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

In [2]:
```
data=pd.read_csv('loan_approval_dataset.csv')
```

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

Out[3]:

	loan_id	no_of_dependents	education	self_employed	income_annum	loan_amount	loan_
0	1	2	Graduate	No	9600000	29900000	
1	2	0	Not Graduate	Yes	4100000	12200000	
2	3	3	Graduate	No	9100000	29700000	
3	4	3	Graduate	No	8200000	30700000	
4	5	5	Not Graduate	Yes	9800000	24200000	

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

Out[4]:

	loan_id	no_of_dependents	education	self_employed	income_annum	loan_amount	lo
4264	4265	5	Graduate	Yes	1000000	2300000	
4265	4266	0	Not Graduate	Yes	3300000	11300000	
4266	4267	2	Not Graduate	No	6500000	23900000	
4267	4268	1	Not Graduate	No	4100000	12800000	
4268	4269	1	Graduate	No	9200000	29700000	

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4269 entries, 0 to 4268
Data columns (total 13 columns):
 #   Column                    Non-Null Count  Dtype 
---  ------                    --------------  ----- 
 0   loan_id                   4269 non-null   int64 
 1    no_of_dependents         4269 non-null   int64 
 2    education                4269 non-null   object
 3    self_employed            4269 non-null   object
 4    income_annum             4269 non-null   int64 
 5    loan_amount              4269 non-null   int64 
 6    loan_term                4269 non-null   int64 
 7    cibil_score              4269 non-null   int64 
 8    residential_assets_value 4269 non-null   int64 
 9    commercial_assets_value  4269 non-null   int64 
 10   luxury_assets_value      4269 non-null   int64 
 11   bank_asset_value         4269 non-null   int64 
 12   loan_status              4269 non-null   object
dtypes: int64(10), object(3)
memory usage: 433.7+ KB
```

Handling Missing Value

In [6]:
```
data.isnull().sum()
```

Out[6]:
```
loan_id                   0
 no_of_dependents         0
