In [135]:
```
import pandas as pd
import pandas as pd
import numpy as np
import seaborn as sns
import plotly.express as px
import plotly.graph_objects as go
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import f1_score, recall_score,precision_score,confusion_matrix,classifi
from sklearn import tree
from sklearn.metrics import roc_auc_score
```

In [136]:
```
loan_data=pd.read_csv("loan_data.csv")
```

In [137]:
```
loan_data.head()
```

Out[137]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome	Loa
0	LP001002	Male	No	0	Graduate	No	5849	0.0	
1	LP001003	Male	Yes	1	Graduate	No	4583	1508.0	
2	LP001005	Male	Yes	0	Graduate	Yes	3000	0.0	
3	LP001006	Male	Yes	0	Not Graduate	No	2583	2358.0	
4	LP001008	Male	No	0	Graduate	No	6000	0.0	

In [138]:
```
loan_data.isnull().sum()
```

Out[138]:
```
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 [139]:
```
loan_data.dtypes
```

Out[139]:
```
Loan_ID               object
Gender                object
Married               object
Dependents            object
Education             object
Self_Employed         object
ApplicantIncome        int64
CoapplicantIncome    float64
LoanAmount           float64
Loan_Amount_Term     float64
Credit_History       float64
Property_Area         object
Loan_Status           object
dtype: object
```

In [140]:
```
loan_data.nunique()
```

Out[140]:
```
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
```

In [141]:
```
loan_data.isnull().sum()
```

Out[141]:
```
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 [142]:
```
loan_data['Loan_Status'].value_counts()
```

Out[142]:
```
Y    422
N    192
Name: Loan_Status, dtype: int64
```

In [143]:
```
loan_data['Credit_History'].value_counts()
```
Out[143]:
```
1.0    475
0.0     89
Name: Credit_History, dtype: int64
```

In [144]:
```
loan_data['Dependents'].value_counts()
```
Out[144]:
```
0     345
1     102
2     101
3+     51
Name: Dependents, dtype: int64
```

In [145]:
```
loan_data['Gender'].value_counts()
```
Out[145]:
```
Male      489
Female    112
Name: Gender, dtype: int64
```

In [146]:
```
loan_data['Loan_Amount_Term'].value_counts()
```
Out[146]:
```
360.0    512
180.0     44
480.0     15
300.0     13
240.0      4
84.0       4
120.0      3
60.0       2
36.0       2
12.0       1
Name: Loan_Amount_Term, dtype: int64
```

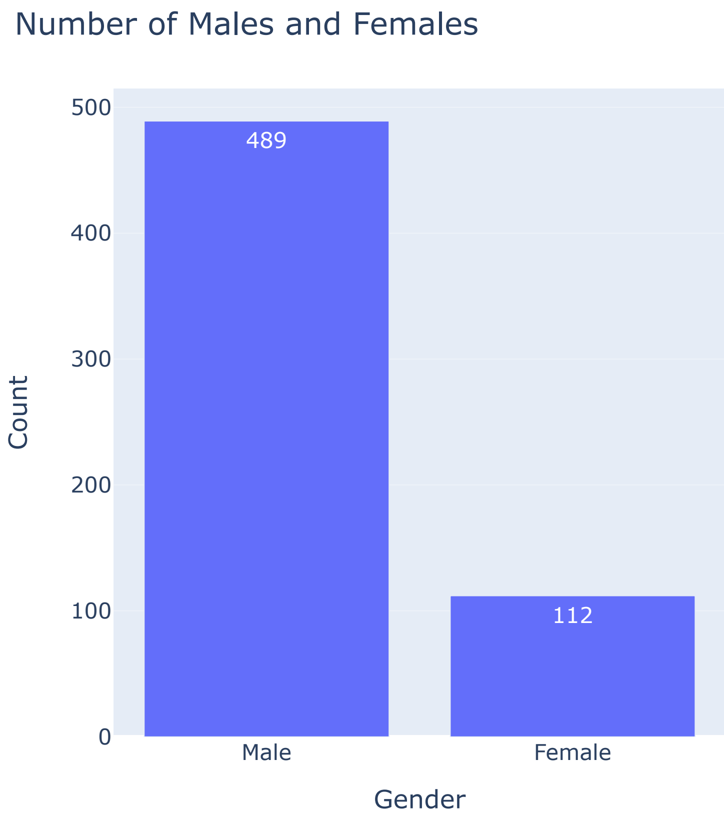
In [147]:
```
loan_data['Self_Employed'].value_counts()
```
Out[147]:
```
No     500
Yes     82
Name: Self_Employed, dtype: int64
```

