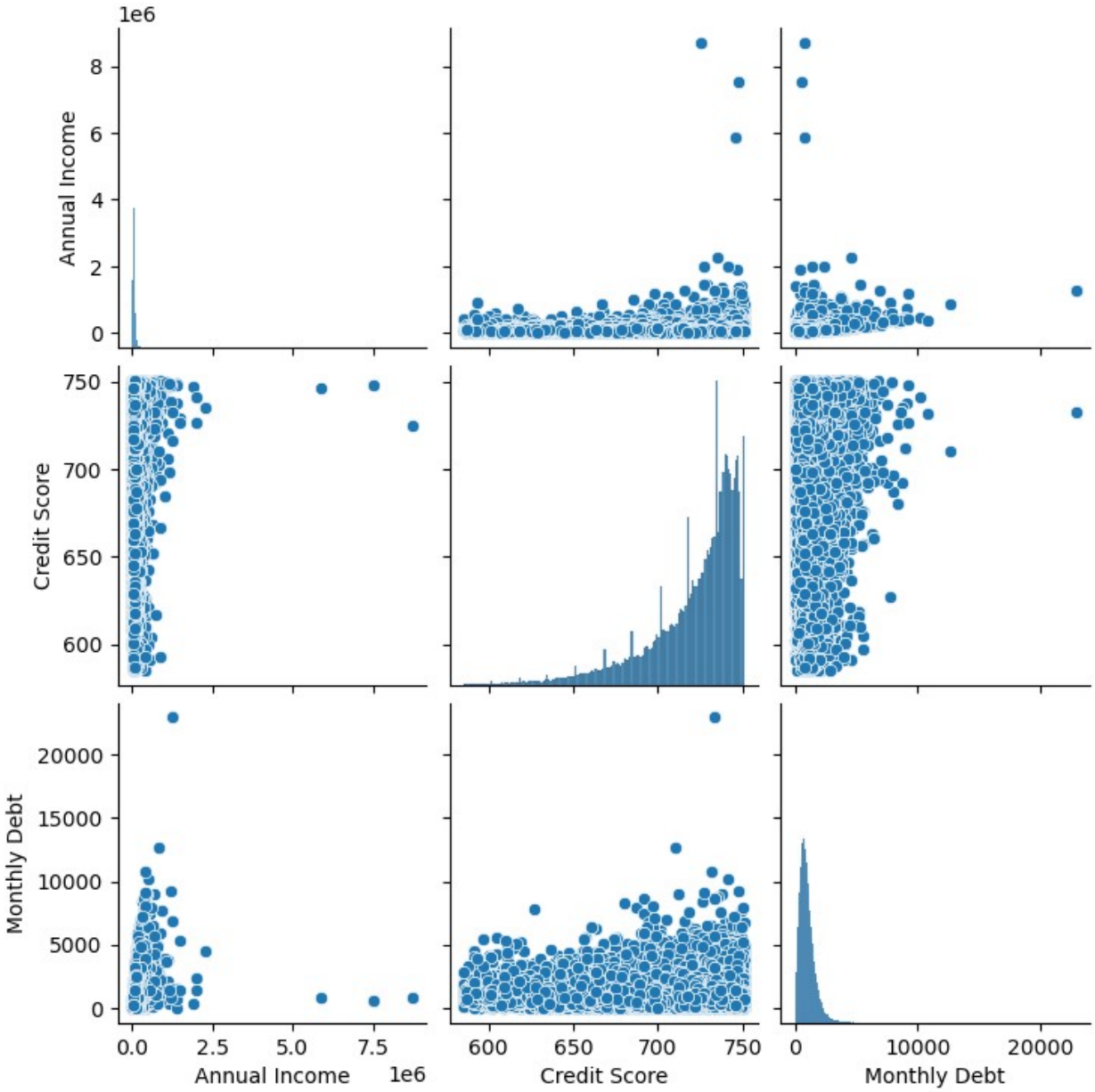
```
loan.select_dtypes(include=np.number).boxplot(rot=90)
```

```
<Axes: >
```




Visualization

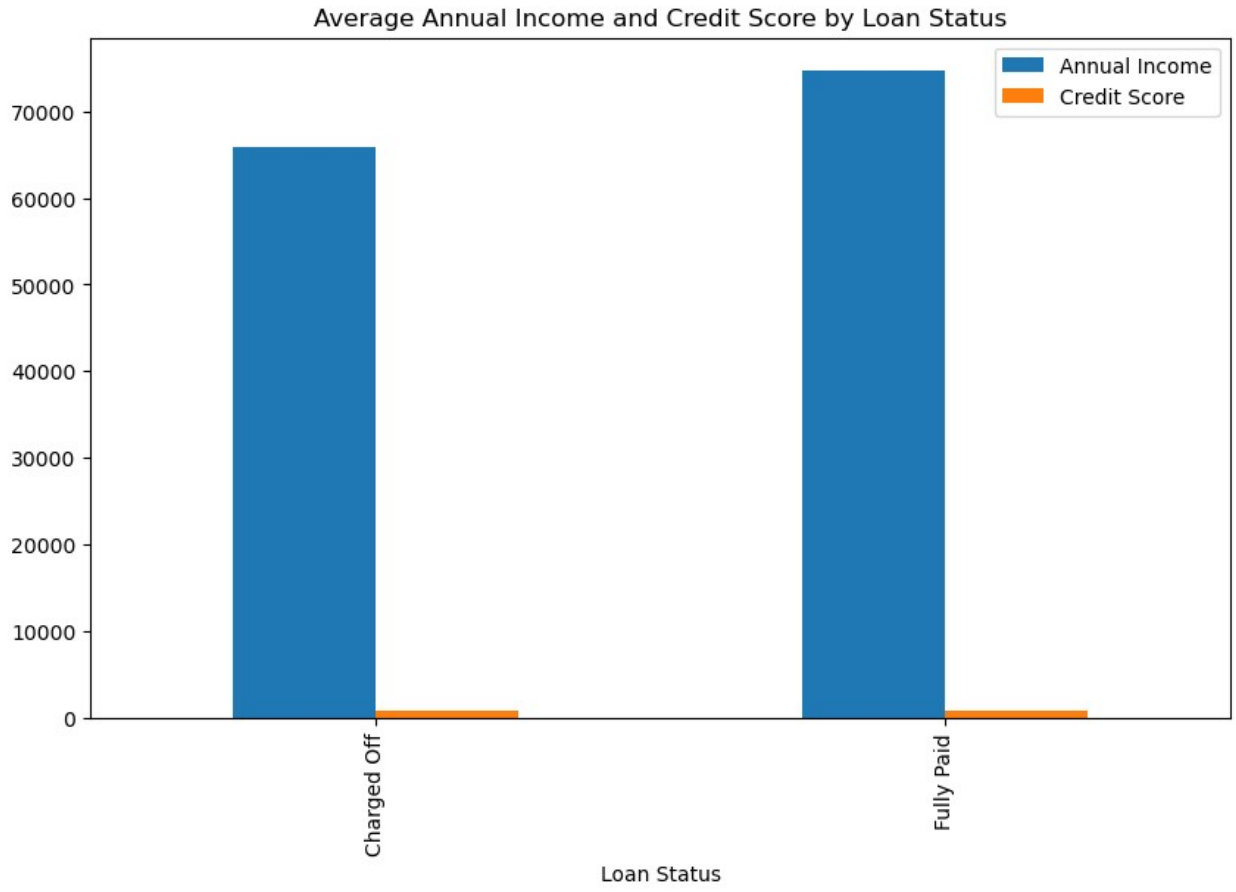
```
sns.pairplot(loan[['Annual Income', 'Credit Score', 'Monthly Debt']])

plt.show()
```




```
# Group by 'Loan Status' and calculating the mean for 'annual Income'
and 'credit Score'
loan.groupby('Loan Status')[['Annual Income', 'Credit
Score']].mean().plot(kind='bar', figsize=(10, 6))
plt.title('Average Annual Income and Credit Score by Loan Status')
plt.show()
```

```
C:\Users\prakhar\AppData\Local\Temp\ipykernel_7348\546519414.py:2:
FutureWarning: The default of observed=False is deprecated and will be
changed to True in a future version of pandas. Pass observed=False to
retain current behavior or observed=True to adopt the future default
```

```
and silence this warning.
  loan.groupby('Loan Status')[['Annual Income', 'Credit
Score']].mean().plot(kind='bar', figsize=(10, 6))
```




## Handelling Null Value or Missing Data

```
for i in loan_num:
    if loan[i].isna().sum()>0:
        print(f'Null Values present in {i} is: \
n{loan[i].isna().sum()}\n % in total is
{round((loan[i].isna().sum()/loan.shape[0]),2)*100}% ')

print('=======================================================')
    else:
        pass
```

```
Null Values present in Credit Score is:
61559
 % in total is 24.0%
=======================================================
Null Values present in Years in current job is:
11476
```

```
 % in total is 4.0%
=====================================================
Null Values present in Annual Income is:
61559
 % in total is 24.0%
=====================================================
Null Values present in Months since last delinquent is:
140377
 % in total is 55.00000000000001%
=====================================================

loan_num

Index(['Current Loan Amount', 'Credit Score', 'Years in current job',
       'Annual Income', 'Monthly Debt', 'Years of Credit History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

## Treating Null Values

### KNN Imputation

This method is used to fill the missing values by identifying the similar data points based on the distance, This method preserves the data's structure and relationships, making it particularly effective for datasets with complex patterns.

- **Processing time is around 1 hr so the dataset with imputed data is preserved in a new csv file named `Loan_Cleaned_Data.csv`.
- Further analysis will be done using that file.

## Reading the Cleaned Dataset

```
loan_clean = pd.read_csv('Imputed_Data_10.csv')

loan_clean.head()

   Unnamed: 0                                Loan ID  \
0           0  000025bb-5694-4cff-b17d-192b1a98ba44
1           1  00002c49-3a29-4bd4-8f67-c8f8fbc1048c
2           2  00002d89-27f3-409b-aa76-90834f359a65
3           3  00005222-b4d8-45a4-ad8c-186057e24233
4           4  0000757f-a121-41ed-b17b-162e76647c1f

                            Customer ID Loan Status  Current Loan
Amount  \
0  5ebc8bb1-5eb9-4404-b11b-a6eebc401a19  Fully Paid
11520
1  927b388d-2e01-423f-a8dc-f7e42d668f46  Fully Paid
```

```
3441
2  defce609-c631-447d-aad6-1270615e89c4  Fully Paid
21029
3  070bcecb-aae7-4485-a26a-e0403e7bb6c5  Fully Paid
18743
4  dde79588-12f0-4811-bab0-e2b07f633fcd  Fully Paid
11731

         Term  Credit Score  Years in current job Home Ownership  \
0  Short Term         741.0                  10.0  Home Mortgage
1  Short Term         734.0                   4.0  Home Mortgage
2  Short Term         747.0                  10.0  Home Mortgage
3  Short Term         747.0                  10.0       Own Home
4  Short Term         746.0                   4.0           Rent

   Annual Income             Purpose  Monthly Debt  Years of Credit
History  \
0        33694.0  Debt Consolidation        584.03
12.3
1        42269.0               other       1106.04
26.3
2        90126.0  Debt Consolidation       1321.85
28.8
3        38072.0  Debt Consolidation        751.92
26.2
4        50025.0  Debt Consolidation        355.18
11.5

   Months since last delinquent  Number of Open Accounts  \
0                          41.0                     10.0
1                          24.0                     17.0
2                          35.6                      5.0
3                          40.0                      9.0
4                          42.4                     12.0

   Number of Credit Problems  Current Credit Balance  Maximum Open
Credit  \
0                        0.0                    6760
16056
1                        0.0                    6262
19149
2                        0.0                   20967
28335
3                        0.0                   22529
43915
4                        0.0                   17391
37081

   Bankruptcies  Tax Liens
0             0          0
```

```
1              0           0
2              0           0
3              0           0
4              0           0
```

