Write a program to predict the eligibility of a customer for loan disbursement.

Process

1. Getting the system ready and loading the data
2. Understanding the data
3. Model Building: Part 1
4. Logistic Regression using stratified k-folds cross-validation

Important Libraries

Python

Pandas

matplotlib

seaborn

sklearn

In [ ]:

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

In [ ]:

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

Choose Files No file chosen

Upload widget is only available when the cell has been executed in the current browser session.
Please rerun this cell to enable.

```
Saving test.csv to test.csv
Saving train.csv to train.csv
```

In [ ]:

```
train=pd.read_csv("train.csv")
train.head()
```

Out[3]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapp
0	LP001002	Male	No	0	Graduate	No	5849	
1	LP001003	Male	Yes	1	Graduate	No	4583	
2	LP001005	Male	Yes	0	Graduate	Yes	3000	
3	LP001006	Male	Yes	0	Not Graduate	No	2583	
4	LP001008	Male	No	0	Graduate	No	6000	

In [ ]:

```
test=pd.read_csv("test.csv")
test.head()
```

Out[4]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapp
0	LP001015	Male	Yes	0	Graduate	No	5720	
1	LP001022	Male	Yes	1	Graduate	No	3076	
2	LP001031	Male	Yes	2	Graduate	No	5000	
3	LP001035	Male	Yes	2	Graduate	No	2340	
4	LP001051	Male	No	0	Not Graduate	No	3276	

In [ ]:

```
train.columns
```

Out[5]:

```
Index(['Loan_ID', 'Gender', 'Married', 'Dependents', 'Education',
       'Self_Employed', 'ApplicantIncome', 'CoapplicantIncome', 'LoanAmoun
t',
       'Loan_Amount_Term', 'Credit_History', 'Property_Area', 'Loan_Statu
s'],
      dtype='object')
```

```
In [ ]:
```

```
print(train.shape, test.shape)
```

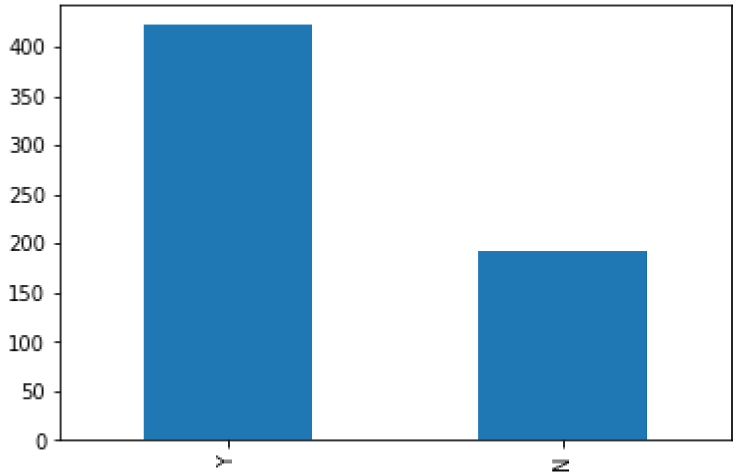
```
(614, 13) (367, 12)
```

```
In [ ]:
```

```
train['Loan_Status'].value_counts().plot.bar()
```

```
Out[7]:
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7911570990>
```



Categorical features: These features have categories (Gender, Married ,Self_Employed, Credit_History, Loan_Status)

Ordinal features: Variables in categorical features having some order involved (Dependents, Education, Property_Area)