In [148]:
```
loan_data['Gender'].value_counts()
```
Out[148]:
```
Male      489
Female    112
Name: Gender, dtype: int64
```

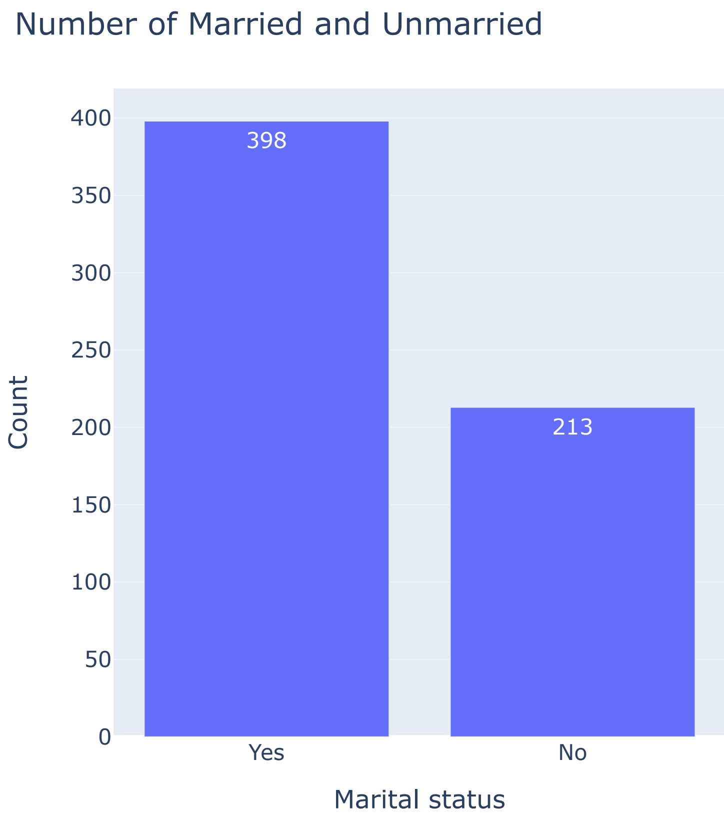
In [ ]:
```

```

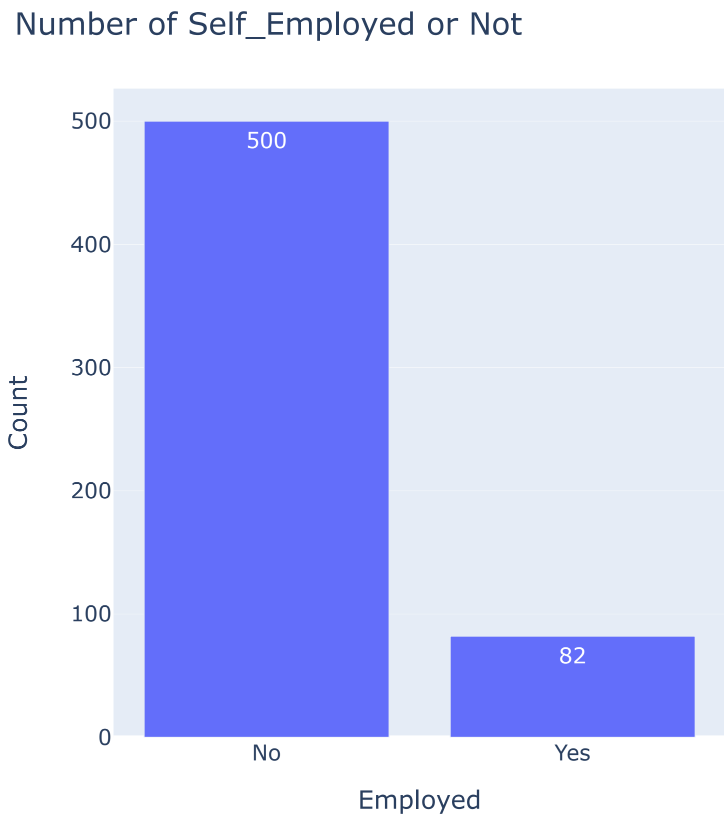
In [149]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Gender'].value_counts().index, y=loan_data[