```
loan_clean=loan_clean.drop('Unnamed: 0',axis=1)
```

```
loan_clean.isna().sum()
```

```
Loan ID                         0
Customer ID                     0
Loan Status                     0
Current Loan Amount             0
Term                            0
Credit Score                    0
Years in current job            0
Home Ownership                  0
Annual Income                   0
Purpose                         0
Monthly Debt                    0
Years of Credit History         0
Months since last delinquent    0
Number of Open Accounts         0
Number of Credit Problems       0
Current Credit Balance          0
Maximum Open Credit             0
Bankruptcies                    0
Tax Liens                       0
dtype: int64
```

```
loan_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 256451 entries, 0 to 256450
Data columns (total 19 columns):
 #   Column                         Non-Null Count   Dtype  
---  ------                         --------------   -----  
 0   Loan ID                        256451 non-null  object 
 1   Customer ID                    256451 non-null  object 
 2   Loan Status                    256451 non-null  object 
 3   Current Loan Amount            256451 non-null  int64  
 4   Term                           256451 non-null  object 
 5   Credit Score                   256451 non-null  float64
 6   Years in current job           256451 non-null  float64
 7   Home Ownership                 256451 non-null  object 
 8   Annual Income                  256451 non-null  float64
 9   Purpose                        256451 non-null  object 
 10  Monthly Debt                   256451 non-null  float64
 11  Years of Credit History        256451 non-null  float64
 12  Months since last delinquent   256451 non-null  float64
```

```
 13  Number of Open Accounts       256451 non-null  float64
 14  Number of Credit Problems     256451 non-null  float64
 15  Current Credit Balance        256451 non-null  int64
 16  Maximum Open Credit           256451 non-null  int64
 17  Bankruptcies                  256451 non-null  int64
 18  Tax Liens                     256451 non-null  int64
dtypes: float64(8), int64(5), object(6)
memory usage: 37.2+ MB
```

```
loan_clean.duplicated().sum()
```

```
25448
```

```
loan_num = loan_clean.select_dtypes(include=np.number).columns
len(loan_num)
```

```
13
```

```
loan_num
```

```
Index(['Current Loan Amount', 'Credit Score', 'Years in current job',
       'Annual Income', 'Monthly Debt', 'Years of Credit History',
       'Months since last delinquent', 'Number of Open Accounts',
       'Number of Credit Problems', 'Current Credit Balance',
       'Maximum Open Credit', 'Bankruptcies', 'Tax Liens'],
      dtype='object')
```

```
loan_obj = loan_clean.select_dtypes(include='object').columns
len(loan_obj)
```

```
6
```

```
loan_obj
```

```
Index(['Loan ID', 'Customer ID', 'Loan Status', 'Term', 'Home
Ownership',
       'Purpose'],
      dtype='object')
```

## Treating Categorical Column

```
loan_obj
```

```
Index(['Loan ID', 'Customer ID', 'Loan Status', 'Term', 'Home
Ownership',
       'Purpose'],
      dtype='object')
```

### Loan Status

```
loan_clean['Loan Status'].unique()  #we can use label encoding for
Loan status and mark as 0 for charged off and 1 for fully paid
```

```
array(['Fully Paid', 'Charged Off'], dtype=object)
```

```
loan_clean['Loan Status'].value_counts()
```

```
Loan Status
Fully Paid     175812
Charged Off     80639
Name: count, dtype: int64
```

```
loan_clean['Loan Status'] = loan_clean['Loan Status'].map({'Charged
Off':1 , 'Fully Paid':0})
```

```
loan_clean.head(2)
```

```
                                  Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-
a6eebc401a19
1  00002c49-3a29-4bd4-8f67-c8f8fbc1048c  927b388d-2e01-423f-a8dc-
f7e42d668f46

   Loan Status  Current Loan Amount        Term  Credit Score  \
0          NaN                11520  Short Term         741.0
1          NaN                 3441  Short Term         734.0

   Years in current job Home Ownership  Annual Income
Purpose  \
0                  10.0  Home Mortgage        33694.0  Debt
Consolidation
1                   4.0  Home Mortgage        42269.0
other

   Monthly Debt  Years of Credit History  Months since last delinquent
\
0        584.03                     12.3                           41.0

1       1106.04                     26.3                           24.0


   Number of Open Accounts  Number of Credit Problems  Current Credit
Balance  \
0                     10.0                        0.0
6760
1                     17.0                        0.0
6262

   Maximum Open Credit  Bankruptcies  Tax Liens
0                16056             0          0
1                19149             0          0
```

```
loan_clean['Loan Status'].unique()   #fully-paid=1  charged off=0
```

```
array([1, 0])
```

Term

```
loan_clean['Term'].unique()

array(['Short Term', 'Long Term'], dtype=object)

loan_clean['Term'].value_counts()

Term
Short Term    192101
Long Term      64350
Name: count, dtype: int64

loan_clean['Term'] = label_encoder.fit_transform(loan_clean['Term'])

loan_clean['Term'].unique()

array([1, 0])

loan_clean.head(1)

                                    Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-
a6eebc401a19

   Loan Status  Current Loan Amount  Term  Credit Score  Years in
current job  \
0            1                11520     1         741.0
10.0

  Home Ownership  Annual Income             Purpose  Monthly Debt  \
0  Home Mortgage        33694.0  Debt Consolidation        584.03

   Years of Credit History  Months since last delinquent  \
0                     12.3                          41.0

   Number of Open Accounts  Number of Credit Problems  Current Credit
Balance  \
0                     10.0                         0.0
6760

   Maximum Open Credit  Bankruptcies  Tax Liens
0                16056             0          0
```

'Home Ownership'

```
loan_clean['Home Ownership'].unique()

array(['Home Mortgage', 'Own Home', 'Rent'], dtype=object)
```

```
df_encoded_HO= pd.get_dummies(loan_clean['Home Ownership'],
columns=['Home Ownership']).astype(int)
df_encoded_HO
```

```
        Home Mortgage  Own Home  Rent
0                   1         0     0
1                   1         0     0
2                   1         0     0
3                   0         1     0
4                   0         0     1
...               ...       ...   ...
256446              0         0     1
256447              0         1     0
256448              1         0     0
256449              1         0     0
256450              1         0     0

[256451 rows x 3 columns]
```

```
loan_clean = pd.concat([loan_clean, df_encoded_HO], axis=1)
loan_clean=loan_clean.drop('Home Ownership',axis=1)

loan_clean.head(1)
#As we can drop one of the column that we fetch after onehot encoding
as
# 1-0 =Home Mortgage
# 0-1 = Own Home
# 0-0 = Rent
#Droping Rent Column
```

```
                                  Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-
a6eebc401a19

   Loan Status  Current Loan Amount  Term  Credit Score  Years in
current job  \
0            1                11520     1         741.0
10.0

   Annual Income             Purpose  Monthly Debt  ...  \
0        33694.0  Debt Consolidation        584.03  ...

   Months since last delinquent  Number of Open Accounts  \
0                          41.0                     10.0

   Number of Credit Problems  Current Credit Balance  Maximum Open
Credit  \
0                        0.0                    6760
16056
```

```
   Bankruptcies  Tax Liens  Home Mortgage  Own Home  Rent
0             0          0              1         0     0

[1 rows x 21 columns]
```

```
loan_clean=loan_clean.drop('Rent',axis=1)
```

```
loan_clean.head(1)
```

```
                                   Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-
a6eebc401a19

   Loan Status  Current Loan Amount  Term  Credit Score  Years in
current job  \
0            1                11520     1         741.0
10.0

   Annual Income             Purpose  Monthly Debt  Years of Credit
History  \
0        33694.0  Debt Consolidation        584.03
12.3

   Months since last delinquent  Number of Open Accounts  \
0                          41.0                     10.0

   Number of Credit Problems  Current Credit Balance  Maximum Open
Credit  \
0                        0.0                    6760
16056

   Bankruptcies  Tax Liens  Home Mortgage  Own Home
0             0          0              1         0
```

Purpose

```
loan_clean['Purpose'].unique()
```

```
array(['Debt Consolidation', 'other', 'Business Loan',
       'Home Improvements', 'Buy House', 'Other', 'Buy a Car',
       'Medical Bills', 'Take a Trip', 'Educational Expenses'],
      dtype=object)
```

```
loan_clean['Purpose'].value_counts()
```

```
Purpose
Debt Consolidation      203605
Home Improvements        14876
other                    14196
Other                     9629
```

```
Business Loan              4672
Buy a Car                  3262
Medical Bills              2862
Take a Trip                1565
Buy House                  1527
Educational Expenses        257
Name: count, dtype: int64
```

```
df_encoded_purpose= pd.get_dummies(loan_clean['Purpose'],
columns=['Purpose']).astype(int)
df_encoded_purpose
```

```
        Business Loan  Buy House  Buy a Car  Debt Consolidation  \
0                   0          0          0                   1
1                   0          0          0                   0
2                   0          0          0                   1
3                   0          0          0                   1
4                   0          0          0                   1
...               ...        ...        ...                 ...
256446              0          0          0                   1
256447              0          0          0                   1
256448              0          0          0                   1
256449              0          0          0                   1
256450              0          0          0                   1

        Educational Expenses  Home Improvements  Medical Bills  Other
\
0                          0                  0              0      0

1                          0                  0              0      0

2                          0                  0              0      0

3                          0                  0              0      0

4                          0                  0              0      0

...                      ...                ...            ...    ...

256446                     0                  0              0      0

256447                     0                  0              0      0

256448                     0                  0              0      0

256449                     0                  0              0      0

256450                     0                  0              0      0


        Take a Trip  other
```

```
0                   0      0
1                   0      1
2                   0      0
3                   0      0
4                   0      0
...               ...    ...
256446              0      0
256447              0      0
256448              0      0
256449              0      0
256450              0      0

[256451 rows x 10 columns]
```

- This type of encoding leads to create a lot of feature instead of this method we can do frequency coding and take its frequency as data

```
frequency_encoding=
loan_clean['Purpose'].value_counts(normalize=False)
loan_clean['Purpose_freq'] =
loan_clean['Purpose'].map(frequency_encoding)

loan_clean = loan_clean.drop('Purpose',axis=1)

loan_clean.head(1)

                                    Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-
a6eebc401a19

   Loan Status  Current Loan Amount  Term  Credit Score  Years in
current job  \
0            1                11520     1         741.0
10.0

   Annual Income  Monthly Debt  Years of Credit History  \
0        33694.0        584.03                     12.3

   Months since last delinquent  Number of Open Accounts  \
0                          41.0                     10.0

   Number of Credit Problems  Current Credit Balance  Maximum Open
Credit  \
0                        0.0                    6760
16056

   Bankruptcies  Tax Liens  Home Mortgage  Own Home  Purpose_freq
0             0          0              1         0        203605

loan_clean=loan_clean.rename(columns={'Purpose_freq':'Purpose'})
```

```
loan_clean.head(1)
```

```
                                   Loan ID
Customer ID  \
0  000025bb-5694-4cff-b17d-192b1a98ba44  5ebc8bb1-5eb9-4404-b11b-
a6eebc401a19

   Loan Status  Current Loan Amount  Term  Credit Score  Years in
current job  \
0            1                11520     1         741.0
10.0

   Annual Income  Monthly Debt  Years of Credit History  \
0        33694.0        584.03                     12.3

   Months since last delinquent  Number of Open Accounts  \
0                          41.0                     10.0

   Number of Credit Problems  Current Credit Balance  Maximum Open
Credit  \
0                        0.0                    6760
16056

   Bankruptcies  Tax Liens  Home Mortgage  Own Home  Purpose
0             0          0              1         0   203605
```

## Overview of Cleaned and encoded data

```
loan_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 256451 entries, 0 to 256450
Data columns (total 20 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   Loan ID                       256451 non-null  object
 1   Customer ID                   256451 non-null  object
 2   Loan Status                   256451 non-null  int32
 3   Current Loan Amount           256451 non-null  int64
 4   Term                          256451 non-null  int32
 5   Credit Score                  256451 non-null  float64
 6   Years in current job          256451 non-null  float64
 7   Annual Income                 256451 non-null  float64
 8   Monthly Debt                  256451 non-null  float64
 9   Years of Credit History       256451 non-null  float64
 10  Months since last delinquent  256451 non-null  float64
 11  Number of Open Accounts       256451 non-null  float64
 12  Number of Credit Problems     256451 non-null  float64
 13  Current Credit Balance        256451 non-null  int64
 14  Maximum Open Credit           256451 non-null  int64
```

```
 15  Bankruptcies                  256451 non-null  int64
 16  Tax Liens                     256451 non-null  int64
 17  Home Mortgage                 256451 non-null  int32
 18  Own Home                      256451 non-null  int32
 19  Purpose                       256451 non-null  int64
dtypes: float64(8), int32(4), int64(6), object(2)
memory usage: 35.2+ MB
```

- customerid and loanid can be remove out from the analysis as they are unique identifier so will not play a crucial role in the process.

