```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Mounted at /content/gdrive
```

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

```
from google.colab import files
data_to_load=files.upload()
```

```
<IPython.core.display.HTML object>
```

```
Saving loan_data_set.csv to loan_data_set.csv
```

```
df=pd.read_csv('loan_data_set.csv')
df
```

```
      Loan_ID  Gender Married  ... Credit_History Property_Area
Loan_Status
0    LP001002    Male      No  ...            1.0         Urban
Y
1    LP001003    Male     Yes  ...            1.0         Rural
N
2    LP001005    Male     Yes  ...            1.0         Urban
Y
3    LP001006    Male     Yes  ...            1.0         Urban
Y
4    LP001008    Male      No  ...            1.0         Urban
Y
..        ...     ...     ...  ...            ...           ...
...
609  LP002978  Female      No  ...            1.0         Rural
Y
610  LP002979    Male     Yes  ...            1.0         Rural
Y
611  LP002983    Male     Yes  ...            1.0         Urban
Y
612  LP002984    Male     Yes  ...            1.0         Urban
Y
613  LP002990  Female      No  ...            0.0     Semiurban
N

[614 rows x 13 columns]
```

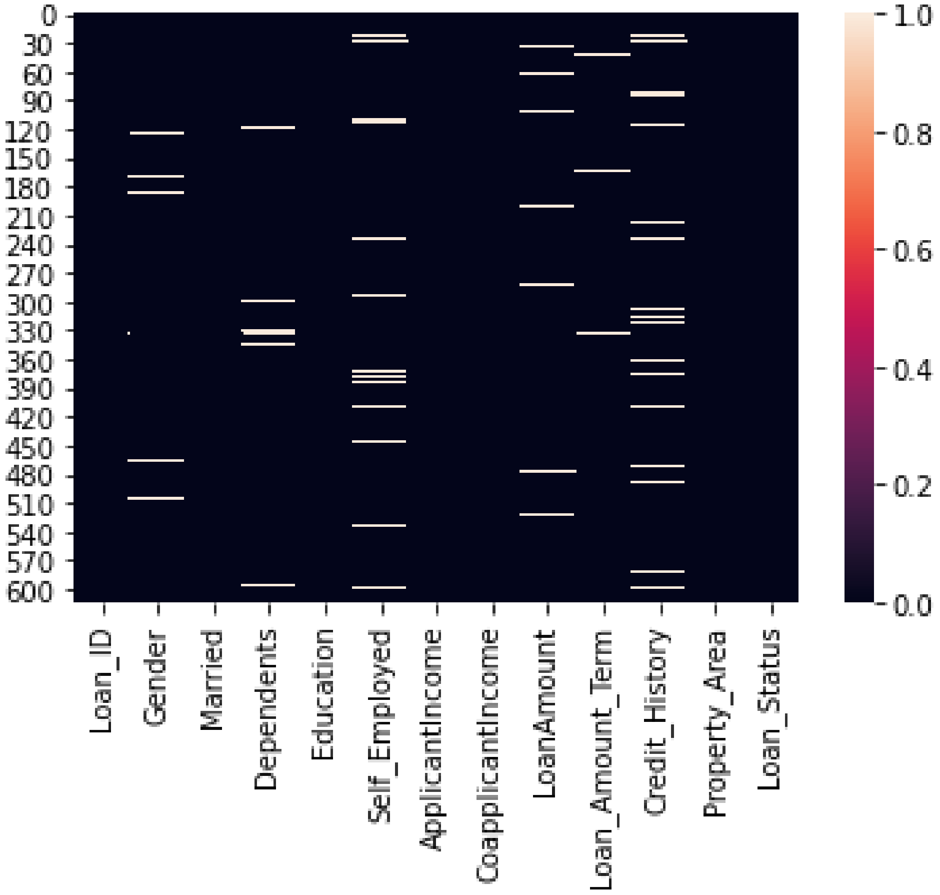
```
df.isnull().sum()
```

```
Loan_ID               0
Gender               13
Married               3
```

```
Dependents           15
Education             0
Self_Employed        32
ApplicantIncome       0
CoapplicantIncome     0
LoanAmount           22
Loan_Amount_Term     14
Credit_History       50
Property_Area         0
Loan_Status           0
dtype: int64
```

```
sns.heatmap(df.isnull())
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7feb6710f2d0>
```



```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 614 entries, 0 to 613
Data columns (total 13 columns):
 #   Column             Non-Null Count  Dtype
---  ------             --------------  -----
```

```
 0   Loan_ID            614 non-null    object 
 1   Gender             601 non-null    object 
 2   Married            611 non-null    object 
 3   Dependents         599 non-null    object 
 4   Education          614 non-null    object 
 5   Self_Employed      582 non-null    object 
 6   ApplicantIncome    614 non-null    int64  
 7   CoapplicantIncome  614 non-null    float64
 8   LoanAmount         592 non-null    float64
 9   Loan_Amount_Term   600 non-null    float64
 10  Credit_History     564 non-null    float64
 11  Property_Area      614 non-null    object 
 12  Loan_Status        614 non-null    object 
dtypes: float64(4), int64(1), object(8)
memory usage: 62.5+ KB
None
```

```
df.nunique()
```

```
Loan_ID              614
Gender                 2
Married                2
Dependents             4
Education              2
Self_Employed          2
ApplicantIncome      505
CoapplicantIncome    287