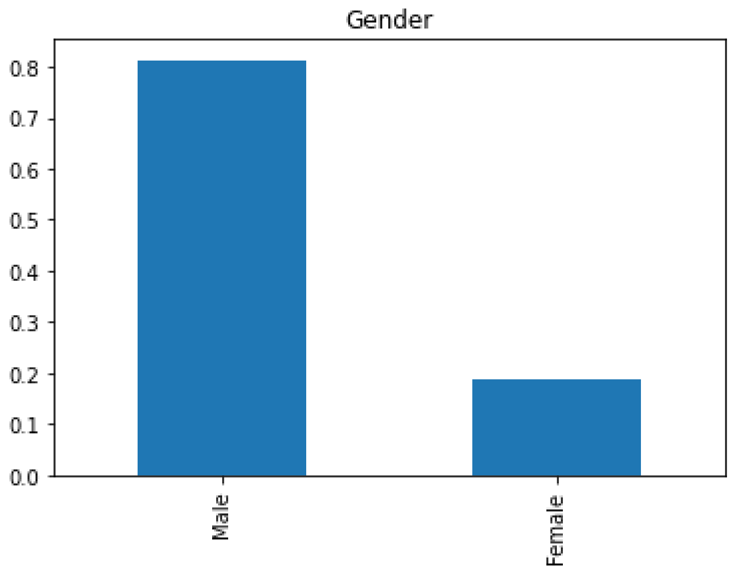
Numerical features: These features have numerical values (ApplicantIncome, CoapplicantIncome, LoanAmount, Loan_Amount_Term)

In [ ]:

```
train['Gender'].value_counts(normalize=True).plot.bar(title='Gender')
```

Out[8]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7910db6210>
```

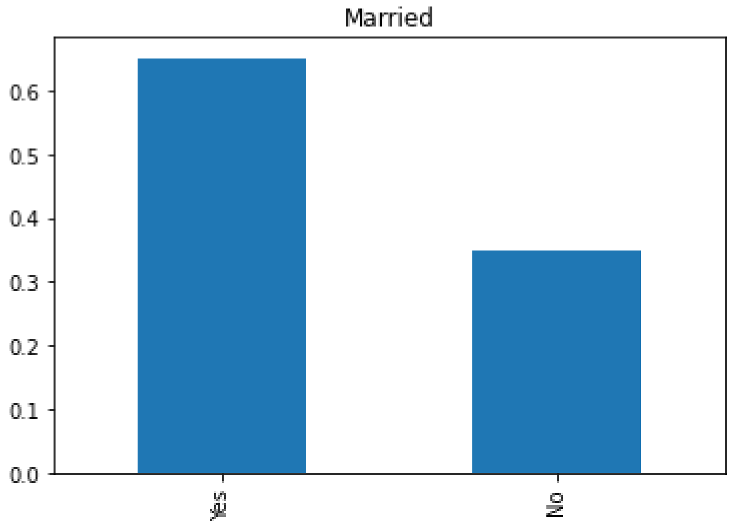


In [ ]:

```
train['Married'].value_counts(normalize=True).plot.bar(title='Married')
```

Out[9]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7911479f90>
```

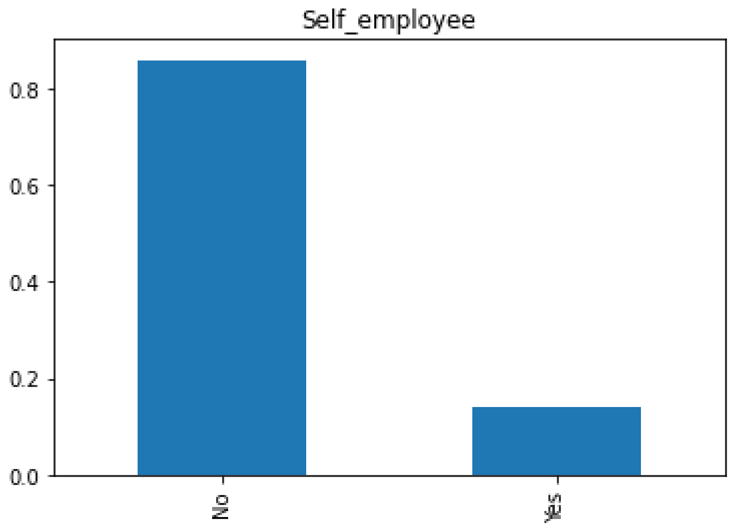


In [ ]:

```
train['Self_Employed'].value_counts(normalize=True).plot.bar(title='Self_employee')
```