```
loan_clean=loan_clean.drop(['Loan ID','Customer ID'],axis=1)
```

- As all columns are now encoded and converted into the machine readable form so now there will be no other dtypes other than fliat or int

```
loan_obj = loan_clean.select_dtypes(include='object').columns
len(loan_obj)

0

loan_num = loan_clean.select_dtypes(include=np.number).columns
len(loan_num)

18

loan_clean.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 256451 entries, 0 to 256450
Data columns (total 18 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   Loan Status                   256451 non-null  int32
 1   Current Loan Amount           256451 non-null  int64
 2   Term                          256451 non-null  int32
 3   Credit Score                  256451 non-null  float64
 4   Years in current job          256451 non-null  float64
 5   Annual Income                 256451 non-null  float64
 6   Monthly Debt                  256451 non-null  float64
 7   Years of Credit History       256451 non-null  float64
 8   Months since last delinquent  256451 non-null  float64
 9   Number of Open Accounts       256451 non-null  float64
 10  Number of Credit Problems     256451 non-null  float64
 11  Current Credit Balance        256451 non-null  int64
 12  Maximum Open Credit           256451 non-null  int64
 13  Bankruptcies                  256451 non-null  int64
 14  Tax Liens                     256451 non-null  int64
 15  Home Mortgage                 256451 non-null  int32
 16  Own Home                      256451 non-null  int32
 17  Purpose                       256451 non-null  int64
```

```
dtypes: float64(8), int32(4), int64(6)
memory usage: 31.3 MB
```

## Treating Duplicated Values

```
loan_clean.duplicated().sum()
```

```
25448
```

```
loan_clean.duplicated().sum()/loan_clean.shape[0]*100
```

```
9.923143212543527
```

- As the amount of duplicated values is not significant and will not play that much crucial role in the analysis we can drop these

```
loan_clean=loan_clean.drop_duplicates()
```

```
loan_clean.duplicated().sum()
```

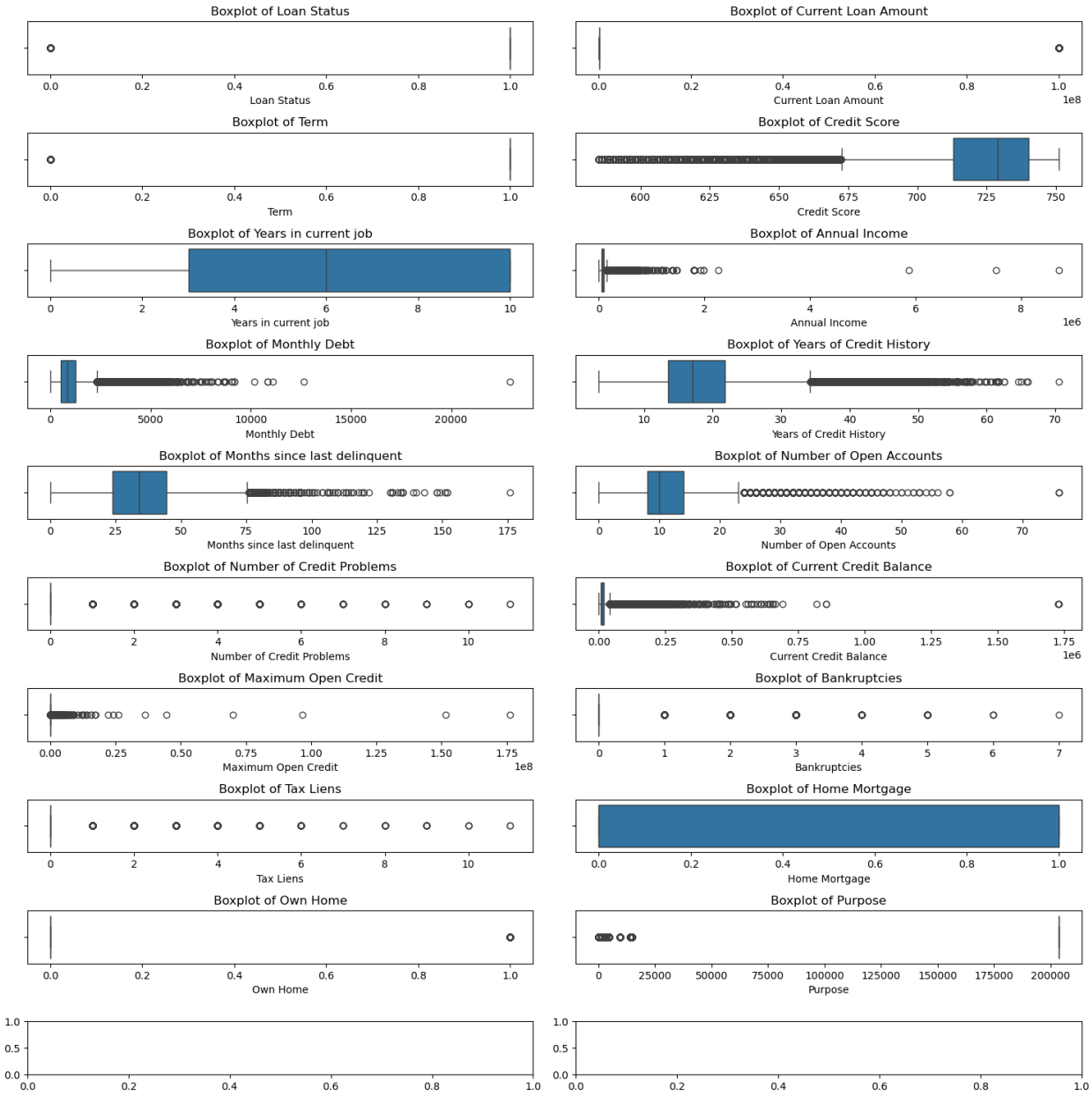
```
0
```

```
loan_clean.shape
```

```
(231003, 18)
```

## Identifying Outliers

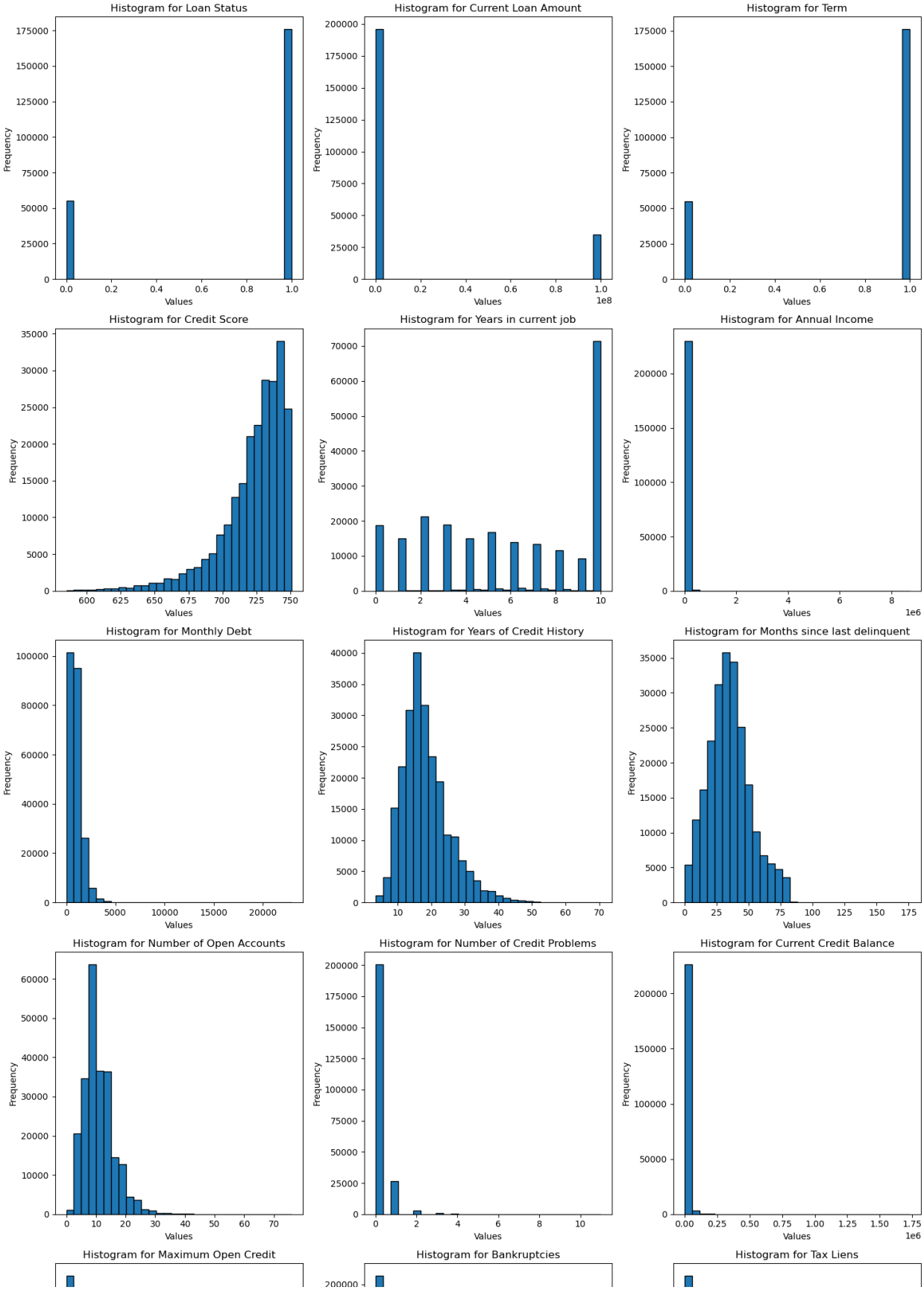
```
fig, axes = plt.subplots(10, 2, figsize=(15, 15))
axes = axes.flatten()

for i, col in enumerate(loan_num):
    sns.boxplot(data=loan_clean, x=col, ax=axes[i])
    axes[i].set_title(f'Boxplot of {col}')

plt.tight_layout()
plt.show()
```




- Features with Outliers: **Monthly Debt,Annual Income,Months since Last Delinquent,Number of Credit Problems,Current Credit Balance,Number of Open Accounts,Years of Credit History,Maximum Open Credit,Bankruptcies,Tax Liens**
- **Features with Few or No Outliers:**
- **Loan Status, Term, Home Mortgage, Own Home, Rent, Purpose_freq**
- **Out of all outliers columns the main columns to focus on is 'Annual Income','Monthly Debt','Credit Score','Current Credit Balance'**
- **For approving loan to a person these features play role a bit high as compared to others so these needs to be treated carefully.**

## Checking the Data is normally distributed or not

```
num_columns = len(loan_num)
n_rows = (num_columns + 2) // 3  # 3 columns per row
fig, axes = plt.subplots(n_rows, 3, figsize=(15, n_rows * 5))