LoanAmount           203
Loan_Amount_Term      10
Credit_History         2
Property_Area          3
Loan_Status            2
dtype: int64
```

```
data_numerical = 
df[['ApplicantIncome','CoapplicantIncome','LoanAmount','Loan_Amount_Te
rm','Credit_History']]
```

```
data_numerical.columns
```

```
Index(['ApplicantIncome', 'CoapplicantIncome', 'LoanAmount',
       'Loan_Amount_Term', 'Credit_History'],
      dtype='object')
```

```
data_non_numerical=df[['Loan_ID','Gender','Married','Dependents','Educ
ation','Self_Employed','Property_Area','Loan_Status']]
```

```
data_non_numerical.columns
```

```
Index(['Loan_ID', 'Gender', 'Married', 'Dependents', 'Education',
       'Self_Employed', 'Property_Area', 'Loan_Status'],
      dtype='object')
```

```
data_numerical.head()
```

```
   ApplicantIncome  CoapplicantIncome  ...  Loan_Amount_Term
Credit_History
0             5849                0.0  ...             360.0
1.0
1             4583             1508.0  ...             360.0
1.0
2             3000                0.0  ...             360.0
1.0
3             2583             2358.0  ...             360.0
1.0
4             6000                0.0  ...             360.0
1.0

[5 rows x 5 columns]
```

```
data_non_numerical.head()
```

```
    Loan_ID Gender Married  ... Self_Employed Property_Area
Loan_Status
0  LP001002   Male      No  ...            No         Urban
Y
1  LP001003   Male     Yes  ...            No         Rural
N
2  LP001005   Male     Yes  ...           Yes         Urban
Y
3  LP001006   Male     Yes  ...            No         Urban
Y
4  LP001008   Male      No  ...            No         Urban
Y

[5 rows x 8 columns]
```

```
data_non_numerical.groupby('Gender')['Loan_ID'].count()
```

```
Gender
Female    112
Male      489
Name: Loan_ID, dtype: int64
```

```
x=data_non_numerical.columns
for i in x[1:]:
  m=data_non_numerical.groupby(i)['Loan_ID'].count().idxmax()
  data_non_numerical[i].fillna(m,inplace=True)
```

```
/usr/local/lib/python3.7/dist-packages/pandas/core/series.py:4536:
SettingWithCopyWarning:
```

```
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  downcast=downcast,
```

```
data_non_numerical.isnull().sum()
```

```
Loan_ID          0
Gender           0
Married          0
Dependents       0
Education        0
Self_Employed    0
Property_Area    0
Loan_Status      0
dtype: int64
```

```
data_non_numerical
```

```
      Loan_ID  Gender Married  ... Self_Employed Property_Area
Loan_Status
0    LP001002    Male      No  ...            No         Urban
Y
1    LP001003    Male     Yes  ...            No         Rural
N
2    LP001005    Male     Yes  ...           Yes         Urban
Y
3    LP001006    Male     Yes  ...            No         Urban
Y
4    LP001008    Male      No  ...            No         Urban
Y
..        ...     ...     ...  ...           ...           ...