Out[10]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7910545a50>
```

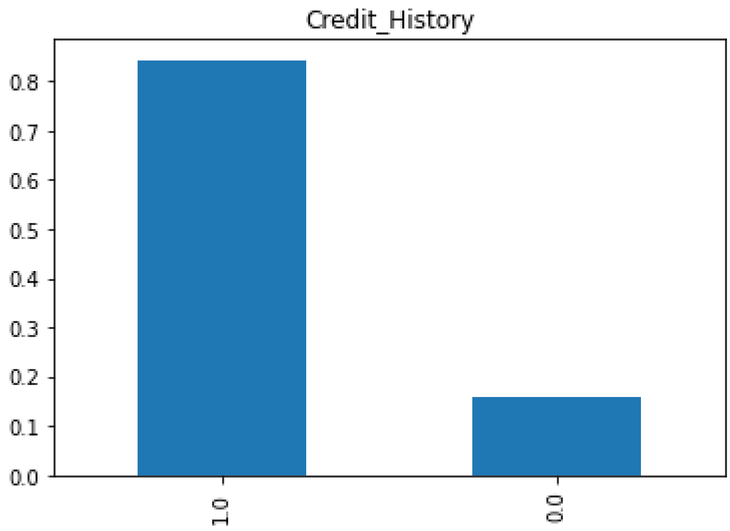


In [ ]:

```
train['Credit_History'].value_counts(normalize=True).plot.bar(title='Credit_History')
```

Out[11]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7910525b90>
```

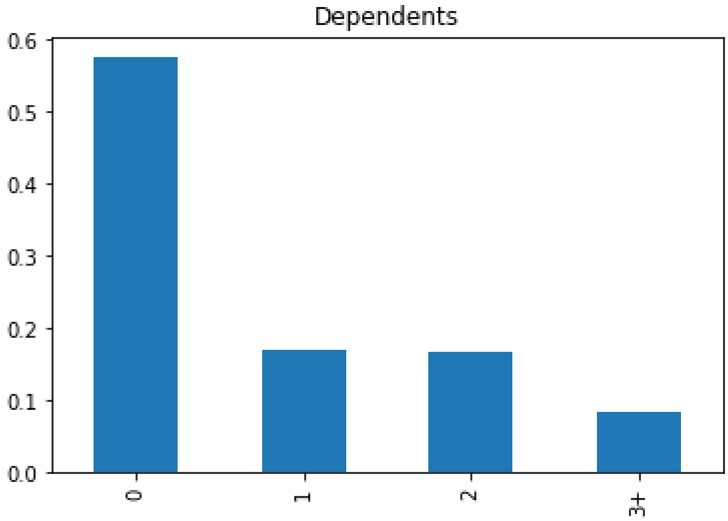


In [ ]:

```
train['Dependents'].value_counts(normalize=True).plot.bar(title='Dependents')
```

Out[12]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f79103fdc10>
```

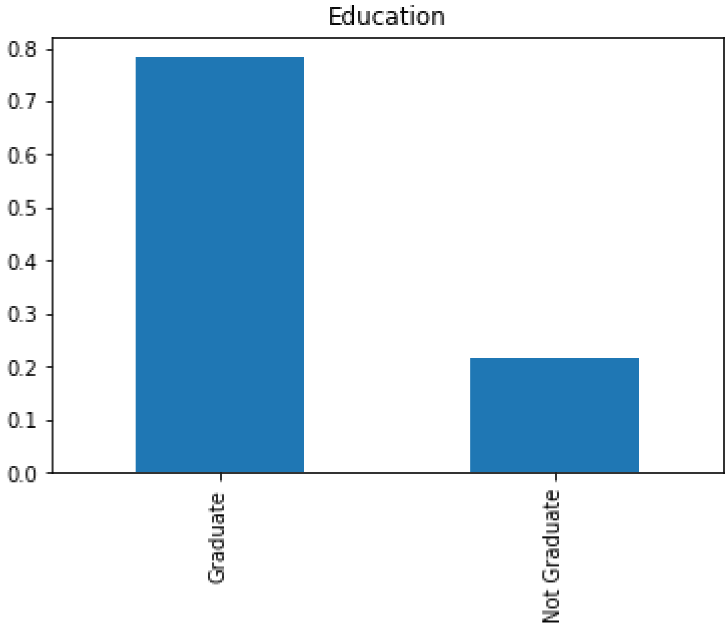


In [ ]:

```
train['Education'].value_counts(normalize=True).plot.bar(title='Education')
```

Out[13]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7910354190>
```

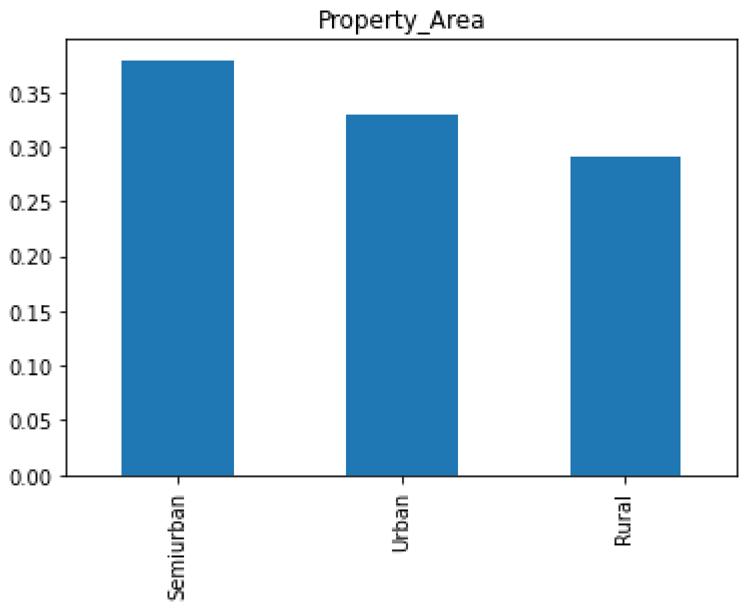


In [ ]:

```
train['Property_Area'].value_counts(normalize=True).plot.bar(title='Property_Area')
```

Out[14]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f791034ab50>
```

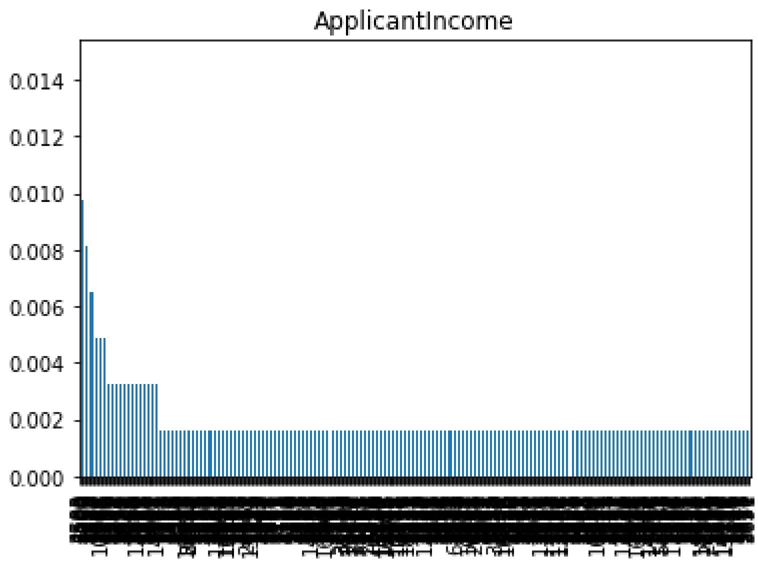


In [ ]:

```
train['ApplicantIncome'].value_counts(normalize=True).plot.bar(title='ApplicantIncome')
```

Out[15]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f79102cc950>
```

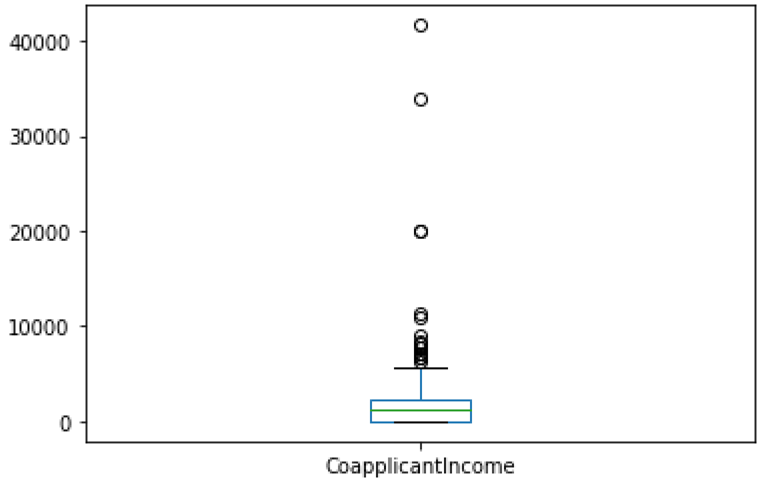


In [ ]:

```
train['CoapplicantIncome'].plot.box()
```

Out[16]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7910252210>
```

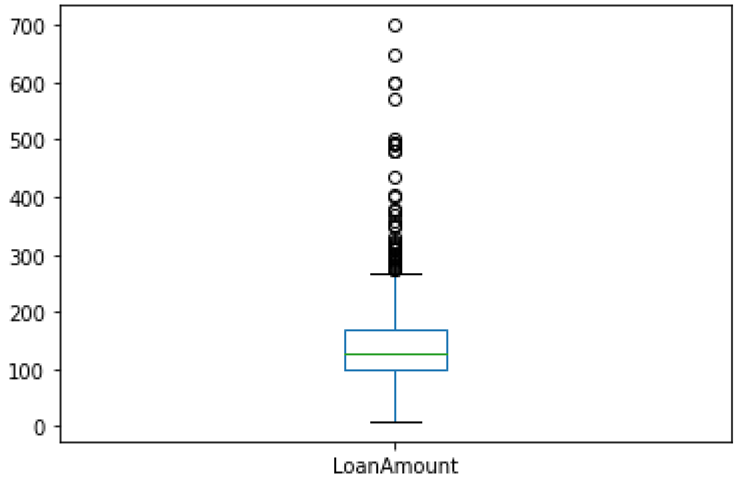


In [ ]:

```
train['LoanAmount'].plot.box()
```

Out[17]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f790f881490>
```

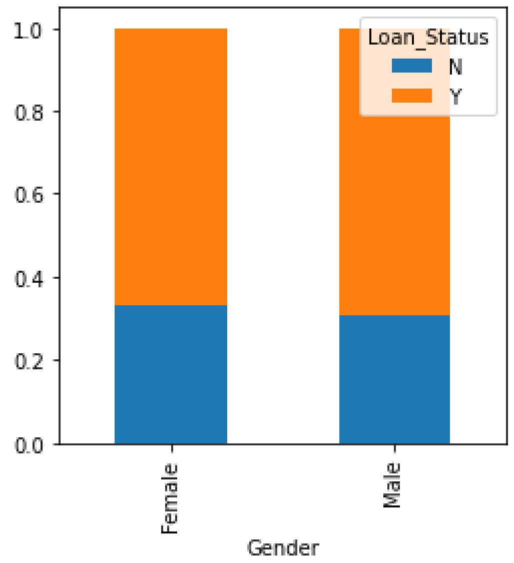


In [ ]:

```
Gender=pd.crosstab(train['Gender'],train['Loan_Status'])
Gender.div(Gender.sum(1).astype(float),axis=0).plot(kind='bar',stacked=True,figsize=(4,4))
```