 education                0
 self_employed            0
 income_annum             0
 loan_amount              0
 loan_term                0
 cibil_score              0
 residential_assets_value 0
 commercial_assets_value  0
 luxury_assets_value      0
 bank_asset_value         0
 loan_status              0
dtype: int64
```

outliers treatment

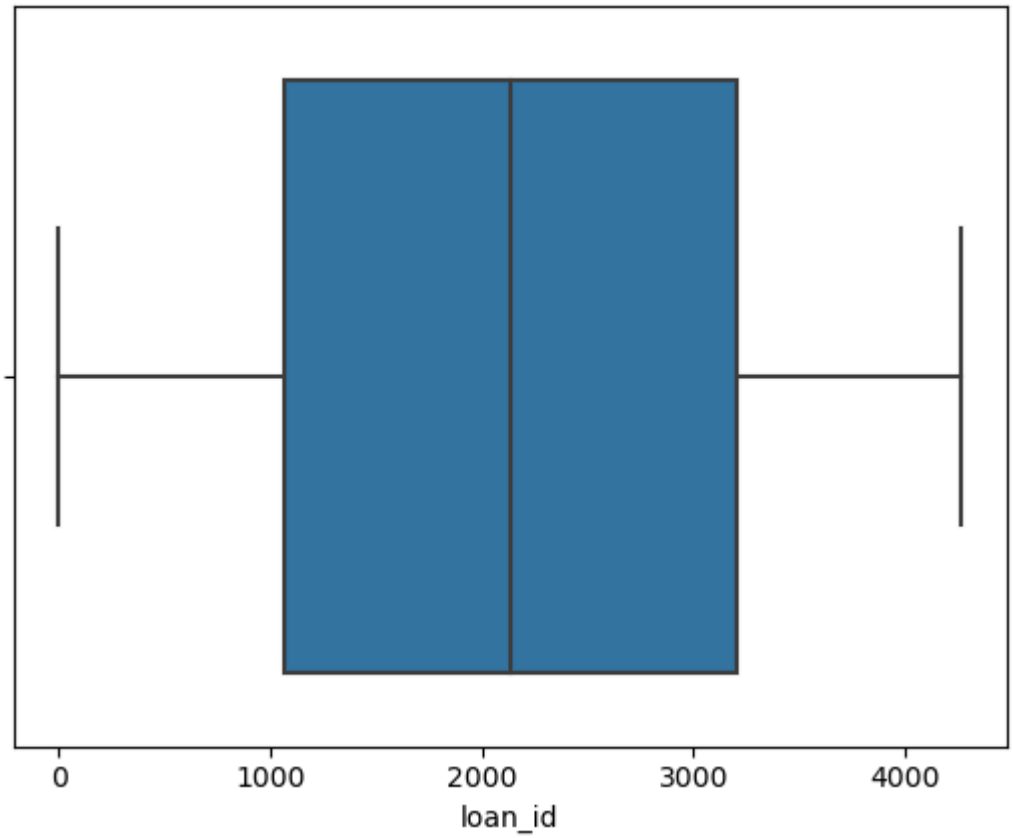
In [7]:
```
data.describe()
```

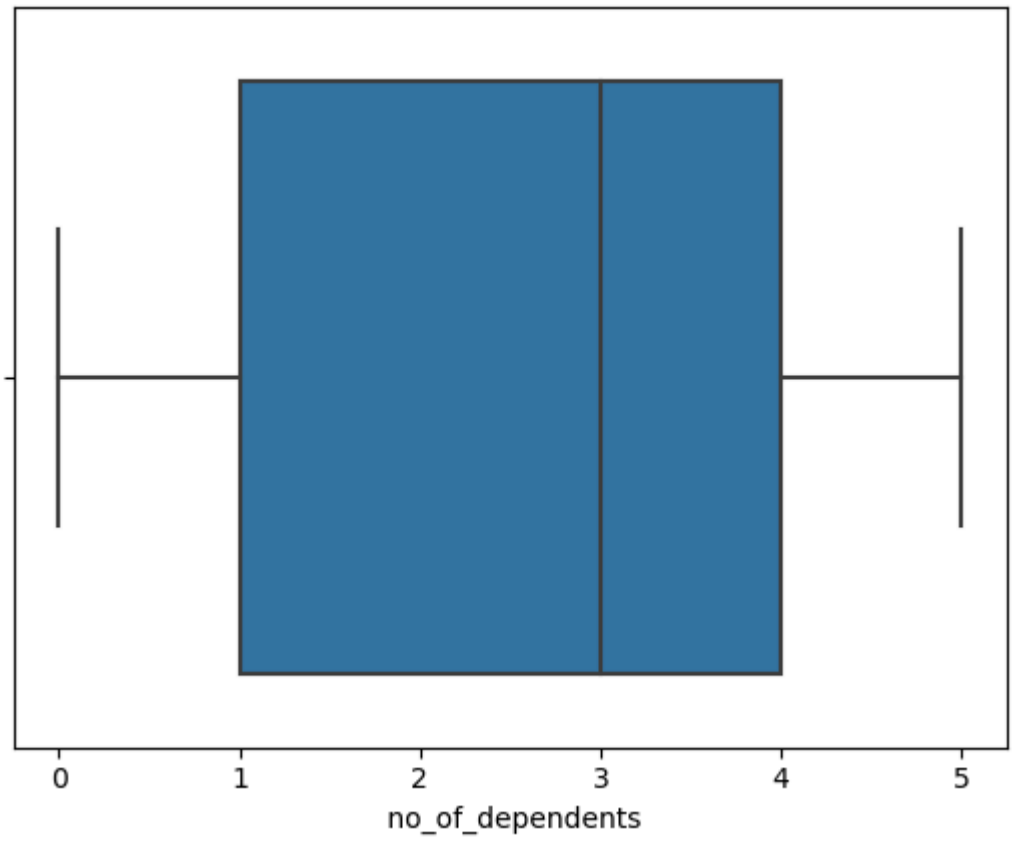
Out[7]:

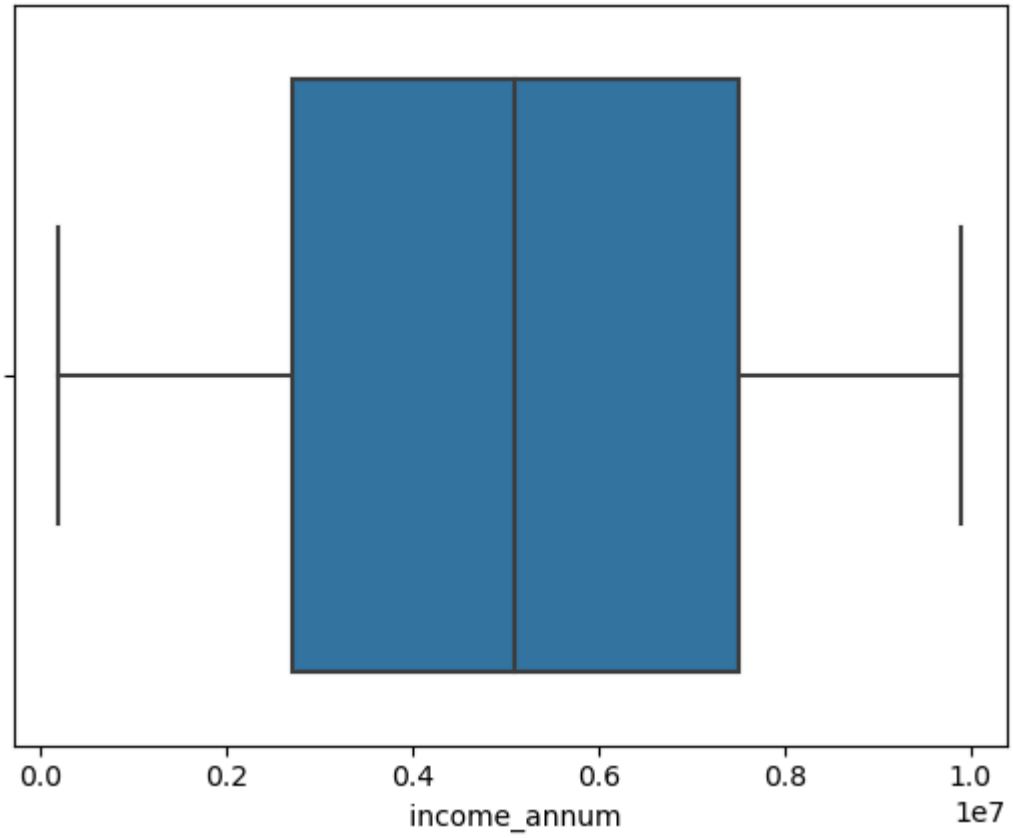
	loan_id	no_of_dependents	income_annum	loan_amount	loan_term	cibil_scc
count	4269.000000	4269.000000	4.269000e+03	4.269000e+03	4269.000000	4269.0000
mean	2135.000000	2.498712	5.059124e+06	1.513345e+07	10.900445	599.9360
std	1232.498479	1.695910	2.806840e+06	9.043363e+06	5.709187	172.4304
min	1.000000	0.000000	2.000000e+05	3.000000e+05	2.000000	300.0000
25%	1068.000000	1.000000	2.700000e+06	7.700000e+06	6.000000	453.0000
50%	2135.000000	3.000000	5.100000e+06	1.450000e+07	10.000000	600.0000