...
609  LP002978  Female      No  ...            No         Rural
Y
610  LP002979    Male     Yes  ...            No         Rural
Y
611  LP002983    Male     Yes  ...            No         Urban
Y
612  LP002984    Male     Yes  ...            No         Urban
Y
613  LP002990  Female      No  ...           Yes     Semiurban
N

[614 rows x 8 columns]
```

```
data_numerical.columns
```

```
Index(['ApplicantIncome', 'CoapplicantIncome', 'LoanAmount',
       'Loan_Amount_Term', 'Credit_History'],
      dtype='object')
```

```
x=data_numerical.columns
for i in x:
  m=data_numerical[i].mean()
  data_numerical[i].fillna(m, inplace=True)
```

```
/usr/local/lib/python3.7/dist-packages/pandas/core/series.py:4536:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  downcast=downcast,
```

```
data_numerical.isnull().sum()
```

```
ApplicantIncome      0
CoapplicantIncome    0
LoanAmount           0
Loan_Amount_Term     0
Credit_History       0
dtype: int64
```

```
data_numerical
```

```
     ApplicantIncome  CoapplicantIncome  ...  Loan_Amount_Term
Credit_History
0               5849                0.0  ...             360.0
1.0
1               4583             1508.0  ...             360.0
1.0
2               3000                0.0  ...             360.0
1.0
3               2583             2358.0  ...             360.0
1.0
4               6000                0.0  ...             360.0
1.0
..               ...                ...  ...               ...
...
609             2900                0.0  ...             360.0
1.0
610             4106                0.0  ...             180.0
1.0
611             8072              240.0  ...             360.0
1.0
612             7583                0.0  ...             360.0
1.0
```

```
613             4583                0.0  ...             360.0
0.0

[614 rows x 5 columns]
```

```
data_non_numerical.isnull().sum()
```

```
Loan_ID          0
Gender           0
Married          0
Dependents       0
Education        0
Self_Employed    0
Property_Area    0
Loan_Status      0
dtype: int64
```

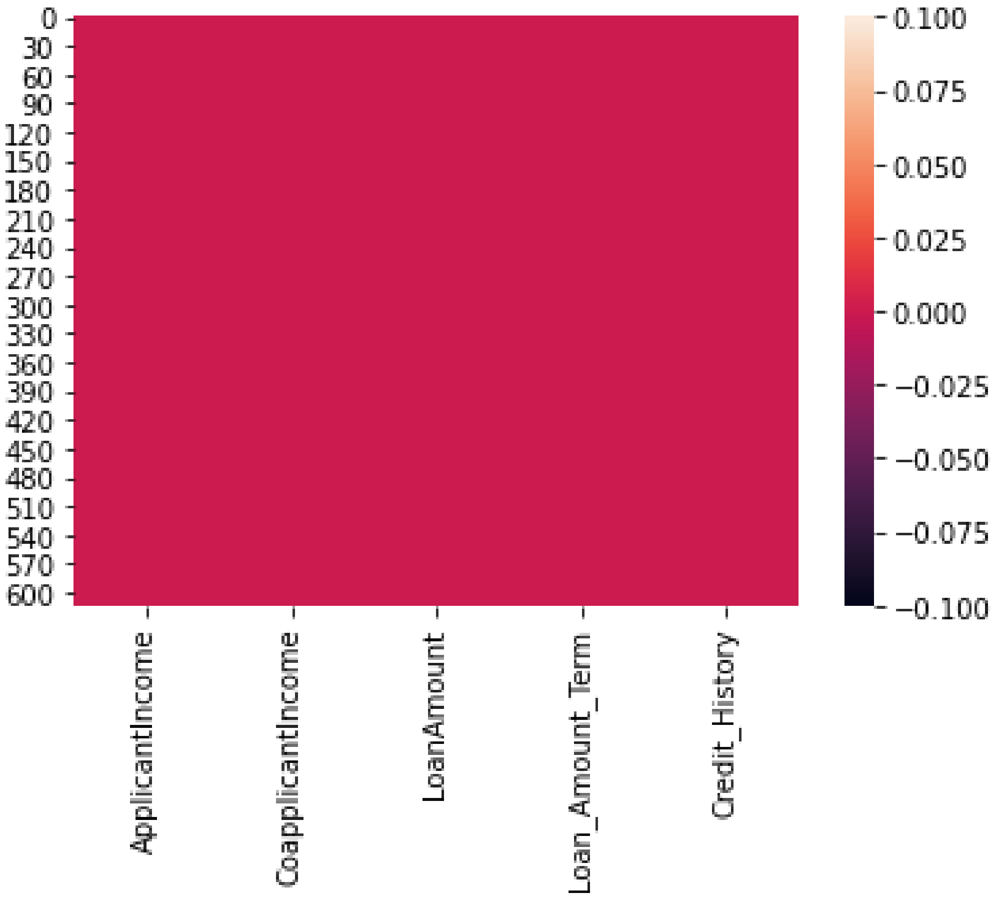
```
data_non_numerical
```

```
      Loan_ID  Gender Married  ... Self_Employed Property_Area
Loan_Status
0    LP001002    Male      No  ...            No         Urban
Y
1    LP001003    Male     Yes  ...            No         Rural
N
2    LP001005    Male     Yes  ...           Yes         Urban
Y
3    LP001006    Male     Yes  ...            No         Urban
Y