Out[18]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe24026ce10>
```

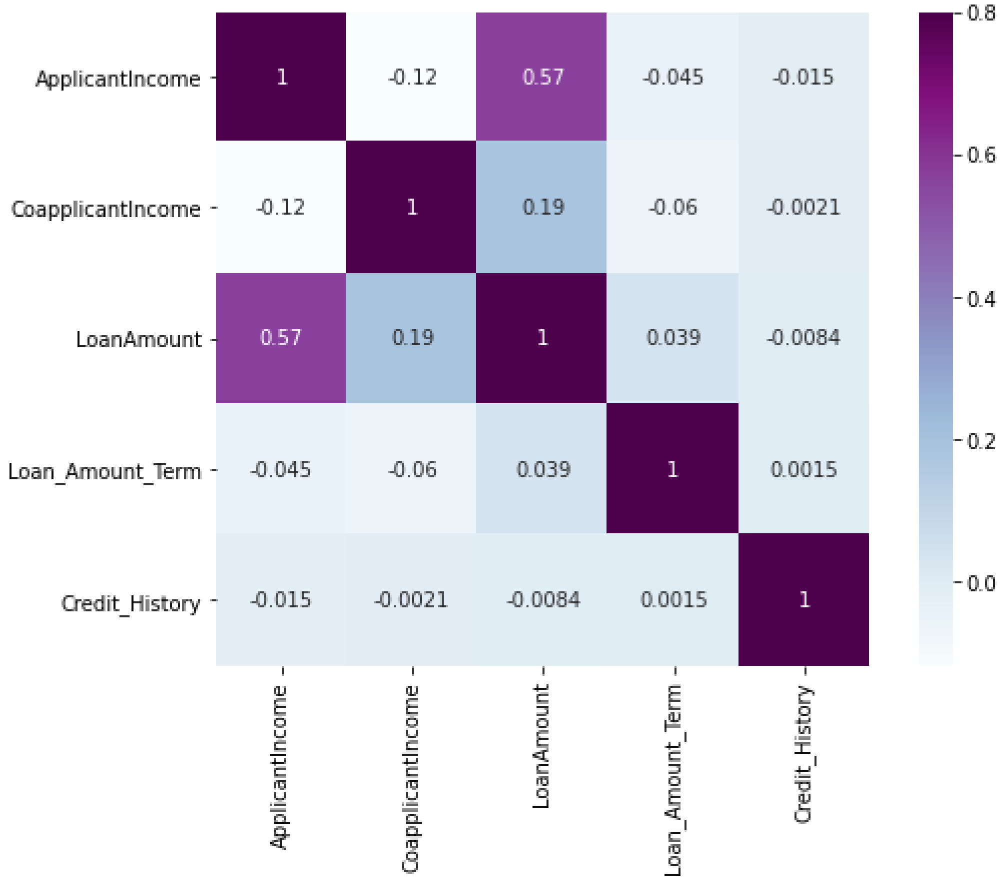


In [ ]:

```
matrix=train.corr()
f,ax=plt.subplots(figsize=(9,6))
sns.heatmap(matrix,vmax=.8,square=True,cmap="BuPu",annot=True)
```

Out[18]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f790f655610>
```



In [ ]:

```
train.isnull().sum()
```

Out[20]:

```
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
```

In [ ]:

```
train['Gender'].fillna(train['Gender'].mode()[0],inplace=True)
print(train['Gender'])
```

```
0        Male
1        Male
2        Male
3        Male
4        Male
        ...  
609    Female
610      Male
611      Male
612      Male
613    Female
Name: Gender, Length: 614, dtype: object
```

In [ ]:

```
train['Married'].fillna(train['Married'].mode()[0],inplace=True)
print(train['Married'])
```

```
0       No
1      Yes
2      Yes
3      Yes
4       No
      ... 
609     No
610    Yes
611    Yes
612    Yes
613     No
Name: Married, Length: 614, dtype: object
```