# Flatten axes if necessary
axes = axes.flatten()

for i, column in enumerate(loan_clean.columns):
    axes[i].hist(loan_clean[column], bins=30, edgecolor='black')
    axes[i].set_title(f'Histogram for {column}')
    axes[i].set_xlabel('Values')
    axes[i].set_ylabel('Frequency')

plt.tight_layout()
plt.show()
```


Histogram for Loan Status
Histogram for Current Loan Amount
Histogram for Term
Histogram for Credit Score
Histogram for Years in current job
Histogram for Annual Income
Histogram for Monthly Debt
Histogram for Years of Credit History
Histogram for Months since last delinquent
Histogram for Number of Open Accounts
Histogram for Number of Credit Problems
Histogram for Current Credit Balance
Histogram for Maximum Open Credit
Histogram for Bankruptcies
Histogram for Tax Liens
Frequency
Values
1e8
1e6

- Data is not Normally distributed so we will use IQR Method for removing Outliers.

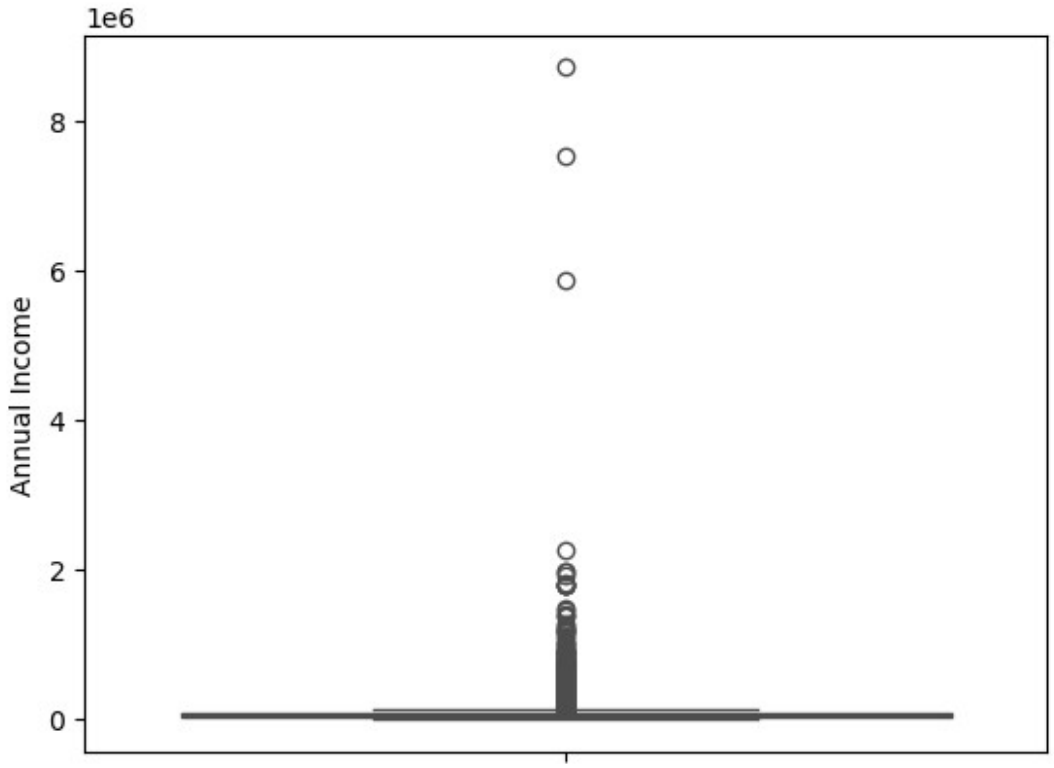
IQR Method

Columns to consider:

- Annual Income

```
sns.boxplot(loan_clean,y='Annual Income',color='blue')
```

```
<Axes: ylabel='Annual Income'>
```



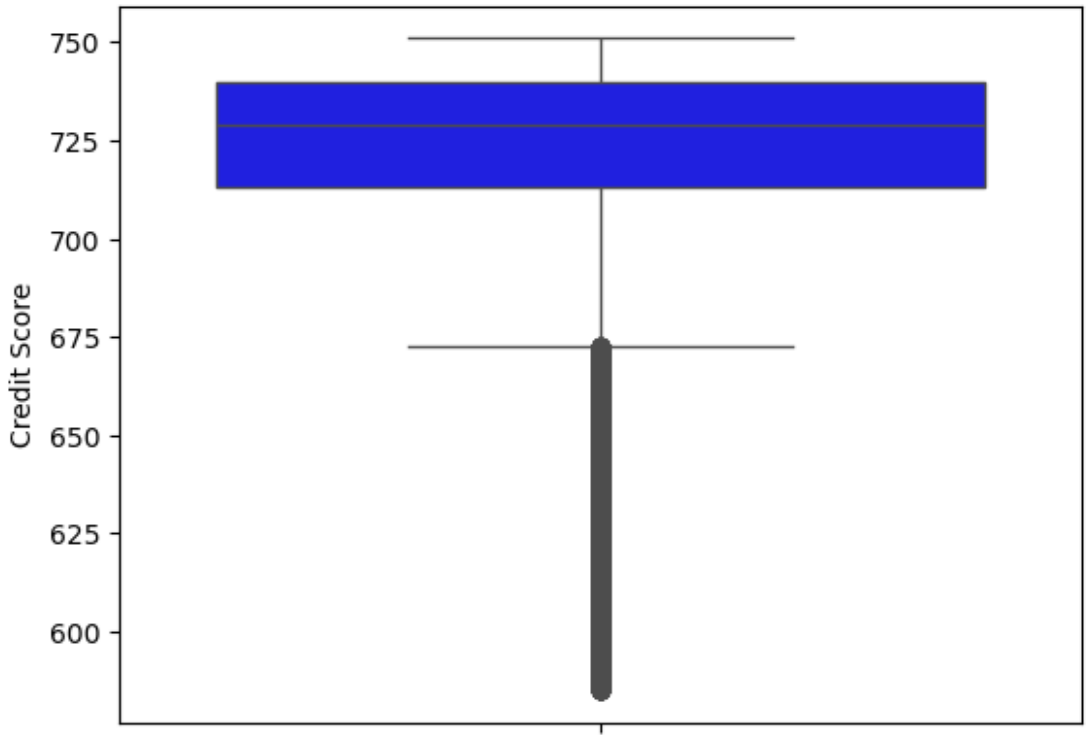

```
Q1 = loan_clean['Annual Income'].quantile(0.25)
Q3 = loan_clean['Annual Income'].quantile(0.75)
IQR = Q3 - Q1

# Define outlier boundaries
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Count the number of outliers
outliers = loan_clean[(loan_clean['Annual Income'] < lower_bound) |
(loan_clean['Annual Income'] > upper_bound)]
num_outliers_AI = outliers.shape[0]

print(f"Number of outliers: {num_outliers_AI}")
print(f"% of outliers: {num_outliers_AI*100/loan_clean.shape[0]}")
```

```
Number of outliers: 10579
% of outliers: 4.5795942044042715
```

- Credit Score

```
sns.boxplot(loan_clean,y='Credit Score',color='blue')
```

```
<Axes: ylabel='Credit Score'>
```




```
Q1 = loan_clean['Credit Score'].quantile(0.25)
Q3 = loan_clean['Credit Score'].quantile(0.75)
IQR = Q3 - Q1

# Define outlier boundaries
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR

# Count the number of outliers
outliers = loan_clean[(loan_clean['Credit Score'] < lower_bound) |
(df['Credit Score'] > upper_bound)]
num_outliers_CS = outliers.shape[0]

print(f"Number of outliers: {num_outliers_CS}")
print(f"% of outliers: {num_outliers_CS*100/loan_clean.shape[0]}")
```

```
Number of outliers: 25104
% of outliers: 10.867391332580096
```

```
C:\Users\prakhar\AppData\Local\Temp\ipykernel_11848\1086913582.py:10:
UserWarning: Boolean Series key will be reindexed to match DataFrame
index.
  outliers = loan_clean[(loan_clean['Credit Score'] < lower_bound) |
(df['Credit Score'] > upper_bound)]

loan_clean.columns

Index(['Loan Status', 'Current Loan Amount', 'Term', 'Credit Score',
       'Years in current job', 'Annual Income', 'Monthly Debt',
       'Years of Credit History', 'Months since last delinquent',
       'Number of Open Accounts', 'Number of Credit Problems',
       'Current Credit Balance', 'Maximum Open Credit',
'Bankruptcies',
       'Tax Liens', 'Home Mortgage', 'Own Home', 'Purpose'],
      dtype='object')
```

- Monthly Debt

```
Q1 = loan_clean['Monthly Debt'].quantile(0.25)
Q3 = loan_clean['Monthly Debt'].quantile(0.75)
IQR = Q3 - Q1
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR
outliers = loan_clean[(loan_clean['Monthly Debt'] < lower_bound) |
(loan_clean['Monthly Debt'] > upper_bound)]
num_outliers_MB = outliers.shape[0]

print(f"Number of outliers: {num_outliers_MB}")
print(f"% of outliers: {num_outliers_MB*100/loan_clean.shape[0]}")

Number of outliers: 7721
% of outliers: 3.3423808348809323
```

Credit Balance

```
Q1 = loan_clean['Current Credit Balance'].quantile(0.25)
Q3 = loan_clean['Current Credit Balance'].quantile(0.75)
IQR = Q3 - Q1
lower_bound = Q1 - 1.5 * IQR
upper_bound = Q3 + 1.5 * IQR
outliers = loan_clean[(loan_clean['Current Credit Balance'] <
lower_bound) | (loan_clean['Current Credit Balance'] > upper_bound)]
num_outliers_CB = outliers.shape[0]

print(f"Number of outliers: {num_outliers_CB}")
print(f"% of outliers: {num_outliers_CB*100/loan_clean.shape[0]}")

Number of outliers: 11911
% of outliers: 5.156210092509621
```

```
print(f"For Annual Income -> Number of outliers: {num_outliers_AI} and
% in total is: {num_outliers_AI*100/loan_clean.shape[0]}% ")
print(f"For Monthly Debt  -> Number of outliers: {num_outliers_MB} and
% in total is: {num_outliers_MB*100/loan_clean.shape[0]}% ")
print(f"For Credit Score  -> Number of outliers: {num_outliers_CS} and
% in total is: {num_outliers_CS*100/loan_clean.shape[0]}% ")
print(f"For Credit Balance-> Number of outliers: {num_outliers_CB} and
% in total is: {num_outliers_CB*100/loan_clean.shape[0]}% ")
```

```
For Annual Income -> Number of outliers: 10579 and % in total is:
4.5795942044042715%
For Monthly Debt  -> Number of outliers: 7721 and % in total is:
3.3423808348809323%
For Credit Score  -> Number of outliers: 25104 and % in total is:
10.867391332580096%
For Credit Balance-> Number of outliers: 11911 and % in total is:
5.156210092509621%
```

## Outlier Treatment

- Replacing the Outlier values with p5 or p95% value based on the position of outlier

```
loan_clean.shape
```

```
(231003, 18)
```

```
#Function to Replace Outliers with p95 andp5 values based on its
position.
def replace_outliers(df, column_name):

    for i in column_name:
        lower_bound = df[i].quantile(0.05)
        upper_bound = df[i].quantile(0.95)
        df[i] = df[i].apply(lambda x: lower_bound if x < lower_bound
else x)
        df[i] = df[i].apply(lambda x: upper_bound if x > upper_bound
else x)

    return df


out_cols = ['Annual Income','Monthly Debt','Credit Score','Current
Credit Balance']

loan_clean = replace_outliers(loan_clean,out_cols)
```

## Descriptive Statistics (Finally)

### Description

```
loan_clean.describe()
#out_cols = ['Annual Income','Monthly Debt','Credit Score','Current
Credit Balance']
# The major influencing outliers now looking fine for further analysis
```

```
         Loan Status  Current Loan Amount           Term   Credit
Score  \
count  231003.000000         2.310030e+05  231003.000000
231003.000000
mean        0.761081         1.522326e+07       0.761977
723.570114
std         0.426424         3.590831e+07       0.425874
20.579849
min         0.000000         7.010000e+02       0.000000
673.000000
25%         1.000000         8.329000e+03       1.000000
713.000000
50%         1.000000         1.453200e+04       1.000000
729.000000
75%         1.000000         2.475800e+04       1.000000
740.000000
max         1.000000         1.000000e+08       1.000000
748.000000

       Years in current job  Annual Income   Monthly Debt  \
count         231003.000000  231003.000000  231003.000000
mean               5.889180   68585.464439     934.746656
std                3.569079   29133.729788     524.590784
min                0.000000   29514.000000     194.340000
25%                3.000000   46309.200000     530.255000
50%                6.000000   62511.400000     842.970000
75%               10.000000   84507.000000    1251.190000
max               10.000000  138165.900000    2111.380000

       Years of Credit History  Months since last delinquent  \
count            231003.000000                  231003.000000
mean                 18.323326                      34.957025
std                   7.068247                      16.615092
min                   3.400000                       0.000000
25%                  13.500000                      23.800000
50%                  17.000000                      34.000000
75%                  21.800000                      44.400000
max                  70.500000                     176.000000