75%	3202.000000	4.000000	7.500000e+06	2.150000e+07	16.000000	748.0000
max	4269.000000	5.000000	9.900000e+06	3.950000e+07	20.000000	900.0000

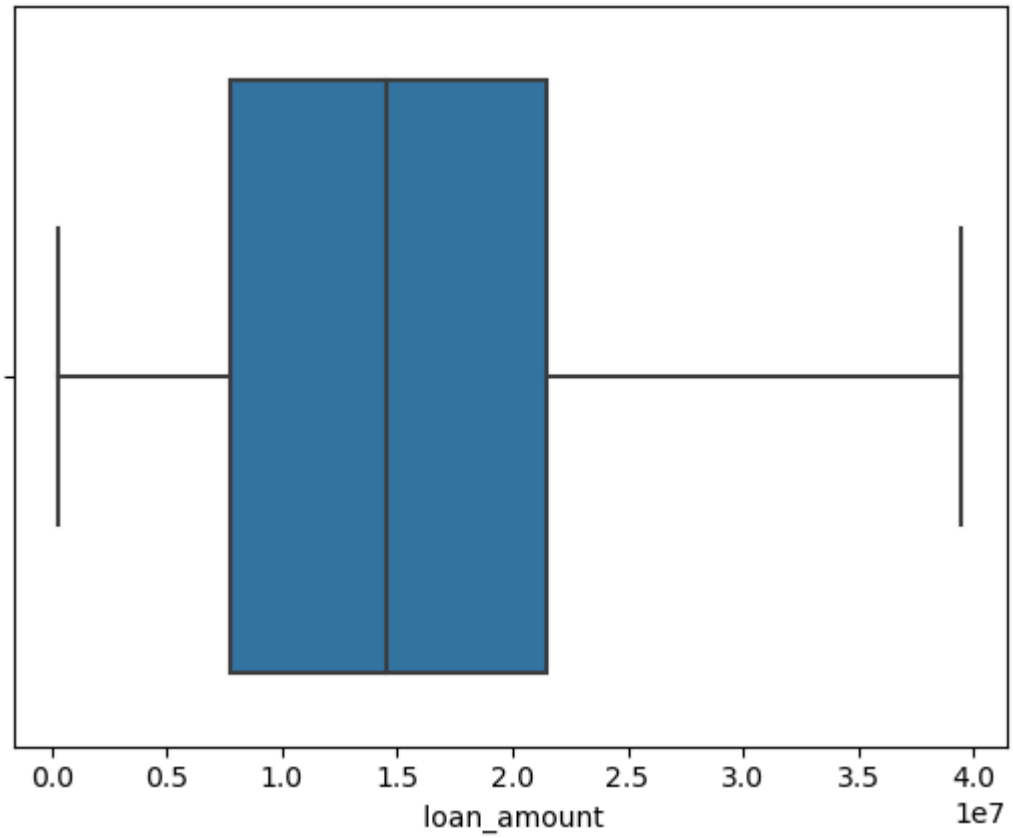
In [ ]:
```

```

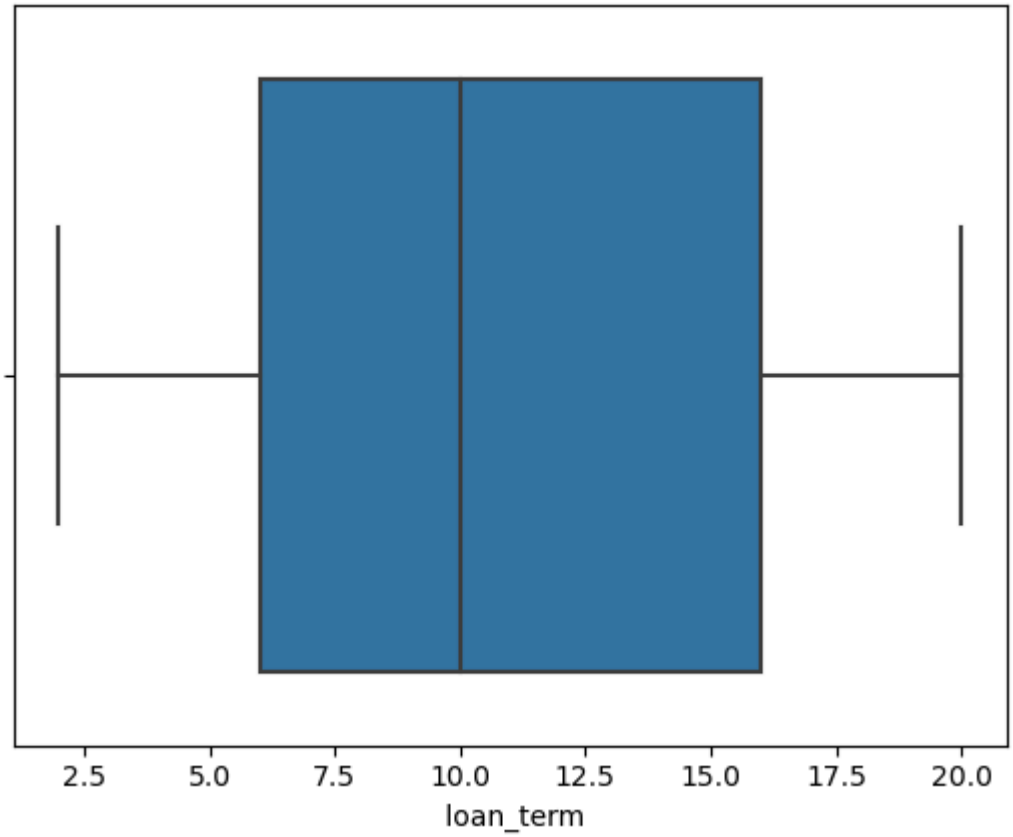
In [8]:
```
for i in data.select_dtypes(include=['int','float']):
    sns.boxplot(data=data,x=i)
    plt.show()
```

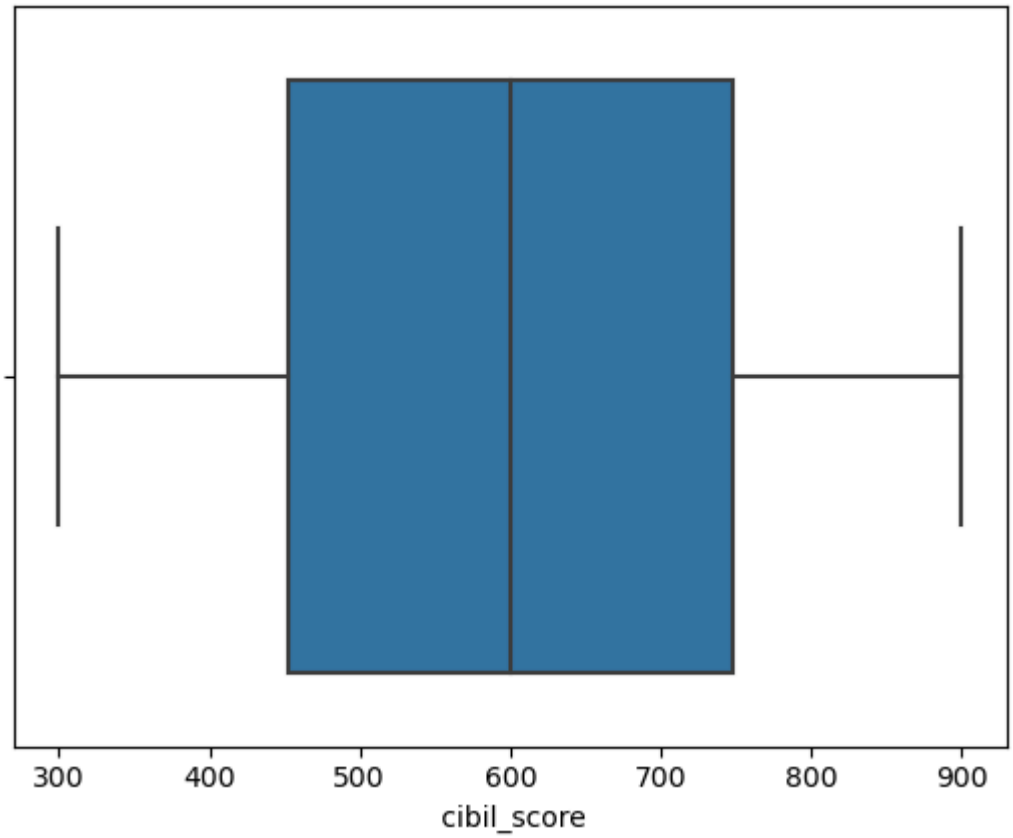


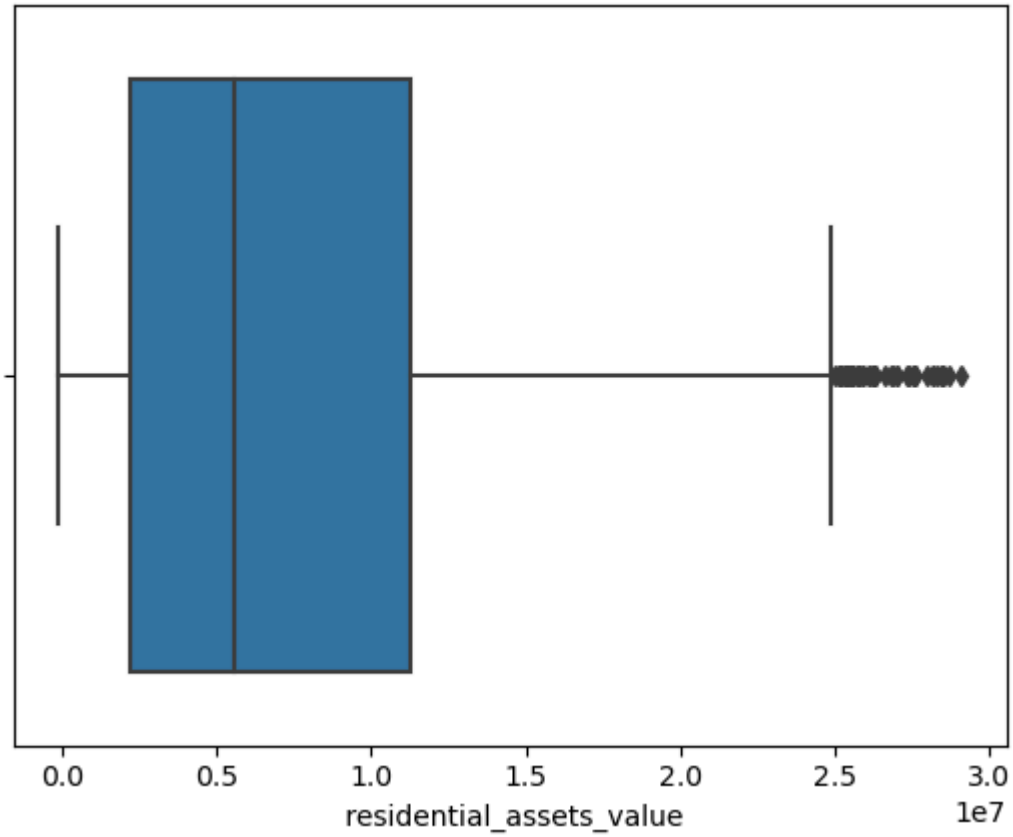


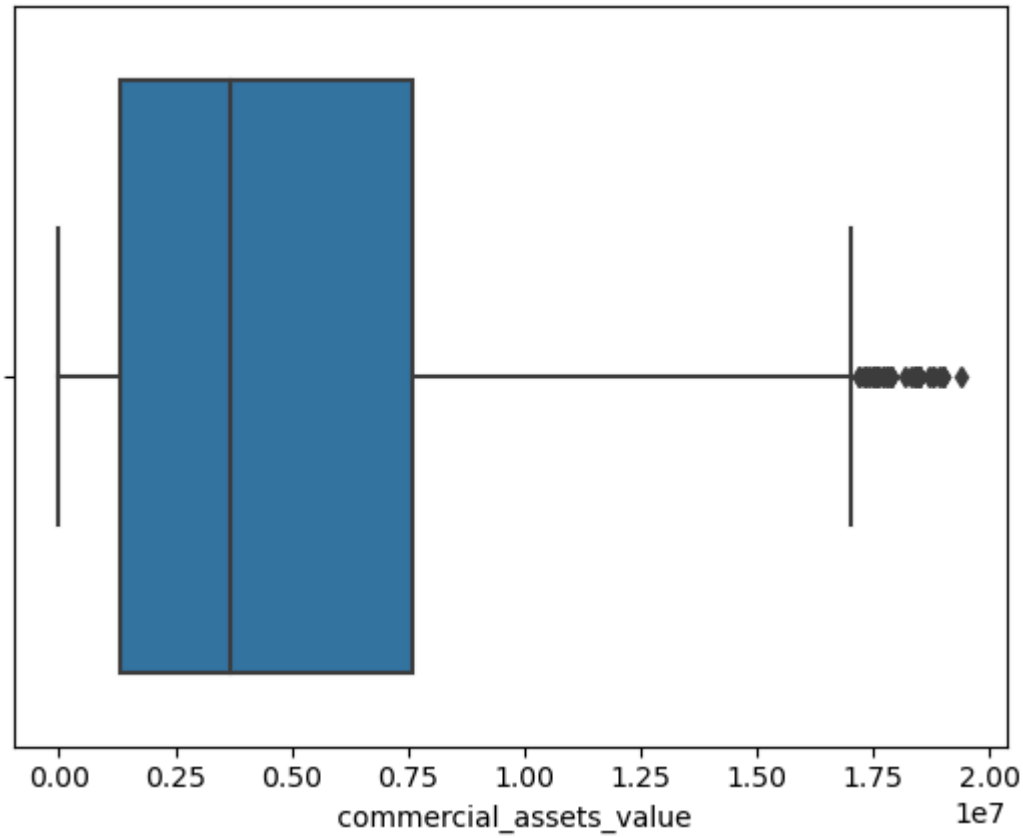

0.0
0.2
0.4
0.6
0.8
1.0
income_annum
1e7

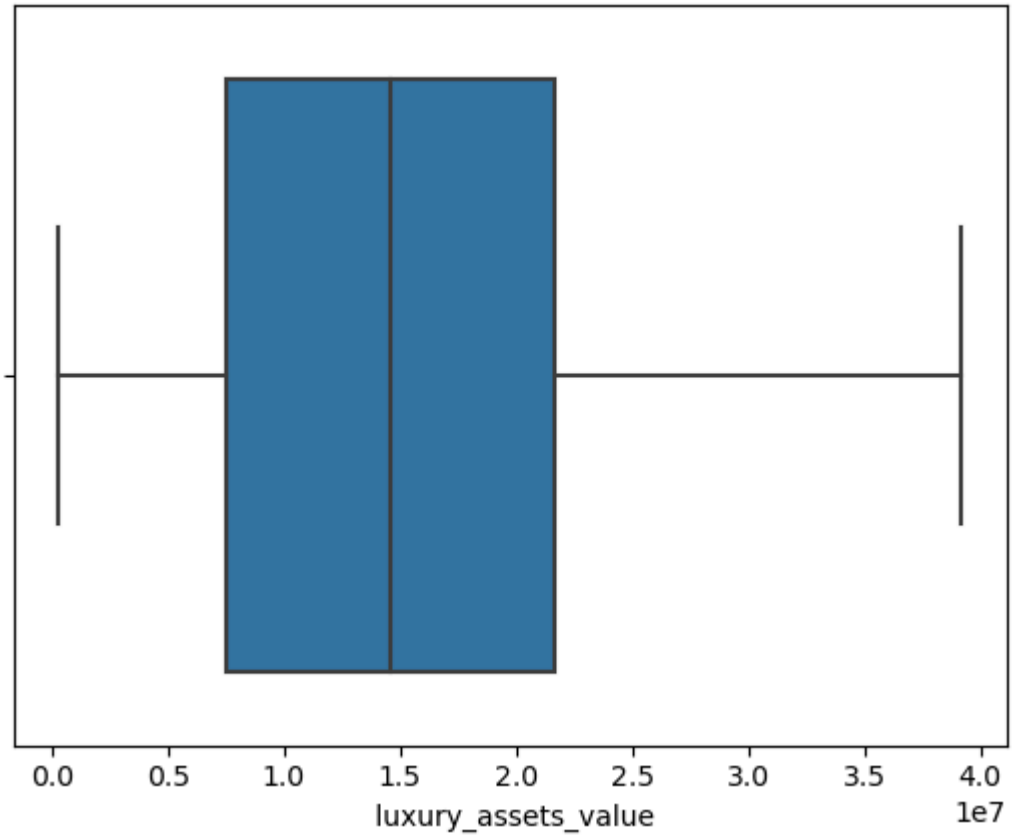

0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
loan_amount
1e7

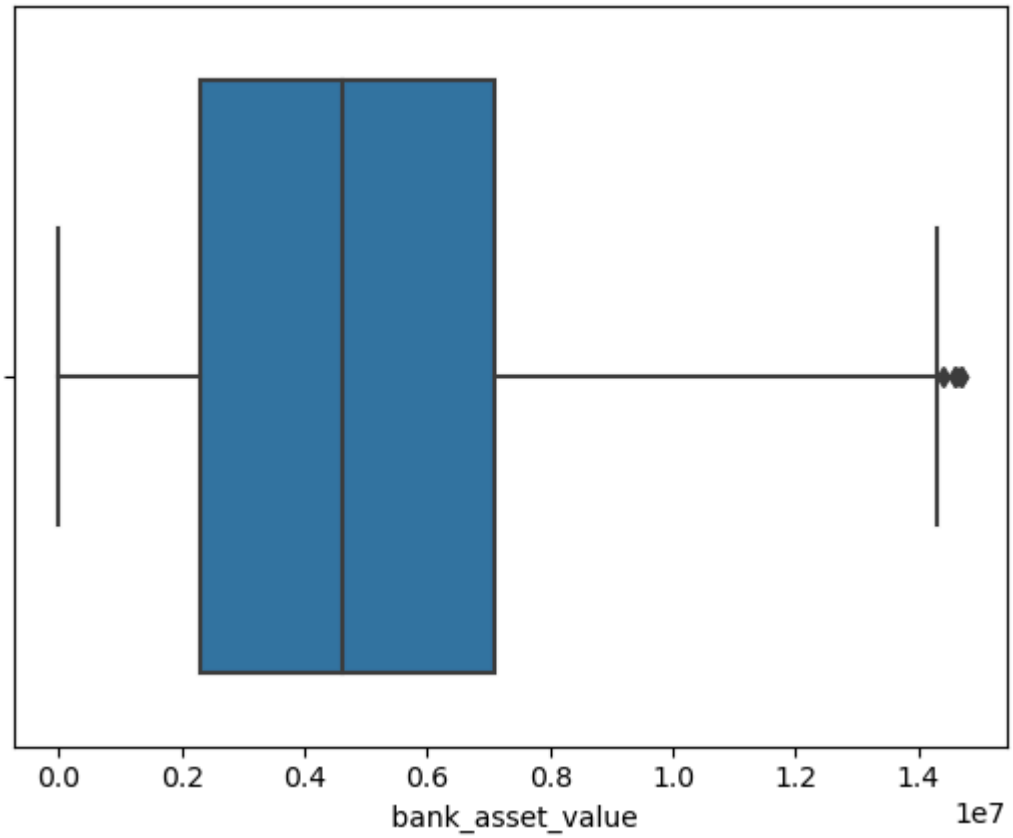

2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
loan_term


300
400
500
600
700
800
900
cibil_score


0.0
0.5
1.0
1.5
2.0
2.5
3.0
residential_assets_value
1e7


0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
commercial_assets_value
1e7


0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
luxury_assets_value
1e7


0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
bank_asset_value
1e7

In [9]:
```
def outliers_treatment(col):
    q1=data[col].quantile(0.25)
    q3=data[col].quantile(0.75)
    IQR=q3-q1
    UB=q3+1.5*IQR
    LB=q1-1.5*IQR
    upper_outlier=data[col] > UB
    lower_outlier=data[col] < LB
    data.loc[upper_outlier,col]=data[col].median()
    data.loc[lower_outlier,col]=data[col].median()
```

In [10]:
```
outliers_treatment(' commercial_assets_value')
```

In [11]:
```
outliers_treatment(' residential_assets_value')
```

Encoding

In [12]:
```
from sklearn.preprocessing import LabelEncoder
```

In [13]:
```
LE=LabelEncoder()
LE
```

Out[13]:
```
LabelEncoder()
```

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In [14]:
```
def HCD (col):
    data[col]=LE.fit_transform(data[[col]])
```

In [15]:
```
for i in data.select_dtypes(include='object'):
    HCD (i)
```