In [ ]:

```
train['Dependents'].fillna(train['Dependents'].mode()[0],inplace=True)
print(train['Dependents'])
```

```
0       0
1       1
2       0
3       0
4       0
       ..
609     0
610    3+
611     1
612     2
613     0
Name: Dependents, Length: 614, dtype: object
```

In [ ]:

```
train['Self_Employed'].fillna(train['Self_Employed'].mode()[0],inplace=True)
print(train['Self_Employed'])
```

```
0       No
1       No
2      Yes
3       No
4       No
      ...
609     No
610     No
611     No
612     No
613    Yes
Name: Self_Employed, Length: 614, dtype: object
```

In [ ]:

```
train['LoanAmount'].fillna(train['LoanAmount'].mode()[0],inplace=True)
print(train['LoanAmount'])
```

```
0      120.0
1      128.0
2       66.0
3      120.0
4      141.0
       ...
609     71.0
610     40.0
611    253.0
612    187.0
613    133.0
Name: LoanAmount, Length: 614, dtype: float64
```

In [ ]:

```
train['Loan_Amount_Term'].fillna(train['Loan_Amount_Term'].mean(),inplace=True)
print(train['LoanAmount'])
```

```
0      120.0
1      128.0
2       66.0
3      120.0
4      141.0
       ...
609     71.0
610     40.0
611    253.0
612    187.0
613    133.0
Name: LoanAmount, Length: 614, dtype: float64
```

In [ ]:

```
train['Credit_History'].fillna(train['Credit_History'].mean(),inplace=True)
print(train['Credit_History'])
```

```
0      1.0
1      1.0
2      1.0
3      1.0
4      1.0
      ...
609    1.0
610    1.0
611    1.0
612    1.0
613    0.0
Name: Credit_History, Length: 614, dtype: float64
```

In [ ]:

```
train.isnull().sum()
```

Out[28]:

```
Loan_ID              0
Gender               0
Married              0
Dependents           0
Education            0
Self_Employed        0
ApplicantIncome      0
CoapplicantIncome    0
LoanAmount           0
Loan_Amount_Term     0
Credit_History       0
Property_Area        0
Loan_Status          0
dtype: int64
```

In [ ]:

```
X=train.drop('Loan_Status',1)
#X=train.drop('Loan_ID')
X=X.drop('Loan_ID',axis=1)
Y=train['Loan_Status']

X=pd.get_dummies(X)

print(X)
print(Y)
```

```
     ApplicantIncome  ...  Property_Area_Urban
0               5849  ...                    1
1               4583  ...                    0
2               3000  ...                    1
3               2583  ...                    1
4               6000  ...                    1
..               ...  ...                  ...
609             2900  ...                    0
610             4106  ...                    0
611             8072  ...                    1
612             7583  ...                    1
613             4583  ...                    0

[614 rows x 20 columns]
0      Y
1      N
2      Y
3      Y
4      Y
      ..
609    Y
610    Y
611    Y
612    Y
613    N
Name: Loan_Status, Length: 614, dtype: object
```

In [ ]:

```
from sklearn.linear_model import LogisticRegression
model=LogisticRegression()
clf=model.fit(X,Y)
df=pd.read_csv('test.csv')
print(df)
```

```
      Loan_ID Gender Married  ... Loan_Amount_Term Credit_History Property_A
rea
0    LP001015   Male     Yes  ...            360.0            1.0         Ur
ban
1    LP001022   Male     Yes  ...            360.0            1.0         Ur
ban
2    LP001031   Male     Yes  ...            360.0            1.0         Ur
ban
3    LP001035   Male     Yes  ...            360.0            NaN         Ur
ban
4    LP001051   Male      No  ...            360.0            1.0         Ur
ban
..        ...    ...     ...  ...              ...            ...
...
362  LP002971   Male     Yes  ...            360.0            1.0         Ur
ban
363  LP002975   Male     Yes  ...            360.0            1.0         Ur
ban
364  LP002980   Male      No  ...            360.0            NaN     Semiur
ban
365  LP002986   Male     Yes  ...            360.0            1.0         Ru
ral
366  LP002989   Male      No  ...            180.0            1.0         Ru
ral

[367 rows x 12 columns]

/usr/local/lib/python3.7/dist-packages/sklearn/linear_model/_logistic.py:94
0: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html (https://scik
it-learn.org/stable/modules/preprocessing.html)
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regre
ssion (https://scikit-learn.org/stable/modules/linear_model.html#logistic-re
gression)
  extra_warning_msg=_LOGISTIC_SOLVER_CONVERGENCE_MSG)
```