       Number of Open Accounts  Number of Credit Problems  \
count            231003.000000              231003.000000
```

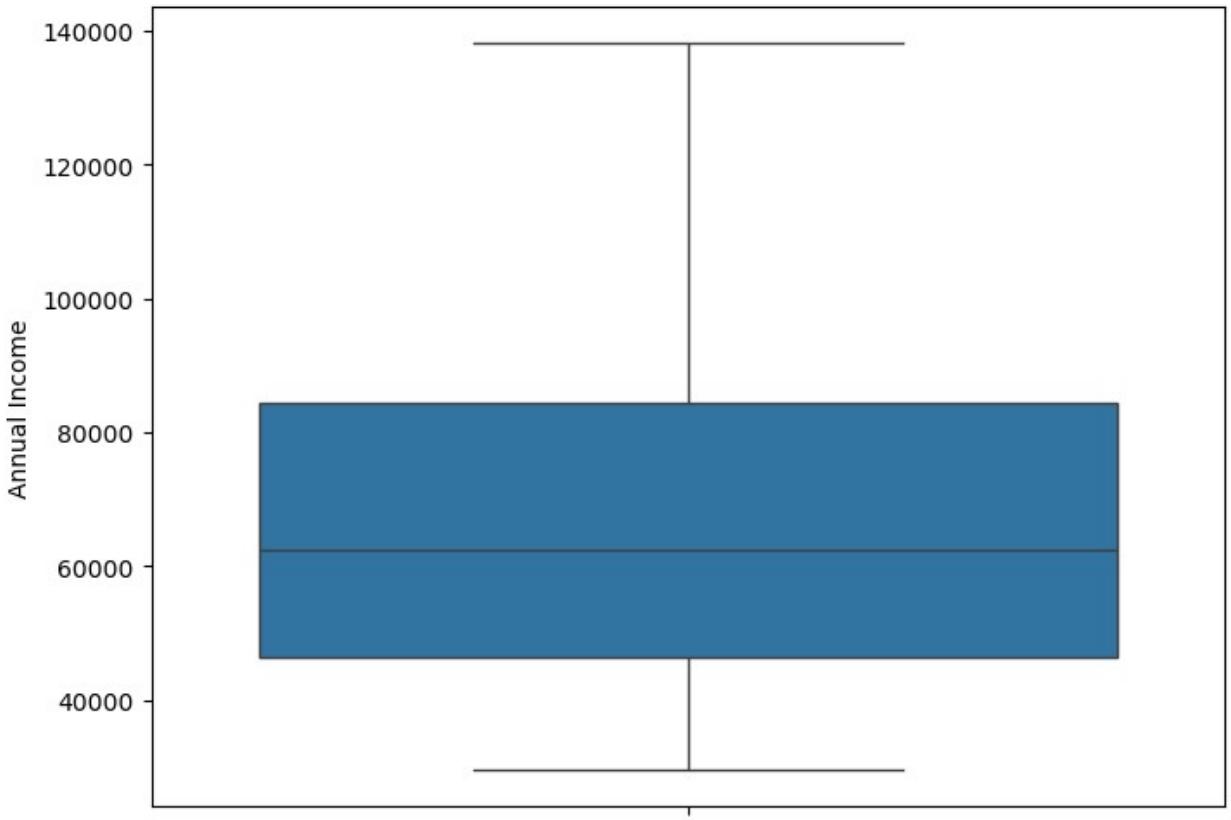
```
mean                  11.093414                    0.156093
std                    4.974482                    0.459734
min                    0.000000                    0.000000
25%                    8.000000                    0.000000
50%                   10.000000                    0.000000
75%                   14.000000                    0.000000
max                   76.000000                   11.000000

       Current Credit Balance  Maximum Open Credit   Bankruptcies  \
count           231003.000000         2.310030e+05  231003.000000
mean             13996.418565         3.640735e+04       0.110367
std              10490.372943         5.819692e+05       0.336605
min               1583.000000         0.000000e+00       0.000000
25%               5956.000000         1.288100e+04       0.000000
50%              11056.000000         2.191800e+04       0.000000
75%              19315.500000         3.651900e+04       0.000000
max              39804.700000         1.763322e+08       7.000000

            Tax Liens  Home Mortgage       Own Home        Purpose
count  231003.000000  231003.000000  231003.000000  231003.000000
mean        0.026801       0.492275       0.088852  163761.250109
std         0.244072       0.499941       0.284530   78142.987969
min         0.000000       0.000000       0.000000     257.000000
25%         0.000000       0.000000       0.000000  203605.000000
50%         0.000000       0.000000       0.000000  203605.000000
75%         0.000000       1.000000       0.000000  203605.000000
max        11.000000       1.000000       1.000000  203605.000000
```

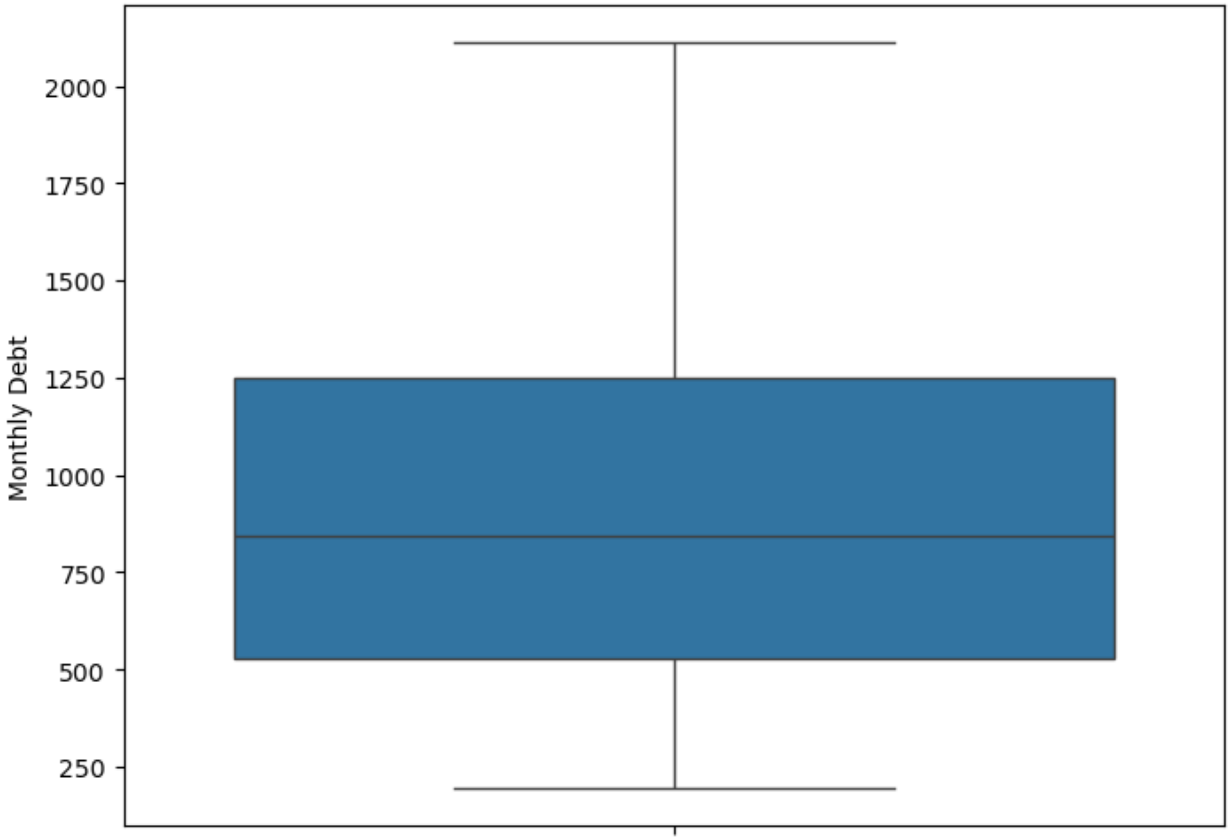
**Inference**:

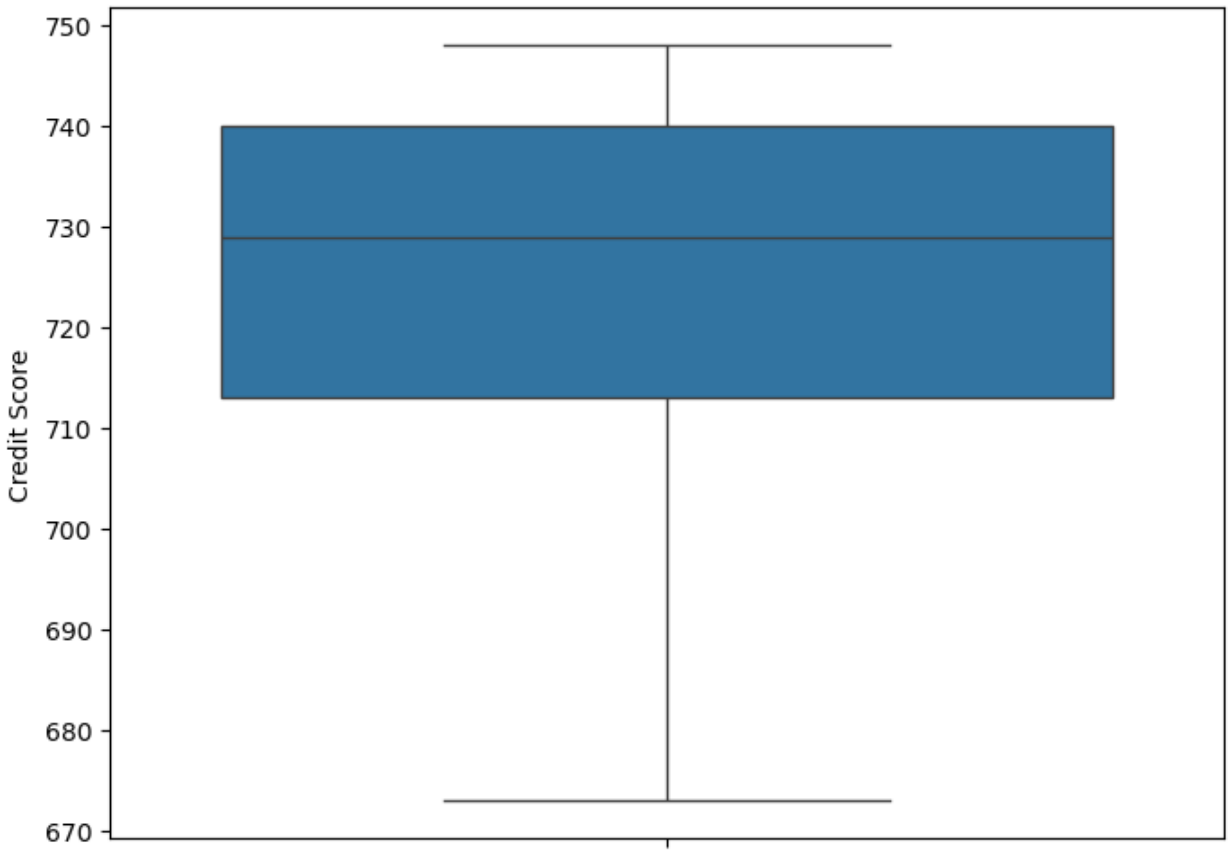
1. About 76% of loans are fully paid, with a significant average loan amount of approximately 15.2 million.
2. Credit scores average around 724, with a range of 673 to 748,
3. The average annual income is about 68,585.
4. No Outliers, duplicated values and null values present in the data

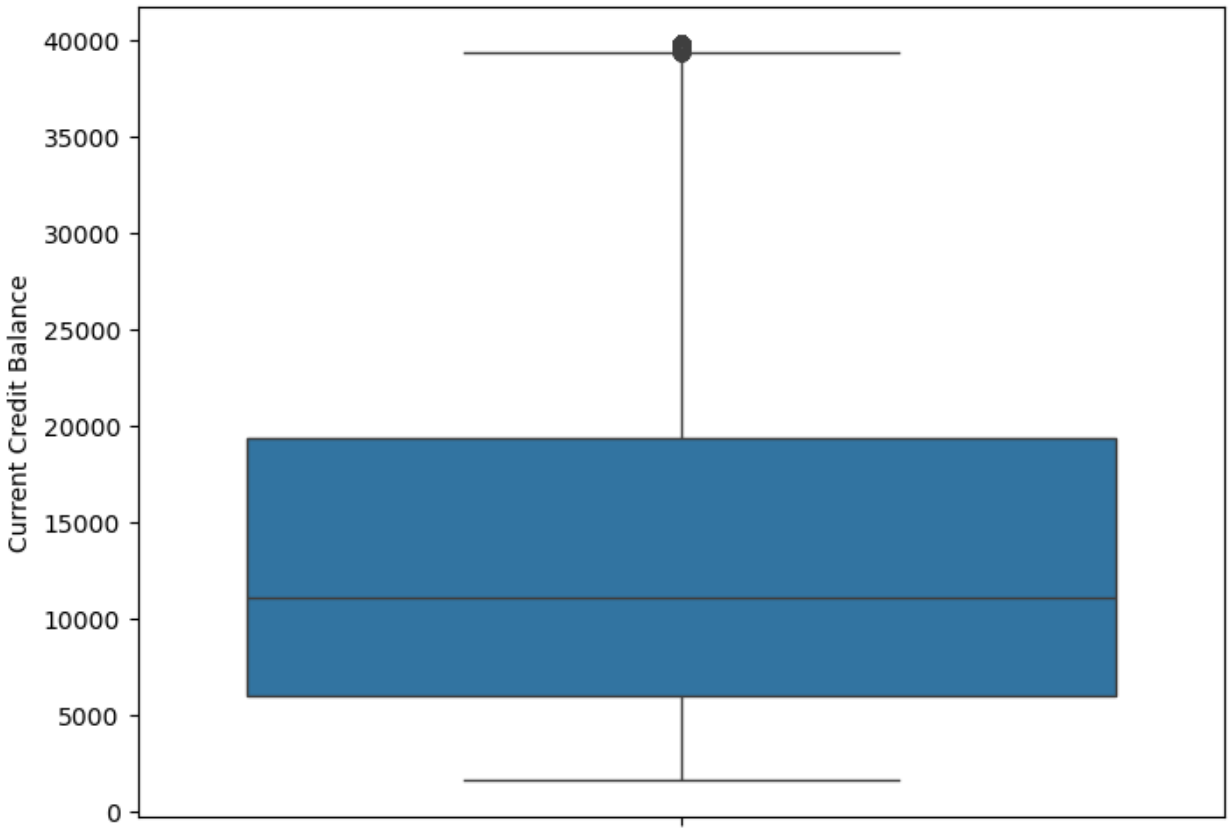
```
out_cols = ['Annual Income','Monthly Debt','Credit Score','Current
Credit Balance']
for i in out_cols:
    plt.figure(figsize=(8, 6))
    print(sns.boxplot(loan_clean,y=i))
```