```
C:\Users\adity\anaconda3\New folder\Lib\site-packages\sklearn\preprocessin
g\_label.py:114: DataConversionWarning: A column-vector y was passed when
a 1d array was expected. Please change the shape of y to (n_samples, ), fo
r example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\adity\anaconda3\New folder\Lib\site-packages\sklearn\preprocessin
g\_label.py:114: DataConversionWarning: A column-vector y was passed when
a 1d array was expected. Please change the shape of y to (n_samples, ), fo
r example using ravel().
  y = column_or_1d(y, warn=True)
C:\Users\adity\anaconda3\New folder\Lib\site-packages\sklearn\preprocessin
g\_label.py:114: DataConversionWarning: A column-vector y was passed when
a 1d array was expected. Please change the shape of y to (n_samples, ), fo
r example using ravel().
  y = column_or_1d(y, warn=True)
```

In [16]:
```
data.head(1)
```

Out[16]:

	loan_id	no_of_dependents	education	self_employed	income_annum	loan_amount	loan_
0	1	2	0	0	9600000	29900000	

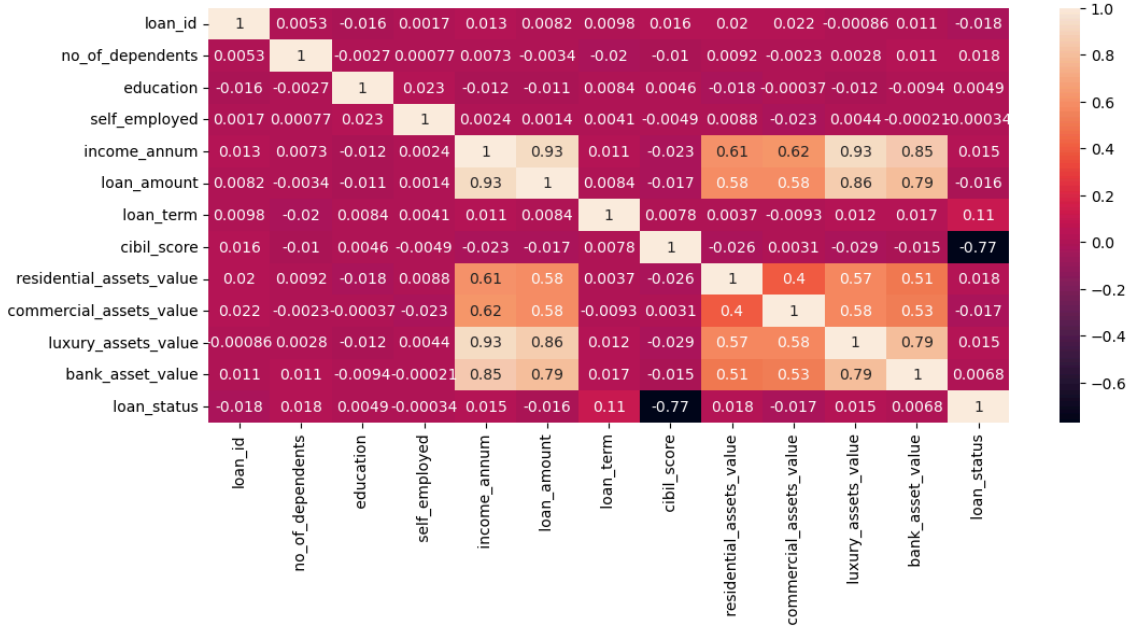
In [17]:
```
data.corr()
```

Out[17]:

	loan_id	no_of_dependents	education	self_employed	income_an
loan_id	1.000000	0.005326	-0.015536	0.001745	0.012
no_of_dependents	0.005326	1.000000	-0.002697	0.000765	0.007
education	-0.015536	-0.002697	1.000000	0.023224	-0.01
self_employed	0.001745	0.000765	0.023224	1.000000	0.002
income_annum	0.012592	0.007266	-0.011625	0.002368	1.000
loan_amount	0.008170	-0.003366	-0.010631	0.001450	0.927
loan_term	0.009809	-0.020111	0.008417	0.004107	0.01
cibil_score	0.016323	-0.009998	0.004649	-0.004866	-0.023
residential_assets_value	0.020031	0.009162	-0.018102	0.008807	0.610
commercial_assets_value	0.022222	-0.002331	-0.000371	-0.022759	0.619
luxury_assets_value	-0.000862	0.002817	-0.012471	0.004413	0.929
bank_asset_value	0.010765	0.011163	-0.009424	-0.000215	0.851
loan_status	-0.017685	0.018114	0.004918	-0.000345	0.015

In [113]:
```
plt.figure(figsize=(12,5))
sns.heatmap(data.corr(),annot=True)
```

Out[113]: <Axes: >



In [ ]:

In [19]:
```
x=data.drop([' loan_status'], axis=1)
```

In [20]:
```
x.head(2)
```

Out[20]:

	loan_id	no_of_dependents	education	self_employed	income_annum	loan_amount	loan_
0	1	2	0	0	9600000	29900000	
1	2	0	1	1	4100000	12200000	

In [21]:
```
y=data[' loan_status']
```

In [22]:
```
y.head(2)
```

Out[22]:
```
0    0
1    1
Name:  loan_status, dtype: int32
```

In [23]:
```
data.skew()
```

Out[23]:
```
loan_id                     0.000000
 no_of_dependents          -0.017971
 education                  0.008905
 self_employed             -0.014529
 income_annum              -0.012814
 loan_amount                0.308724
 loan_term                  0.036359
 cibil_score               -0.009039
 residential_assets_value   0.918472
 commercial_assets_value    0.907465
 luxury_assets_value        0.322208
 bank_asset_value           0.560725
 loan_status                0.504087
dtype: float64
```

In [24]:
```
from sklearn.preprocessing import PowerTransformer
```

In [25]:
```
pt=PowerTransformer()
```

In [26]:
```
pt
```

Out[26]:
```
PowerTransformer()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [27]:
```
x=pt.fit_transform(x)
```