In [ ]:

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

Out[31]:

```
Loan_ID               0
Gender               11
Married               0
Dependents           10
Education             0
Self_Employed        23
ApplicantIncome       0
CoapplicantIncome     0
LoanAmount            5
Loan_Amount_Term      6
Credit_History       29
Property_Area         0
dtype: int64
```

In [ ]:

```
df['Gender'].fillna(df['Gender'].mode()[0],inplace=True)
df['Dependents'].fillna(df['Dependents'].mode()[0],inplace=True)
df['Self_Employed'].fillna(df['Self_Employed'].mode()[0],inplace=True)
df['LoanAmount'].fillna(df['LoanAmount'].mean(),inplace=True)
#df['Loan_Amount_Term'].fillna(df[Loan_Amount_Term].mean(),inplace=True)
df['Credit_History'].fillna(df['Credit_History'].mean(),inplace=True)
```

In [ ]:

```
df.isnull().sum()
df['Loan_Amount_Term'].fillna(df['Loan_Amount_Term'].mean(),inplace=True)
```

In [ ]:

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

Out[34]:

```
Loan_ID              0
Gender               0
Married              0
Dependents           0
Education            0
Self_Employed        0
ApplicantIncome      0
CoapplicantIncome    0
LoanAmount           0
Loan_Amount_Term     0
Credit_History       0
Property_Area        0
dtype: int64
```

In [ ]:

```
df=df.drop('Loan_ID',axis=1)
df=pd.get_dummies(df)
print(X)
print(df)
```

```
     ApplicantIncome  ...  Property_Area_Urban
0               5849  ...                    1
1               4583  ...                    0
2               3000  ...                    1
3               2583  ...                    1
4               6000  ...                    1
..               ...  ...                  ...
609             2900  ...                    0
610             4106  ...                    0
611             8072  ...                    1
612             7583  ...                    1
613             4583  ...                    0

[614 rows x 20 columns]
     ApplicantIncome  ...  Property_Area_Urban
0               5720  ...                    1
1               3076  ...                    1
2               5000  ...                    1
3               2340  ...                    1
4               3276  ...                    1
..               ...  ...                  ...
362             4009  ...                    1
363             4158  ...                    1
364             3250  ...                    0
365             5000  ...                    0
366             9200  ...                    0

[367 rows x 20 columns]
```

In [ ]:

```
clf.predict(df)
```

Out[36]:

```
array(['Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y',
       'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'N', 'Y',
       'Y', 'N', 'N', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'N', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y',
       'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'N', 'N', 'N', 'Y', 'Y', 'Y', 'N', 'N', 'Y', 'N', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'N',
       'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y',
       'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'N', 'N', 'Y', 'N',
       'Y', 'Y', 'Y', 'Y', 'N', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'N', 'Y',
       'Y', 'N', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'N', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y',
       'Y', 'N', 'N', 'N', 'Y', 'Y', 'Y', 'N', 'Y', 'N', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'N',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'N', 'N', 'Y', 'Y', 'Y', 'Y',
       'N', 'N', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N',
       'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y',
       'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y',
       'N', 'Y', 'Y', 'N', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y', 'Y',
       'Y', 'Y', 'Y'], dtype=object)
```