fig.update_layout(title='Number of Males and Females',xaxis_title='Gender',yaxis_title='Cou
fig.show()
```



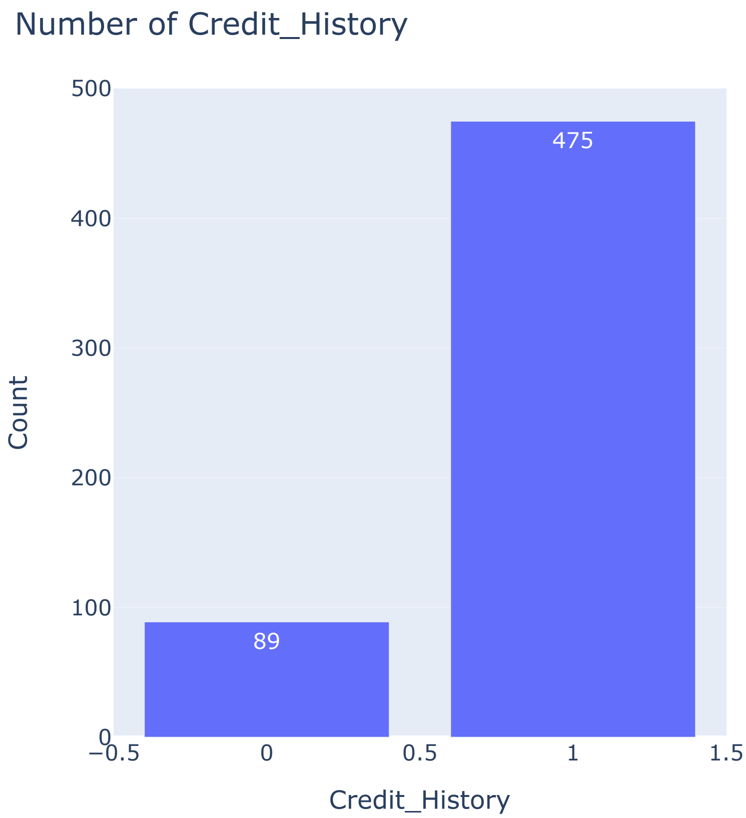
In [150]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Married'].value_counts().index, y=loan_data
fig.update_layout(title='Number of Married and Unmarried',xaxis_title='Marital status',yaxi
fig.show()
```