Train_test_split

In [28]:
```
from sklearn.model_selection import train_test_split
```

In [29]:
```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.20,random_st
```

In [30]:
```
x_train.shape
```

Out[30]: (3415, 12)

In [31]:
```
x_test.shape
```

Out[31]: (854, 12)

In [32]:
```
y_train.shape
```

Out[32]: (3415,)

In [33]:
```
y_test.shape
```

Out[33]: (854,)

LogisticRegression

In [34]:
```
from sklearn.linear_model import LogisticRegression
```

In [35]:
```
LR=LogisticRegression(max_iter=100)
```

In [36]:
```
LR
```

Out[36]:
```
LogisticRegression()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [37]:
```
LR.fit(x_train,y_train)
```

Out[37]:
```
LogisticRegression()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [38]:
```
model_pred=LR.predict(x_test)
```

In [39]:
```
from sklearn.metrics import confusion_matrix, accuracy_score, f1_score
```

In [40]:
```
confusion_matrix(y_test,model_pred)
```

Out[40]:
```
array([[499,  32],
       [ 42, 281]], dtype=int64)
```

In [41]:
```
accuracy_score(y_test,model_pred)
```

Out[41]:
```
0.9133489461358314
```

In [42]:
```
f1_score(y_test,model_pred)
```

Out[42]:
```
0.8836477987421384
```

In [43]:
```
pd.DataFrame(y_train).value_counts()
```

Out[43]:
```
 loan_status
0              2125
1              1290
Name: count, dtype: int64
```

In [44]:
```
from sklearn.metrics import classification_report
```

In [45]:
```
print((classification_report(y_test,model_pred)))
```

```
              precision    recall  f1-score   support

           0       0.92      0.94      0.93       531
           1       0.90      0.87      0.88       323

    accuracy                           0.91       854
   macro avg       0.91      0.90      0.91       854
weighted avg       0.91      0.91      0.91       854
```