```
Axes(0.125,0.11;0.775x0.77)
Axes(0.125,0.11;0.775x0.77)
Axes(0.125,0.11;0.775x0.77)
Axes(0.125,0.11;0.775x0.77)
```


Annual Income
140000
120000
100000
80000
60000
40000


Monthly Debt
2000
1750
1500
1250
1000
750
500
250


Credit Score
750
740
730
720
710
700
690
680
670




```
loan_clean
```

| | Loan Status | Current Loan Amount | Term | Credit Score | \ |
|---|---|---|---|---|---|
| 0 | 1 | 11520 | 1 | 741.0 | |
| 1 | 1 | 3441 | 1 | 734.0 | |
| 2 | 1 | 21029 | 1 | 747.0 | |
| 3 | 1 | 18743 | 1 | 747.0 | |
| 4 | 1 | 11731 | 1 | 746.0 | |
| ... | ... | ... | ... | ... | |
| 256444 | 0 | 11953 | 1 | 717.0 | |
| 256446 | 1 | 3911 | 1 | 718.0 | |
| 256447 | 1 | 5078 | 1 | 737.0 | |
| 256448 | 0 | 12116 | 1 | 746.0 | |
| 256450 | 1 | 27902 | 0 | 678.0 | |

| | Years in current job | Annual Income | Monthly Debt | \ |
|---|---|---|---|---|
| 0 | 10.0 | 33694.0 | 584.03 | |
| 1 | 4.0 | 42269.0 | 1106.04 | |
| 2 | 10.0 | 90126.0 | 1321.85 | |
| 3 | 10.0 | 38072.0 | 751.92 | |
| 4 | 4.0 | 50025.0 | 355.18 | |
| ... | ... | ... | ... | |
| 256444 | 10.0 | 39844.0 | 982.82 | |
| 256446 | 2.0 | 90041.0 | 1706.58 | |

```
256447                   10.0        77186.0       1376.47
256448                    9.0        52504.0        297.96
256450                   10.0       117480.0       2111.38

        Years of Credit History  Months since last delinquent  \
0                          12.3                          41.0
1                          26.3                          24.0
2                          28.8                          35.6
3                          26.2                          40.0
4                          11.5                          42.4
...                         ...                           ...
256444                     11.7                          52.2
256446                     19.9                          47.8
256447                     19.1                          47.0
256448                     15.1                          82.0
256450                     18.0                          11.0

        Number of Open Accounts  Number of Credit Problems  \
0                          10.0                        0.0
1                          17.0                        0.0
2                           5.0                        0.0
3                           9.0                        0.0
4                          12.0                        0.0
...                         ...                        ...
256444                      9.0                        1.0
256446                     16.0                        0.0
256447                      9.0                        0.0
256448                      8.0                        0.0
256450                     10.0                        0.0

        Current Credit Balance  Maximum Open Credit  Bankruptcies  Tax
Liens  \
0                       6760.0                16056             0
0
1                       6262.0                19149             0
0
2                      20967.0                28335             0
0
3                      22529.0                43915             0
0
4                      17391.0                37081             0
0
...                        ...                  ...           ...
...
256444                  4176.0                 4783             1
0
256446                 39804.7                44080             0
0
256447                  1717.0                 9758             0
0
```

```
256448                   3315.0                 20090              0
0
256450                  28317.0                 62371              0
0

        Home Mortgage  Own Home  Purpose
0                   1         0   203605
1                   1         0    14196
2                   1         0   203605
3                   0         1   203605
4                   0         0   203605
...               ...       ...      ...
256444              1         0   203605
256446              0         0   203605
256447              0         1   203605
256448              1         0   203605
256450              1         0   203605

[231003 rows x 18 columns]
```

Correlation

```
corr=loan_clean.corr()

corr

                              Loan Status  Current Loan Amount
Term  \
Loan Status                      1.000000             0.237303
0.172304
Current Loan Amount              0.237303             1.000000
0.039599
Term                             0.172304             0.039599
1.000000
Credit Score                     0.215927             0.070174
0.397549
Years in current job             0.004638             0.005439 -
0.063821
Annual Income                    0.079552             0.033891 -
0.101754
Monthly Debt                    -0.017102            -0.001447 -
0.163270
Years of Credit History          0.033285             0.013226 -
0.035126
Months since last delinquent     0.011343             0.000994
0.011753
Number of Open Accounts         -0.019496            -0.002151 -
0.077302
Number of Credit Problems       -0.009143             0.000720
0.020201
```

```
Current Credit Balance           -0.001719             0.001500 -
0.142357
Maximum Open Credit               0.006925             0.006079 -
0.005704
Bankruptcies                      0.001123             0.003735
0.021422
Tax Liens                        -0.012014            -0.002504
0.004398
Home Mortgage                     0.061814             0.019469 -
0.099277
Own Home                         -0.007820            -0.005773
0.009268
Purpose                          -0.000340             0.000039 -
0.032289

                            Credit Score  Years in current job  \
Loan Status                     0.215927              0.004638
Current Loan Amount             0.070174              0.005439
Term                            0.397549             -0.063821
Credit Score                    1.000000             -0.014309
Years in current job           -0.014309              1.000000
Annual Income                   0.038169              0.131134
Monthly Debt                   -0.072543              0.133753
Years of Credit History         0.110206              0.222887
Months since last delinquent    0.023279             -0.000876
Number of Open Accounts        -0.040309              0.047784
Number of Credit Problems      -0.074424              0.043394
Current Credit Balance         -0.011186              0.132306
Maximum Open Credit             0.010719              0.003902
Bankruptcies                   -0.059855              0.046402
Tax Liens                      -0.031288              0.008058
Home Mortgage                   0.056677              0.196205
Own Home                       -0.011751              0.013431
Purpose                         0.050984              0.035109

                            Annual Income  Monthly Debt  \
Loan Status                      0.079552     -0.017102
Current Loan Amount              0.033891     -0.001447
Term                            -0.101754     -0.163270
Credit Score                     0.038169     -0.072543
Years in current job             0.131134      0.133753
Annual Income                    1.000000      0.534028
Monthly Debt                     0.534028      1.000000
Years of Credit History          0.235135      0.189469
Months since last delinquent    -0.055580     -0.050294
Number of Open Accounts          0.252777      0.427530
Number of Credit Problems       -0.031860     -0.056920
Current Credit Balance           0.389811      0.544381
Maximum Open Credit              0.033789      0.022173
```

| | | |
|---|---|---|
| Bankruptcies | -0.065437 | -0.080256 |
| Tax Liens | 0.036394 | 0.017374 |
| Home Mortgage | 0.242087 | 0.216322 |
| Own Home | -0.050555 | -0.039182 |
| Purpose | -0.008727 | 0.111294 |

| | Years of Credit History \ |
|---|---|
| Loan Status | 0.033285 |
| Current Loan Amount | 0.013226 |
| Term | -0.035126 |
| Credit Score | 0.110206 |
| Years in current job | 0.222887 |
| Annual Income | 0.235135 |
| Monthly Debt | 0.189469 |
| Years of Credit History | 1.000000 |
| Months since last delinquent | -0.028086 |
| Number of Open Accounts | 0.128284 |
| Number of Credit Problems | 0.060981 |
| Current Credit Balance | 0.260225 |
| Maximum Open Credit | 0.021449 |
| Bankruptcies | 0.061729 |
| Tax Liens | 0.020696 |
| Home Mortgage | 0.180068 |
| Own Home | 0.031491 |
| Purpose | 0.010057 |

| | Months since last delinquent \ |
|---|---|
| Loan Status | 0.011343 |
| Current Loan Amount | 0.000994 |
| Term | 0.011753 |
| Credit Score | 0.023279 |
| Years in current job | -0.000876 |
| Annual Income | -0.055580 |
| Monthly Debt | -0.050294 |
| Years of Credit History | -0.028086 |
| Months since last delinquent | 1.000000 |
| Number of Open Accounts | -0.049946 |
| Number of Credit Problems | 0.106300 |
| Current Credit Balance | -0.031295 |
| Maximum Open Credit | -0.001420 |
| Bankruptcies | 0.119647 |
| Tax Liens | 0.014304 |
| Home Mortgage | -0.030340 |
| Own Home | -0.000871 |
| Purpose | 0.005638 |

| | Number of Open Accounts \ |
|---|---|
| Loan Status | -0.019496 |
| Current Loan Amount | -0.002151 |
| Term | -0.077302 |

```
Credit Score                                -0.040309
Years in current job                         0.047784
Annual Income                                0.252777
Monthly Debt                                 0.427530
Years of Credit History                      0.128284
Months since last delinquent                -0.049946
Number of Open Accounts                      1.000000
Number of Credit Problems                   -0.014866
Current Credit Balance                       0.324836
Maximum Open Credit                          0.018433
Bankruptcies                                -0.023750
Tax Liens                                    0.005525
Home Mortgage                                0.135470
Own Home                                    -0.008173
Purpose                                      0.108892

                            Number of Credit Problems  \
Loan Status                                 -0.009143
Current Loan Amount                          0.000720
Term                                         0.020201
Credit Score                                -0.074424
Years in current job                         0.043394
Annual Income                               -0.031860
Monthly Debt                                -0.056920
Years of Credit History                      0.060981
Months since last delinquent                 0.106300
Number of Open Accounts                     -0.014866
Number of Credit Problems                    1.000000
Current Credit Balance                      -0.163367
Maximum Open Credit                         -0.008183
Bankruptcies                                 0.759845
Tax Liens                                    0.582385
Home Mortgage                               -0.000724
Own Home                                     0.007254
Purpose                                     -0.004448