In [151]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Self_Employed'].value_counts().index, y=loa
fig.update_layout(title='Number of Self_Employed or Not',xaxis_title='Employed',yaxis_title
fig.show()
```



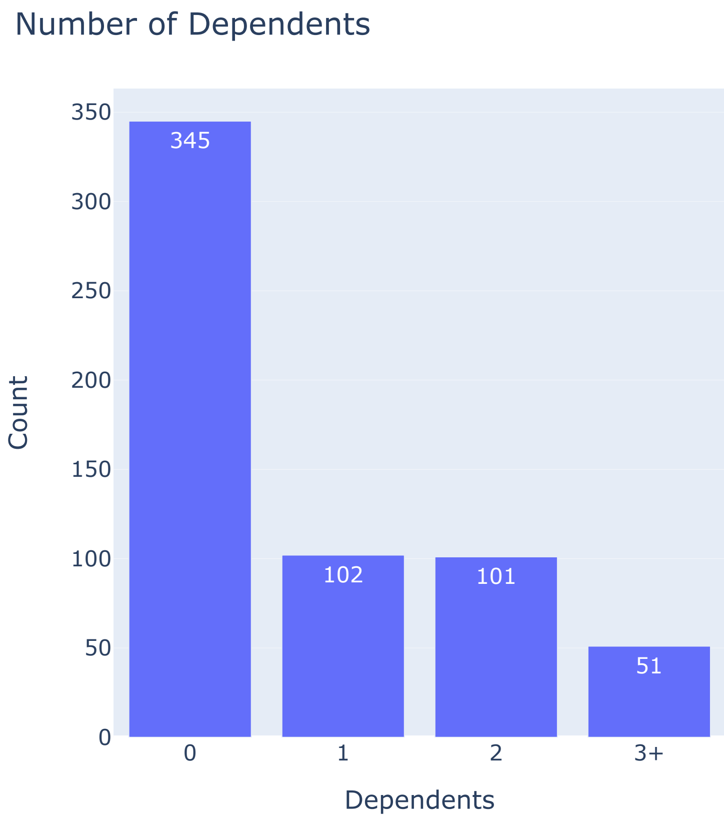
In [152]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Credit_History'].value_counts().index, y=lo
fig.update_layout(title='Number of Credit_History',xaxis_title='Credit_History',yaxis_title
fig.show()
```



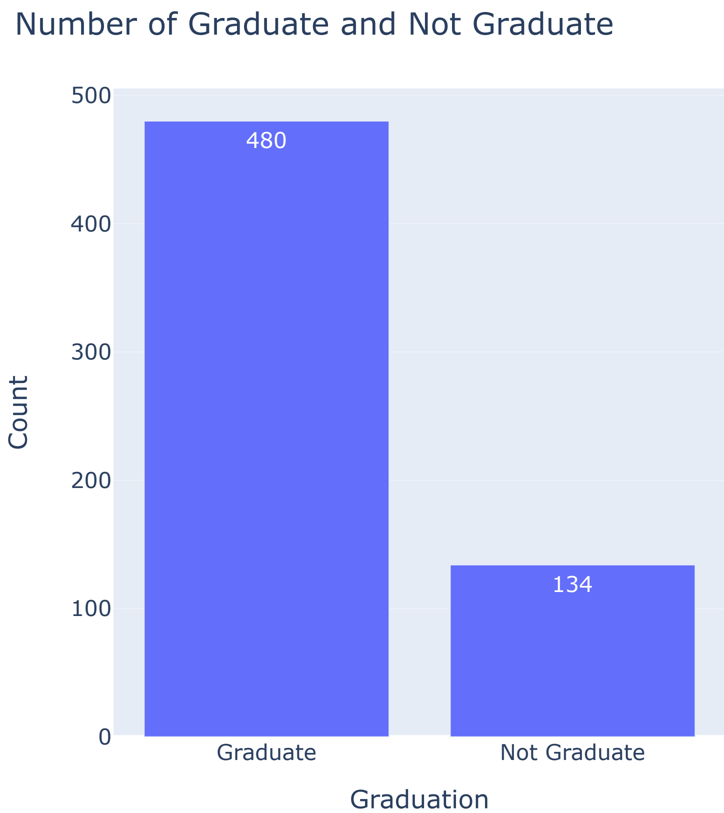
In [153]:
```
loan_data.dtypes
```

Out[153]:
```
Loan_ID               object
Gender                object
Married               object
Dependents            object
Education             object
Self_Employed         object
ApplicantIncome        int64
CoapplicantIncome    float64
LoanAmount           float64
Loan_Amount_Term     float64
Credit_History       float64
Property_Area         object
Loan_Status           object
dtype: object
```