4    LP001008    Male      No  ...            No         Urban
Y
..        ...     ...     ...  ...           ...           ...
...
609  LP002978  Female      No  ...            No         Rural
Y
610  LP002979    Male     Yes  ...            No         Rural
Y
611  LP002983    Male     Yes  ...            No         Urban
Y
612  LP002984    Male     Yes  ...            No         Urban
Y
613  LP002990  Female      No  ...           Yes     Semiurban
N

[614 rows x 8 columns]
```

```
sns.heatmap(data_numerical.isnull())
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7feb5e27c310>
```



```
data_numerical.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 614 entries, 0 to 613
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   ApplicantIncome    614 non-null    int64  
 1   CoapplicantIncome  614 non-null    float64
 2   LoanAmount         614 non-null    float64
 3   Loan_Amount_Term   614 non-null    float64
 4   Credit_History     614 non-null    float64
dtypes: float64(4), int64(1)
memory usage: 24.1 KB
```

```
data_non_numerical.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 614 entries, 0 to 613
Data columns (total 8 columns):
 #   Column         Non-Null Count  Dtype 
---  ------         --------------  ----- 
 0   Loan_ID        614 non-null    object
 1   Gender         614 non-null    object
 2   Married        614 non-null    object
 3   Dependents     614 non-null    object
 4   Education      614 non-null    object
 5   Self_Employed  614 non-null    object
 6   Property_Area  614 non-null    object
 7   Loan_Status    614 non-null    object
dtypes: object(8)
memory usage: 38.5+ KB
```

```
data_non_numerical.columns
```

```
Index(['Loan_ID', 'Gender', 'Married', 'Dependents', 'Education',
       'Self_Employed', 'Property_Area', 'Loan_Status'],
      dtype='object')
```

```
dummies=pd.get_dummies(data_non_numerical,columns=['Gender','Married',
'Dependents',
           'Education', 'Self_Employed', 'Property_Area',
'Loan_Status'])
```

```
dummies
```

```
      Loan_ID  Gender_Female  ...  Loan_Status_N  Loan_Status_Y
0    LP001002              0  ...              0              1
1    LP001003              0  ...              1              0
2    LP001005              0  ...              0              1
3    LP001006              0  ...              0              1
4    LP001008              0  ...              0              1
..        ...            ...  ...            ...            ...