                            Current Credit Balance  Maximum Open
Credit  \
Loan Status                               -0.001719
0.006925
Current Loan Amount                        0.001500
0.006079
Term                                      -0.142357             -
0.005704
Credit Score                              -0.011186
0.010719
Years in current job                       0.132306
0.003902
Annual Income                              0.389811
```

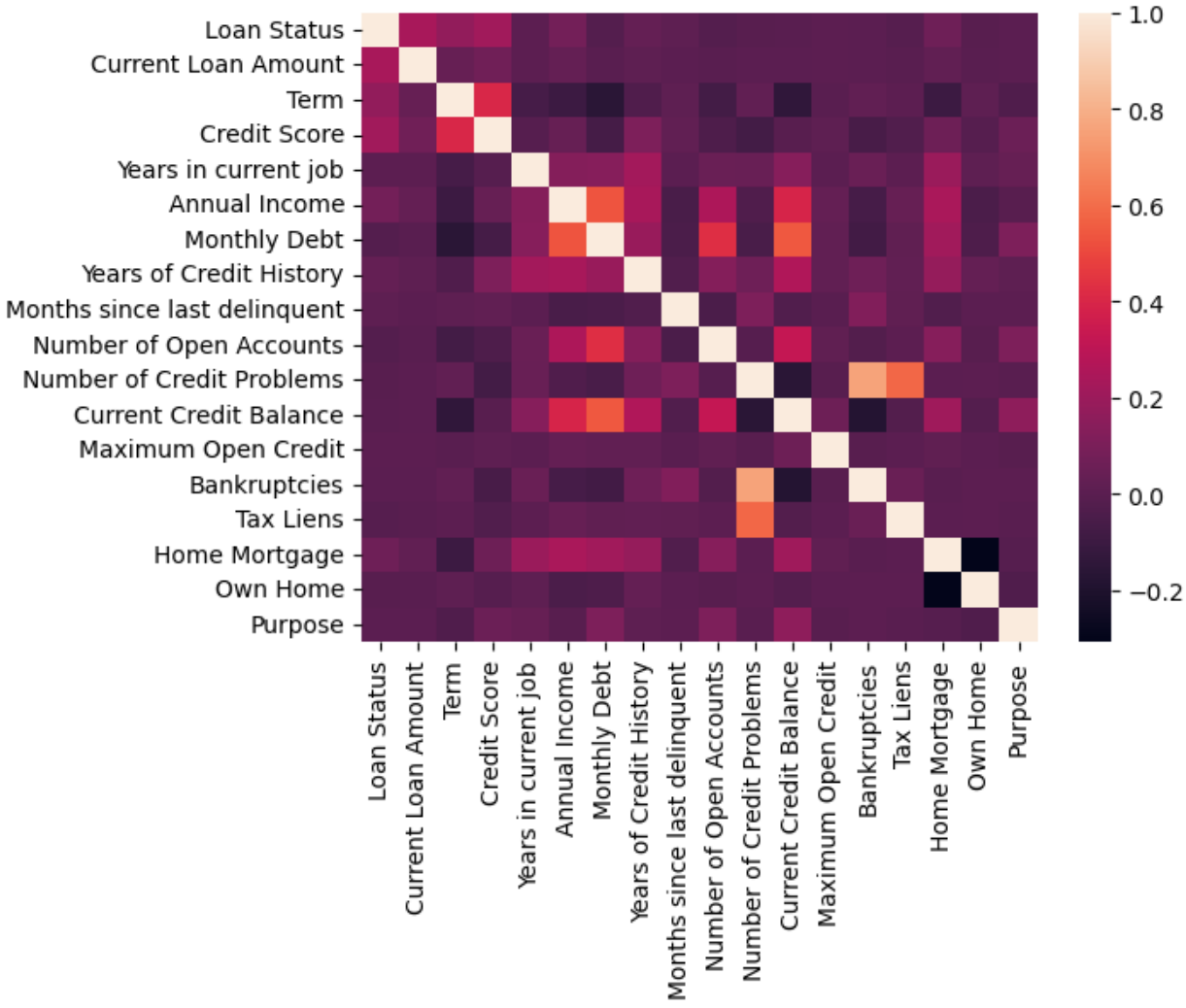
```
0.033789
Monthly Debt                                0.544381
0.022173
Years of Credit History                     0.260225
0.021449
Months since last delinquent               -0.031295            -
0.001420
Number of Open Accounts                     0.324836
0.018433
Number of Credit Problems                  -0.163367            -
0.008183
Current Credit Balance                      1.000000
0.059722
Maximum Open Credit                         0.059722
1.000000
Bankruptcies                               -0.180308            -
0.009835
Tax Liens                                  -0.022084            -
0.000473
Home Mortgage                               0.208409
0.017605
Own Home                                   -0.016650
0.001517
Purpose                                     0.158639            -
0.006761

                                Bankruptcies  Tax Liens  Home
Mortgage  \
Loan Status                         0.001123  -0.012014       0.061814

Current Loan Amount                 0.003735  -0.002504       0.019469

Term                                0.021422   0.004398      -0.099277

Credit Score                       -0.059855  -0.031288       0.056677

Years in current job                0.046402   0.008058       0.196205

Annual Income                      -0.065437   0.036394       0.242087

Monthly Debt                       -0.080256   0.017374       0.216322

Years of Credit History             0.061729   0.020696       0.180068

Months since last delinquent        0.119647   0.014304      -0.030340

Number of Open Accounts            -0.023750   0.005525       0.135470

Number of Credit Problems           0.759845   0.582385      -0.000724
```

```
Current Credit Balance           -0.180308  -0.022084       0.208409

Maximum Open Credit              -0.009835  -0.000473       0.017605

Bankruptcies                      1.000000   0.047988      -0.003538

Tax Liens                         0.047988   1.000000       0.001927

Home Mortgage                    -0.003538   0.001927       1.000000

Own Home                          0.004191   0.004234      -0.307488

Purpose                           0.004510  -0.004442      -0.015370
```

```
                            Own Home   Purpose
Loan Status                -0.007820 -0.000340
Current Loan Amount        -0.005773  0.000039
Term                        0.009268 -0.032289
Credit Score               -0.011751  0.050984
Years in current job        0.013431  0.035109
Annual Income              -0.050555 -0.008727
Monthly Debt               -0.039182  0.111294
Years of Credit History     0.031491  0.010057
Months since last delinquent -0.000871  0.005638
Number of Open Accounts    -0.008173  0.108892
Number of Credit Problems   0.007254 -0.004448
Current Credit Balance     -0.016650  0.158639
Maximum Open Credit         0.001517 -0.006761
Bankruptcies                0.004191  0.004510
Tax Liens                   0.004234 -0.004442
Home Mortgage              -0.307488 -0.015370
Own Home                    1.000000 -0.036633
Purpose                    -0.036633  1.000000
```

```
sns.heatmap(corr)
```

```
<Axes: >
```

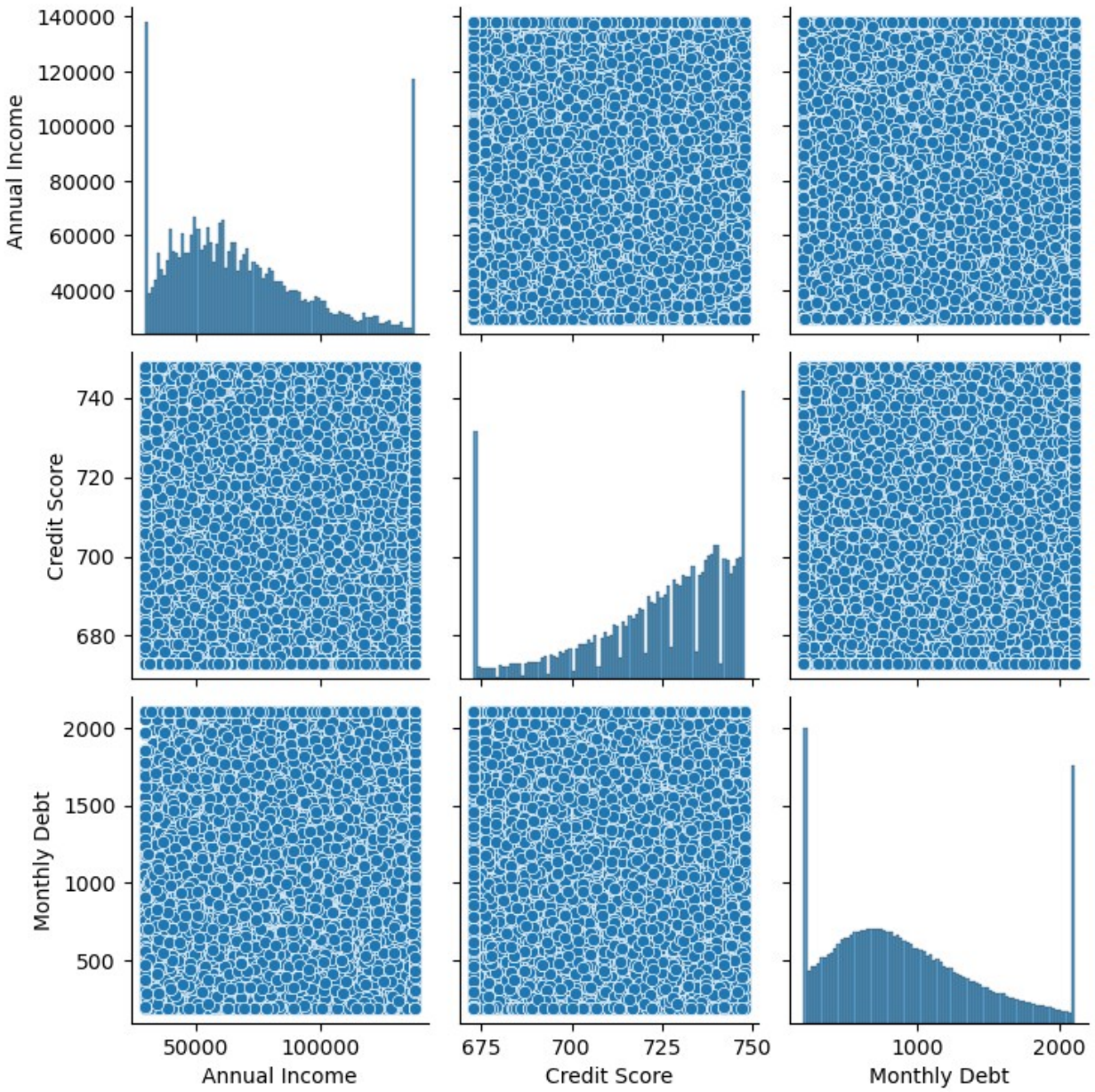



**Inference**: The correlation matrix reveals several important relationships:

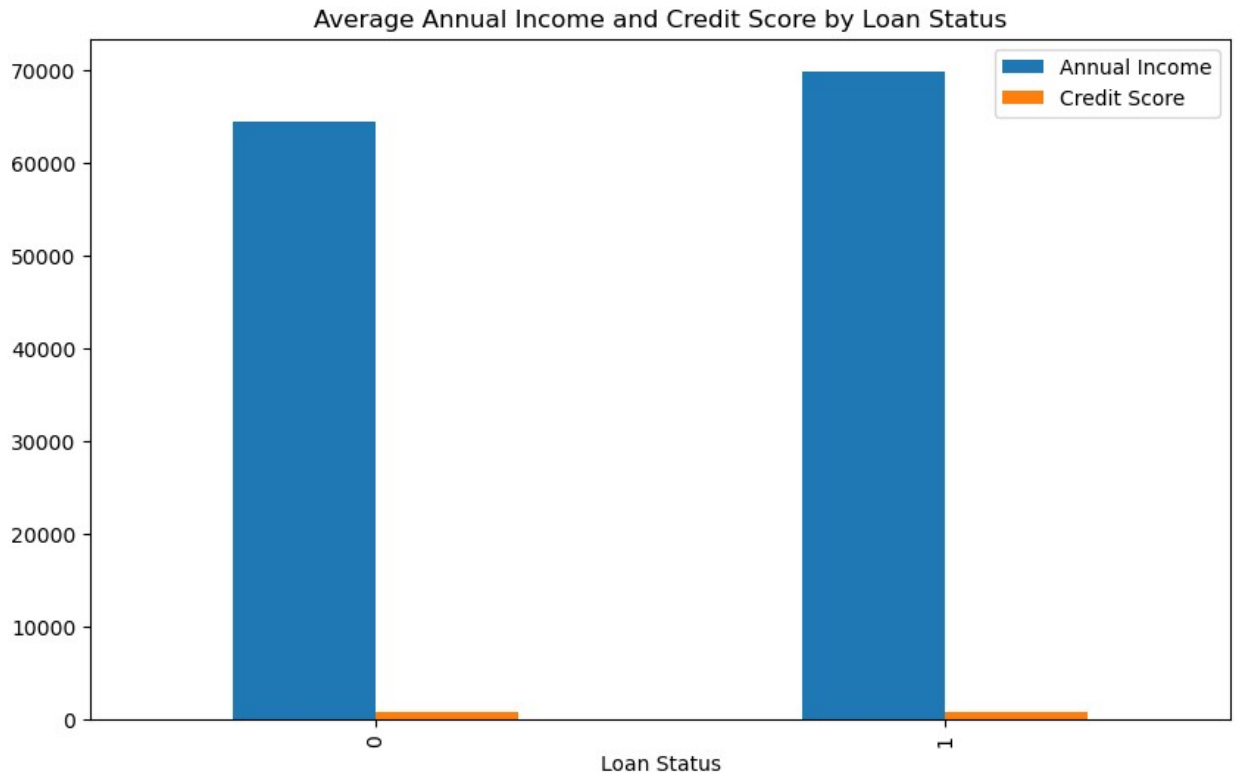
1. "Loan Status" shows a moderate positive correlation with "Current Loan Amount" (0.24) and "Credit Score" (0.22), indicating that higher loan amounts and better credit scores are associated with successful loan repayment.
2. "Monthly Debt" and "Annual Income" exhibit a strong positive correlation (0.53), suggesting that as income increases, monthly debt also tends to rise.
3. the "Number of Credit Problems" is significantly correlated with "Bankruptcies" (0.76), underscoring a strong link between credit issues and financial distress.

Visualisation