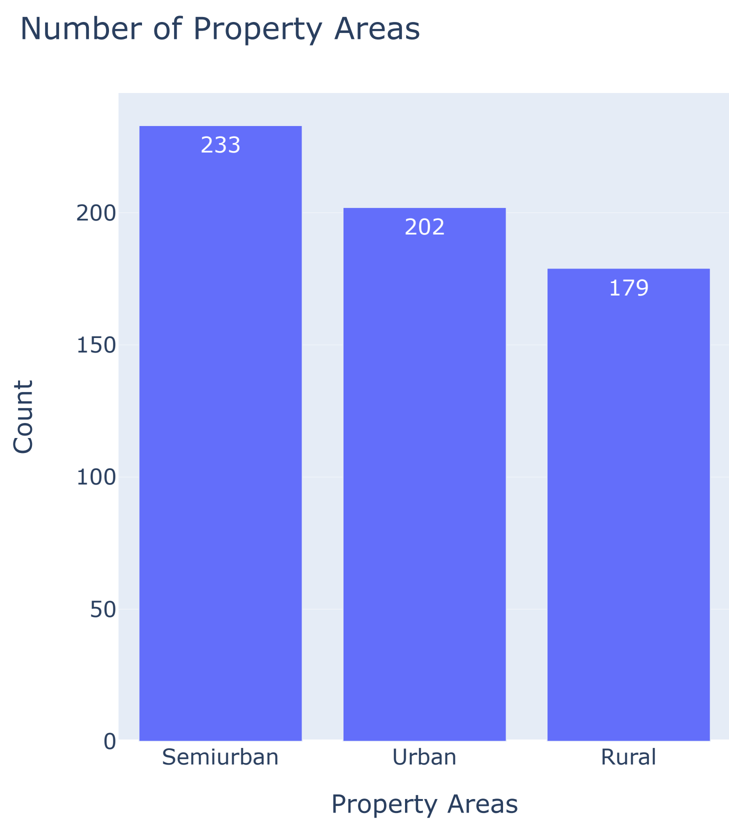
In [154]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Dependents'].value_counts().index, y=loan_d
fig.update_layout(title='Number of Dependents',xaxis_title='Dependents',yaxis_title='Count'
fig.show()
```



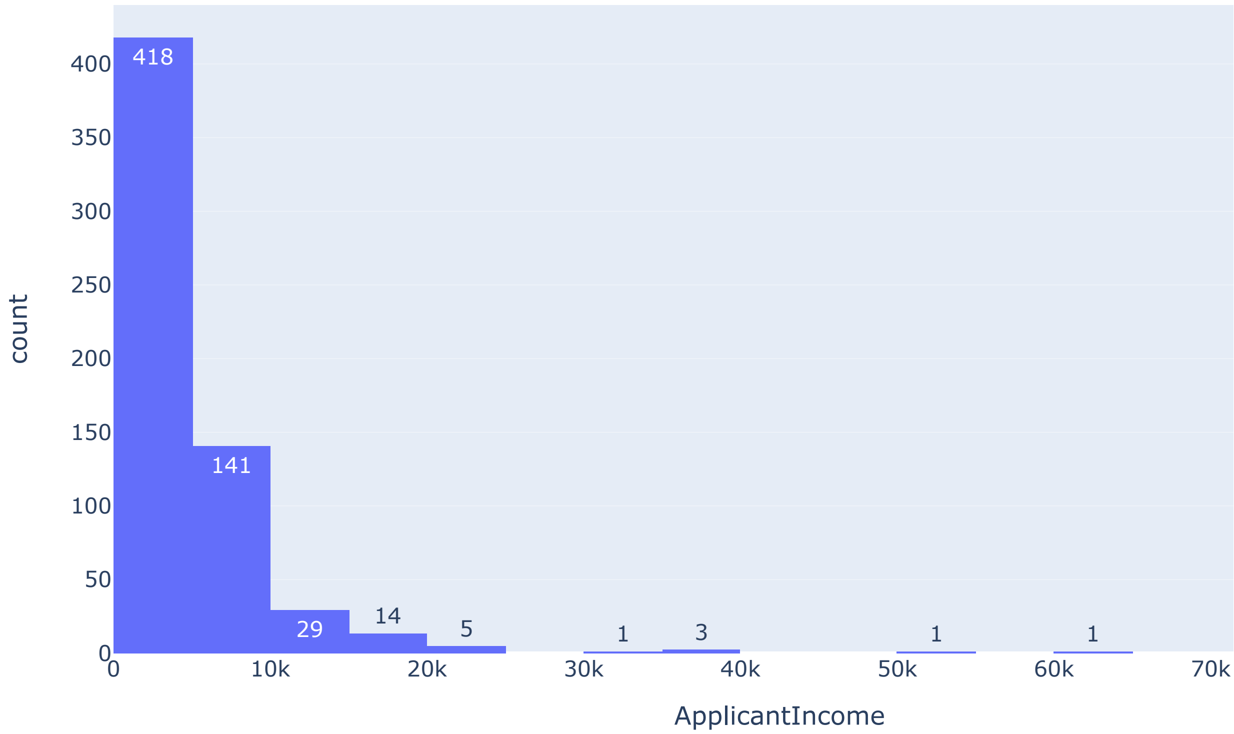
In [155]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Education'].value_counts().index, y=loan_da
fig.update_layout(title='Number of Graduate and Not Graduate',xaxis_title='Graduation',yaxi
fig.show()
```