DECISION TREE

In [47]:
```
from sklearn.tree import DecisionTreeClassifier
```

In [52]:
```
DTC=DecisionTreeClassifier(max_depth=5,criterion='entropy')
```

In [53]:
```
DTC
```

Out[53]:
```
DecisionTreeClassifier(criterion='entropy', max_depth=5)
```

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In [54]:
```
DTC.fit(x_train,y_train)
```

Out[54]:
```
DecisionTreeClassifier(criterion='entropy', max_depth=5)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [57]:
```
dt_pred=DTC.predict(x_test)
```

In [72]:
```
confusion_matrix(y_test,dt_pred)
```

Out[72]:
```
array([[510,  21],
       [  4, 319]], dtype=int64)
```

In [73]:
```
from sklearn.metrics import accuracy_score,f1_score
```

In [74]:
```
accuracy_score(y_test,dt_pred)
```

Out[74]:
```
0.9707259953161592
```

In [75]:
```
f1_score(y_test,dt_pred)
```

Out[75]:
```
0.9622926093514328
```

tree

In [76]:
```
from sklearn import tree
```

In [78]:
```
data.columns
```

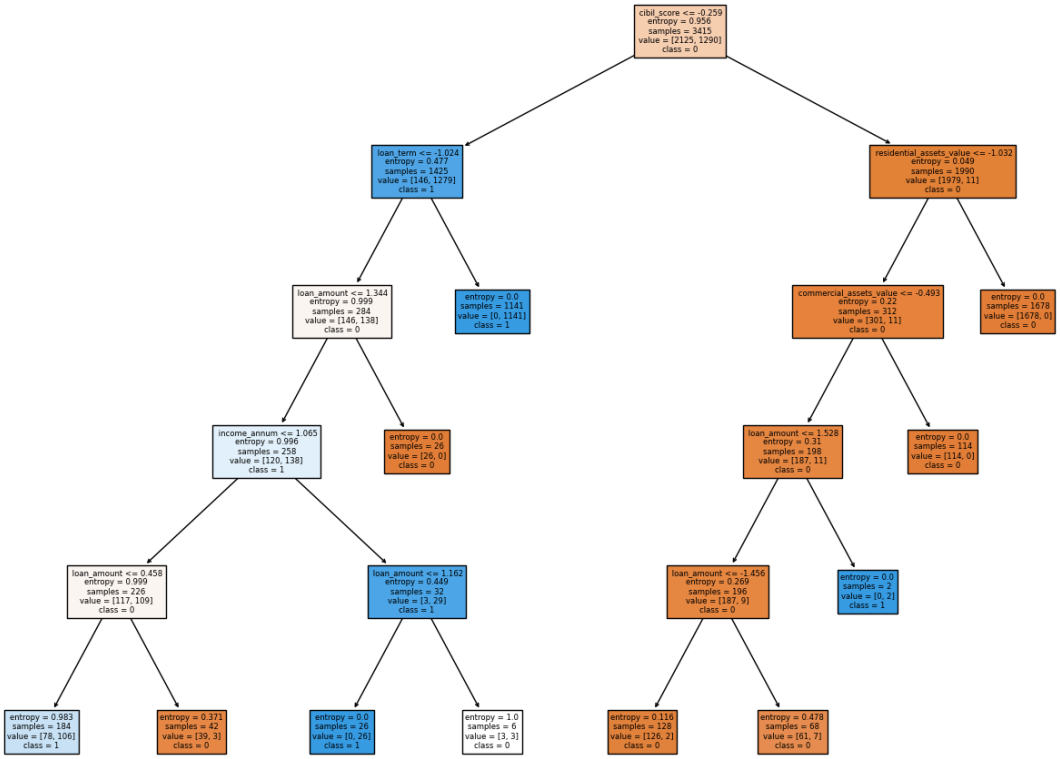
Out[78]:
```
Index(['loan_id', ' no_of_dependents', ' education', ' self_employed',
       ' income_annum', ' loan_amount', ' loan_term', ' cibil_score',
       ' residential_assets_value', ' commercial_assets_value',
       ' luxury_assets_value', ' bank_asset_value', ' loan_status'],
      dtype='object')
```

In [79]:
```
t=['loan_id', ' no_of_dependents', ' education', ' self_employed',
       ' income_annum', ' loan_amount', ' loan_term', ' cibil_score',
       ' residential_assets_value', ' commercial_assets_value',
       ' luxury_assets_value', ' bank_asset_value',]
```

In [80]:
```
data[' loan_status'].unique()
```

Out[80]:
```
array([0, 1])
```

In [89]:
```
plt.figure(figsize=(16,12))
tree.plot_tree(DTC,feature_names=t,class_names=['0', '1'], filled=True)
plt.show()
```



RandomForestClassifier

In [96]:
```
from sklearn.ensemble import RandomForestClassifier
```

In [97]:
```
RFC=RandomForestClassifier(n_estimators=200)
```

In [98]:
```
RFC
```

Out[98]:
```
RandomForestClassifier(n_estimators=200)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [99]:
```
RFC.fit(x_train,y_train)
```

Out[99]:
```
RandomForestClassifier(n_estimators=200)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
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In [100]:
```
RFC_pred=RFC.predict(x_test)
```

In [102]:
```
RFC_pred[:5]
```

Out[102]:
```
array([0, 0, 0, 0, 0])
```

In [104]:
```
confusion_matrix(y_test,RFC_pred)
```

Out[104]:
```
array([[523,   8],
       [  8, 315]], dtype=int64)
```

In [105]:
```
from sklearn.metrics import accuracy_score, f1_score
```

In [106]:
```
accuracy_score(y_test,RFC_pred)
```

Out[106]:
```
0.9812646370023419
```

In [107]:
```
f1_score(y_test,RFC_pred)
```

Out[107]:
```
0.9752321981424149
```

In [ ]:
```

```