```
sns.pairplot(loan_clean[['Annual Income', 'Credit Score', 'Monthly
Debt']])

plt.show()
```




```
# Group by 'Loan Status' and calculate the mean for 'Annual Income'
and 'Credit Score'
loan_clean.groupby('Loan Status')[['Annual Income', 'Credit
Score']].mean().plot(kind='bar', figsize=(10, 6))
plt.title('Average Annual Income and Credit Score by Loan Status')
plt.show()
```




## New Cleaned Dataset (Final)

- The Dataset free from null values and Outliers is stored as **cleaned_data.csv**

```
loan_clean.to_csv('Loan_Cleaned_10.csv')
```

# Feature Scaling

- For Feature Scaling first we need to split the feature and label columns
- Label Column - `Loan Status`

```
X = loan_clean.drop('Loan Status',axis=1)

X.sample(5,random_state=54)
```

| | Current Loan Amount | Term | Credit Score | Years in current job |
|---|---|---|---|---|
| 165308 | 34825 | 0 | 673.0 | 7.0 |
| 128830 | 16728 | 1 | 745.0 | 4.0 |
| 240162 | 99999999 | 0 | 728.0 | 2.0 |
| 152258 | 3228 | 1 | 694.8 | 1.0 |
| 169875 | 99999999 | 1 | 745.0 | 4.0 |

```
        Annual Income  Monthly Debt  Years of Credit History  \
165308        91604.0       2111.38                     42.5
128830        54764.0        803.20                     24.0
240162        97280.0       1548.37                     10.8
152258        45444.6        325.16                      7.9
169875        52453.0        546.38                     18.5

        Months since last delinquent  Number of Open Accounts  \
165308                          45.6                     10.0
128830                          51.4                      6.0
240162                          78.0                     12.0
152258                          14.8                      5.0
169875                          45.0                     11.0

        Number of Credit Problems  Current Credit Balance  \
165308                        0.0                 39804.7
128830                        1.0                  9681.0
240162                        0.0                 16889.0
152258                        0.0                  3084.0
169875                        0.0                 16770.0

        Maximum Open Credit  Bankruptcies  Tax Liens  Home Mortgage
Own Home  \
165308                84825             0          0               1
0
128830                24325             0          0               1
0
240162                56109             0          0               0
0
152258                 3803             0          0               0
0
169875                27903             0          0               0
0

        Purpose
165308     9629
128830   203605
240162   203605
152258   203605
169875   203605
```

```
X.shape
```

```
(231003, 17)
```

```
Y = pd.DataFrame(loan_clean['Loan Status'])
```

```
Y.sample(5,random_state=54)
```

```
        Loan Status
165308            0
```

```
128830             1
240162             1
152258             0
169875             1
```

```
Y.shape
```

```
(231003, 1)
```

### MinMax Scaling

- As described earlier the given data is not normally distributed so we cannot use Z-Score/ Standard Scalar
- MinMax Scalar is a suitable option It will scale the data between 0 and 1.

```
scaler = MinMaxScaler()
```

```
X_scaled = scaler.fit_transform(X)
```

```
X_scaled=pd.DataFrame(X_scaled,columns=X.columns)
```

```
type(X_scaled)
```

```
pandas.core.frame.DataFrame
```

```
X_scaled
```

```
        Current Loan Amount  Term  Credit Score  Years in current job
\
0                  0.000108   1.0      0.906667                   1.0
1                  0.000027   1.0      0.813333                   0.4
2                  0.000203   1.0      0.986667                   1.0
3                  0.000180   1.0      0.986667                   1.0
4                  0.000110   1.0      0.973333                   0.4
...                     ...   ...           ...                   ...
230998             0.000113   1.0      0.586667                   1.0
230999             0.000032   1.0      0.600000                   0.2
231000             0.000044   1.0      0.853333                   1.0
231001             0.000114   1.0      0.973333                   0.9
231002             0.000272   0.0      0.066667                   1.0

        Annual Income  Monthly Debt  Years of Credit History  \
```

```
0            0.038471      0.203277                  0.132638
1            0.117393      0.475577                  0.341282
2            0.557855      0.588152                  0.378539
3            0.078765      0.290855                  0.339791
4            0.188777      0.083900                  0.120715
...               ...           ...                       ...
230998       0.095074      0.411301                  0.123696
230999       0.557073      0.788841                  0.245902
231000       0.438759      0.616643                  0.233979
231001       0.211593      0.054052                  0.174367
231002       0.809613      1.000000                  0.217586

        Months since last delinquent  Number of Open Accounts  \
0                           0.232955                 0.131579
1                           0.136364                 0.223684
2                           0.202273                 0.065789
3                           0.227273                 0.118421
4                           0.240909                 0.157895
...                              ...                      ...
230998                      0.296591                 0.118421
230999                      0.271591                 0.210526
231000                      0.267045                 0.118421
231001                      0.465909                 0.105263
231002                      0.062500                 0.131579

        Number of Credit Problems  Current Credit Balance  \
0                        0.000000                0.135447
1                        0.000000                0.122417
2                        0.000000                0.507146
3                        0.000000                0.548013
4                        0.000000                0.413587
...                           ...                     ...
230998                   0.090909                0.067841
230999                   0.000000                1.000000
231000                   0.000000                0.003506
231001                   0.000000                0.045315
231002                   0.000000                0.699446

        Maximum Open Credit  Bankruptcies  Tax Liens  Home Mortgage
Own Home  \
0                  0.000091      0.000000        0.0            1.0
0.0
1                  0.000109      0.000000        0.0            1.0
0.0
2                  0.000161      0.000000        0.0            1.0
0.0
3                  0.000249      0.000000        0.0            0.0
1.0
4                  0.000210      0.000000        0.0            0.0
0.0
```

```
...                    ...           ...        ...             ...
...
230998             0.000027      0.142857        0.0             1.0
0.0
230999             0.000250      0.000000        0.0             0.0
0.0
231000             0.000055      0.000000        0.0             0.0
1.0
231001             0.000114      0.000000        0.0             1.0
0.0
231002             0.000354      0.000000        0.0             1.0
0.0

          Purpose
0        1.000000
1        0.068548
2        1.000000
3        1.000000
4        1.000000
...           ...
230998   1.000000
230999   1.000000
231000   1.000000
231001   1.000000
231002   1.000000

[231003 rows x 17 columns]
```

- Data is scaled between 0 and 1

```
loan_clean.to_csv('cleaned_data.csv')
```

# Train-Test Split

```
X_scaled

        Current Loan Amount  Term  Credit Score  Years in current job
\
0                  0.000108   1.0      0.906667                   1.0

1                  0.000027   1.0      0.813333                   0.4

2                  0.000203   1.0      0.986667                   1.0

3                  0.000180   1.0      0.986667                   1.0

4                  0.000110   1.0      0.973333                   0.4
```

```
...                     ...   ...           ...                     ...

230998              0.000113   1.0      0.586667                     1.0

230999              0.000032   1.0      0.600000                     0.2

231000              0.000044   1.0      0.853333                     1.0

231001              0.000114   1.0      0.973333                     0.9

231002              0.000272   0.0      0.066667                     1.0


        Annual Income  Monthly Debt  Years of Credit History  \
0            0.038471      0.203277                 0.132638
1            0.117393      0.475577                 0.341282
2            0.557855      0.588152                 0.378539
3            0.078765      0.290855                 0.339791
4            0.188777      0.083900                 0.120715
...               ...           ...                      ...
230998       0.095074      0.411301                 0.123696
230999       0.557073      0.788841                 0.245902
231000       0.438759      0.616643                 0.233979
231001       0.211593      0.054052                 0.174367
231002       0.809613      1.000000                 0.217586

        Months since last delinquent  Number of Open Accounts  \
0                           0.232955                 0.131579
1                           0.136364                 0.223684
2                           0.202273                 0.065789
3                           0.227273                 0.118421
4                           0.240909                 0.157895
...                              ...                      ...
230998                      0.296591                 0.118421
230999                      0.271591                 0.210526
231000                      0.267045                 0.118421
231001                      0.465909                 0.105263
231002                      0.062500                 0.131579

        Number of Credit Problems  Current Credit Balance  \
0                        0.000000                0.135447
1                        0.000000                0.122417
2                        0.000000                0.507146
3                        0.000000                0.548013
4                        0.000000                0.413587
...                           ...                     ...
230998                   0.090909                0.067841
230999                   0.000000                1.000000
231000                   0.000000                0.003506
231001                   0.000000                0.045315
```

```
231002                    0.000000                0.699446

        Maximum Open Credit  Bankruptcies  Tax Liens  Home Mortgage
Own Home  \
0                  0.000091      0.000000        0.0             1.0
0.0
1                  0.000109      0.000000        0.0             1.0
0.0
2                  0.000161      0.000000        0.0             1.0
0.0
3                  0.000249      0.000000        0.0             0.0
1.0
4                  0.000210      0.000000        0.0             0.0
0.0
...                     ...           ...        ...             ...
...
230998             0.000027      0.142857        0.0             1.0
0.0
230999             0.000250      0.000000        0.0             0.0
0.0
231000             0.000055      0.000000        0.0             0.0
1.0
231001             0.000114      0.000000        0.0             1.0
0.0
231002             0.000354      0.000000        0.0             1.0
0.0

         Purpose
0       1.000000
1       0.068548
2       1.000000
3       1.000000
4       1.000000
...          ...
230998  1.000000
230999  1.000000
231000  1.000000
231001  1.000000
231002  1.000000

[231003 rows x 17 columns]

Y

X_train, X_test, Y_train, Y_test = train_test_split(X_scaled, Y,
test_size = 0.25, random_state=100)

X_train.head(2)

X_train.shape
```

```
X_test.head(2)

X_test.shape

Y_train.head(2)

Y_train.shape

Y_test.head(2)

Y_test.shape
```

## Storing the Train and Test

**Last Column in train and test data csv files are y_train and y_test**

```
Training_Data = pd.concat([X_train,Y_train],axis=1)
Test_Data = pd.concat([X_test,Y_test],axis=1)

#One unknown 0 column is creating as 1st column so need to remove
while using the data

Training_Data.to_csv('train_data_10.csv')
Test_Data.to_csv('test_data_10.csv')
```