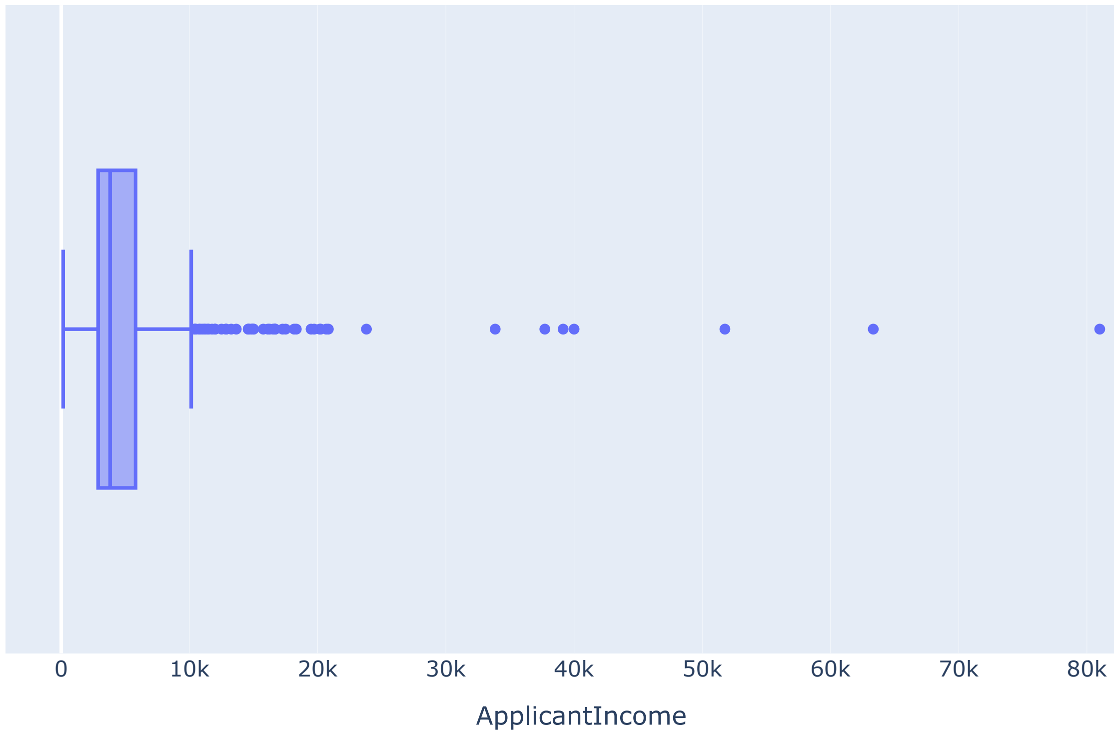
In [156]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Property_Area'].value_counts().index, y=loai
fig.update_layout(title='Number of Property Areas',xaxis_title='Property