609  LP002978              1  ...              0              1
610  LP002979              0  ...              0              1
611  LP002983              0  ...              0              1
612  LP002984              0  ...              0              1
613  LP002990              1  ...              1              0

[614 rows x 18 columns]
```

```
from sklearn.preprocessing import StandardScaler
sc=StandardScaler()
data_numerical.iloc[:,1:]=sc.fit_transform(data_numerical.iloc[:,1:])
```

```
/usr/local/lib/python3.7/dist-packages/pandas/core/indexing.py:1734:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#
returning-a-view-versus-a-copy
  isetter(loc, value[:, i].tolist())
```

```
#data_numerical.iloc[2:8,2:5]
```

```
   LoanAmount  Loan_Amount_Term  Credit_History
2   -0.957641          0.279851        0.451640
3   -0.314547          0.279851        0.451640
4   -0.064454          0.279851        0.451640
5    1.436099          0.279851        0.451640
6   -0.612275          0.279851        0.451640
7    0.138001          0.279851       -2.410441
```

```
df_loan=pd.concat([data_numerical.iloc[:,1:],dummies.drop(['Loan_ID'],
axis=1)],axis=1)
```

```
df_loan
```

```
     CoapplicantIncome  LoanAmount  ...  Loan_Status_N  Loan_Status_Y
0            -0.554487    0.000000  ...              0              1
1            -0.038732   -0.219273  ...              1              0
2            -0.554487   -0.957641  ...              0              1
3             0.251980   -0.314547  ...              0              1
4            -0.554487   -0.064454  ...              0              1
..                 ...         ...  ...            ...            ...
609          -0.554487   -0.898095  ...              0              1
610          -0.554487   -1.267279  ...              0              1
611          -0.472404    1.269371  ...              0              1
612          -0.554487    0.483367  ...              0              1
613          -0.554487   -0.159728  ...              1              0

[614 rows x 21 columns]
```

```
df_loan.isnull().sum()
```

```
CoapplicantIncome          0
LoanAmount                 0
Loan_Amount_Term           0
Credit_History             0
Gender_Female              0
Gender_Male                0
Married_No                 0
Married_Yes                0
Dependents_0               0
Dependents_1               0
Dependents_2               0
Dependents_3+              0
Education_Graduate         0
Education_Not Graduate     0
Self_Employed_No           0
Self_Employed_Yes          0
Property_Area_Rural        0
```

```
Property_Area_Semiurban    0
Property_Area_Urban        0
Loan_Status_N              0
Loan_Status_Y              0
dtype: int64
```

```
from sklearn.model_selection import train_test_split
x=df_loan.drop(["Loan_Status_N","Loan_Status_Y"],axis=1)
y=df_loan["Loan_Status_Y"]
X_train,X_test,y_train,y_test
=train_test_split(x,y,test_size=0.2,random_state=30)
```

```
X_test
```

```
     CoapplicantIncome  ...  Property_Area_Urban
193          -0.554487  ...                    0
334           0.072423  ...                    1
343          -0.554487  ...                    0
24            0.445901  ...                    0
47           -0.554487  ...                    1
..                 ...  ...                  ...
453           0.288917  ...                    0
31           -0.554487  ...                    1
293          -0.554487  ...                    1
410          -0.554487  ...                    0
108           0.676760  ...                    1

[123 rows x 19 columns]
```

```
y_test
```

```
193    1
334    1
343    1
24     0
47     1
      ..