Areas',yaxis_title=
fig.show()
```



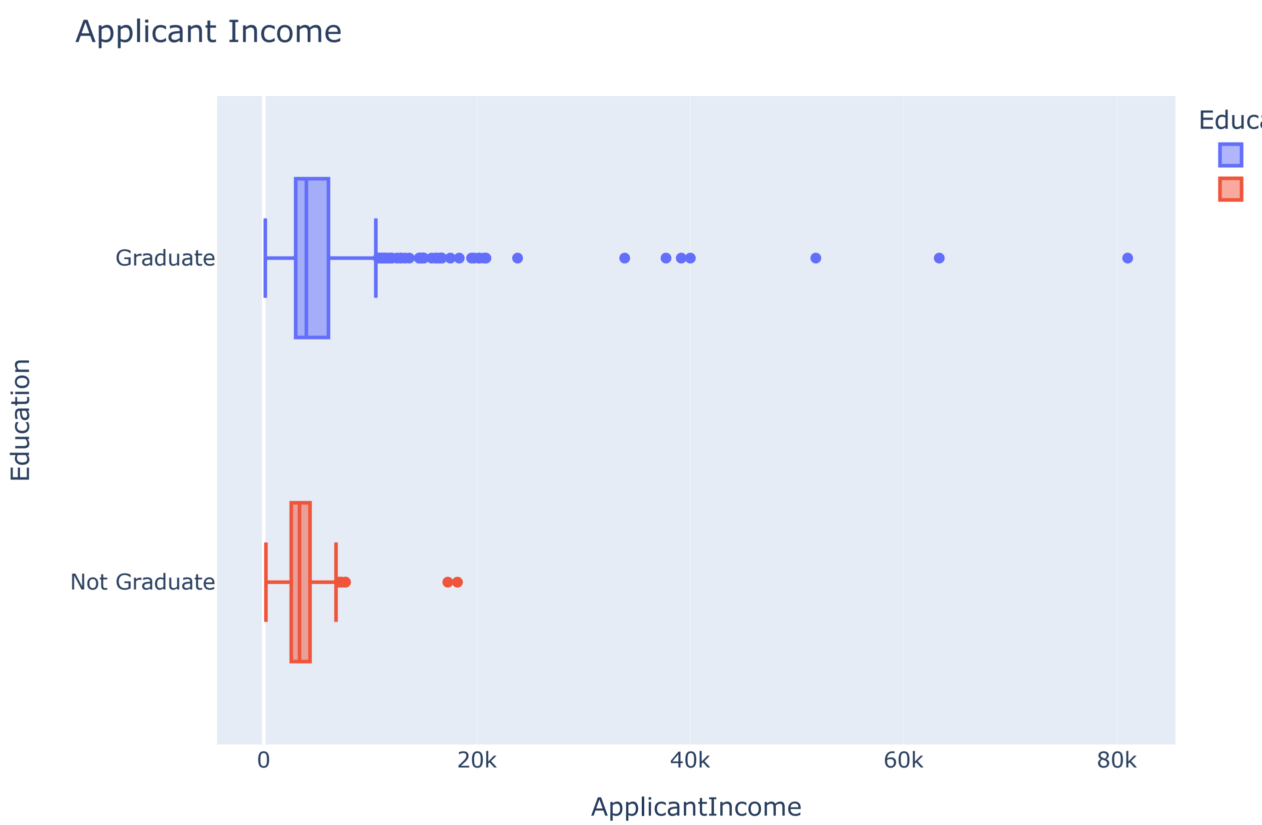
In [157]:
```
fig=px.histogram(data_frame=loan_data,x='ApplicantIncome',text_auto=True,nbins=20)