453    1
31     0
293    0
410    0
108    0
Name: Loan_Status_Y, Length: 123, dtype: uint8
```

```
from sklearn.svm import SVC
svclassifier=SVC(kernel='linear')
svclassifier.fit(X_train,y_train)
```

```
SVC(C=1.0, break_ties=False, cache_size=200, class_weight=None,
coef0=0.0,
    decision_function_shape='ovr', degree=3, gamma='scale',
kernel='linear',
    max_iter=-1, probability=False, random_state=None, shrinking=True,
    tol=0.001, verbose=False)
```

```
pred_1=svclassifier.predict(X_test)
```

```
from sklearn.metrics import  classification_report, confusion_matrix,
accuracy_score
print(confusion_matrix(y_test,pred_1))
print(classification_report(y_test,pred_1))
print(accuracy_score(y_test,pred_1))
```

```
[[13 24]
 [ 2 84]]
              precision    recall  f1-score   support

           0       0.87      0.35      0.50        37
           1       0.78      0.98      0.87        86

    accuracy                           0.79       123
   macro avg       0.82      0.66      0.68       123
weighted avg       0.80      0.79      0.76       123

0.7886178861788617
```

```
from sklearn.neighbors import KNeighborsClassifier
knn = KNeighborsClassifier()
knn.fit(X_train, y_train)
```

```
KNeighborsClassifier(algorithm='auto', leaf_size=30,
metric='minkowski',
                     metric_params=None, n_jobs=None, n_neighbors=5,
p=2,
                     weights='uniform')
```

```
pred_2=knn.predict(X_test)
```

```
from sklearn.metrics import  classification_report, confusion_matrix,
accuracy_score
print(confusion_matrix(y_test,pred_2))
print(classification_report(y_test,pred_2))
print(accuracy_score(y_test,pred_2))
```

```
[[14 23]
 [ 7 79]]
              precision    recall  f1-score   support

           0       0.67      0.38      0.48        37
           1       0.77      0.92      0.84        86

    accuracy                           0.76       123
   macro avg       0.72      0.65      0.66       123
```

```
weighted avg       0.74      0.76      0.73       123

0.7560975609756098
```

```
from sklearn.naive_bayes import GaussianNB
clf = GaussianNB()
clf.fit(X_train, y_train)
pred_3=clf.predict(X_test)
from sklearn.metrics import  classification_report, confusion_matrix,
accuracy_score
print(confusion_matrix(y_test,pred_3))
print(classification_report(y_test,pred_3))
print(accuracy_score(y_test,pred_3))
```

```
[[14 23]
 [ 5 81]]
              precision    recall  f1-score   support

           0       0.74      0.38      0.50        37
           1       0.78      0.94      0.85        86

    accuracy                           0.77       123
   macro avg       0.76      0.66      0.68       123
weighted avg       0.77      0.77      0.75       123

0.7723577235772358
```

```
from sklearn.tree import DecisionTreeClassifier
dtree = DecisionTreeClassifier(random_state=0)
tree = dtree.fit(X_train, y_train)
pred_4=tree.predict(X_test)
```

```
from sklearn.metrics import  classification_report, confusion_matrix,
accuracy_score
print(confusion_matrix(y_test,pred_4))
print(classification_report(y_test,pred_4))
print(accuracy_score(y_test,pred_4))
```

```
[[19 18]
 [20 66]]
              precision    recall  f1-score   support

           0       0.49      0.51      0.50        37
           1       0.79      0.77      0.78        86

    accuracy                           0.69       123
   macro avg       0.64      0.64      0.64       123
weighted avg       0.70      0.69      0.69       123
```

```
0.6910569105691057
```

```
from sklearn.ensemble import  VotingClassifier
from sklearn.ensemble import  BaggingClassifier
from sklearn.ensemble import  AdaBoostClassifier,
RandomForestClassifier, ExtraTreesClassifier
from sklearn.metrics import  accuracy_score, f1_score, log_loss

voting_clf=VotingClassifier(estimators=[('SVC', svclassifier),
('DTree',dtree),('NB',clf),('KNN',knn)])
voting_clf.fit(X_train, y_train)
preds=voting_clf.predict(X_test)
acc=accuracy_score(y_test, preds)
l_loss=log_loss(y_test, preds)
f1=f1_score(y_test, preds)

print("Accuracy is: "+str(acc))
print("Log Loss is: "+str(l_loss))
print("F1 Score is: "+str(f1))
```

```
Accuracy is: 0.6910569105691057
Log Loss is: 10.670626798072515
F1 Score is: 0.7738095238095238
```