fig.update_layout(width=900,height=500)
fig.show()
```



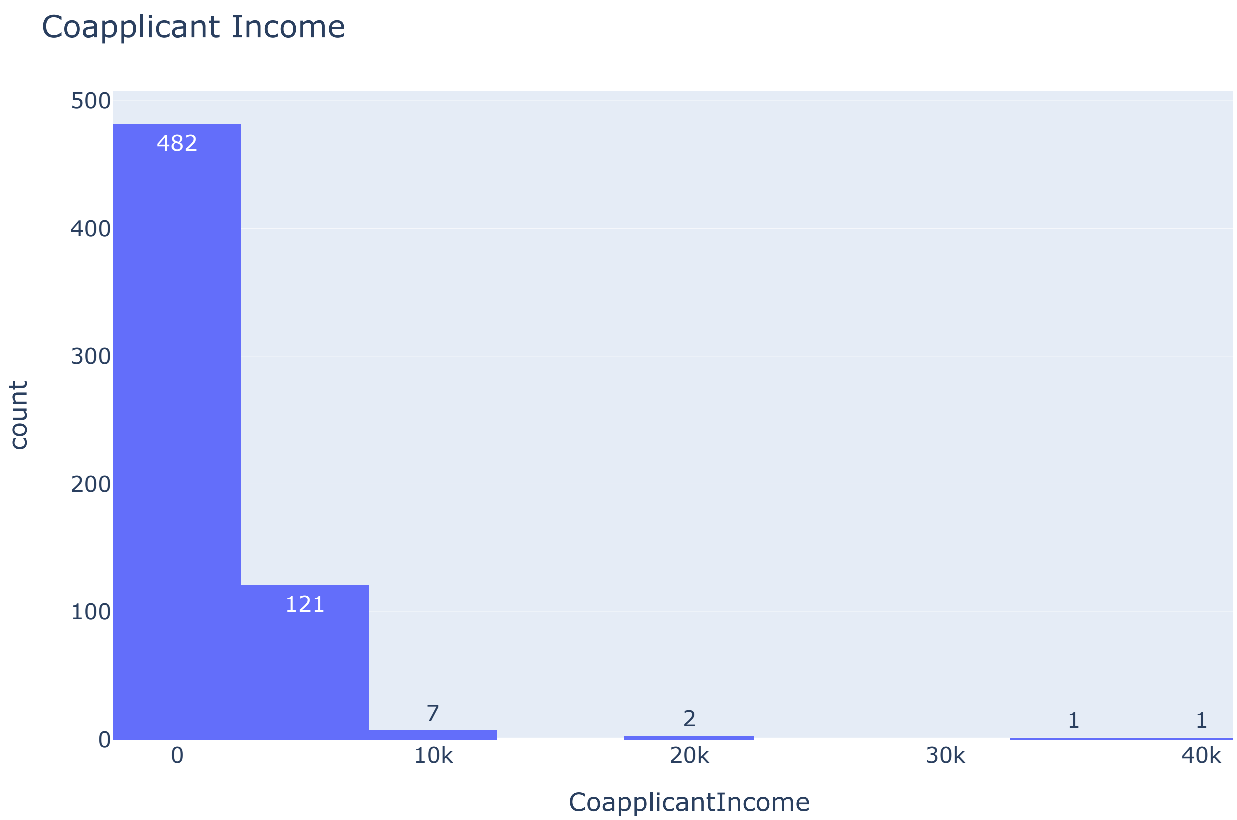
In [158]:
```
fig=px.box(data_frame=loan_data,x='ApplicantIncome')
fig.update_layout(width=800,height=500)
fig.show()
```



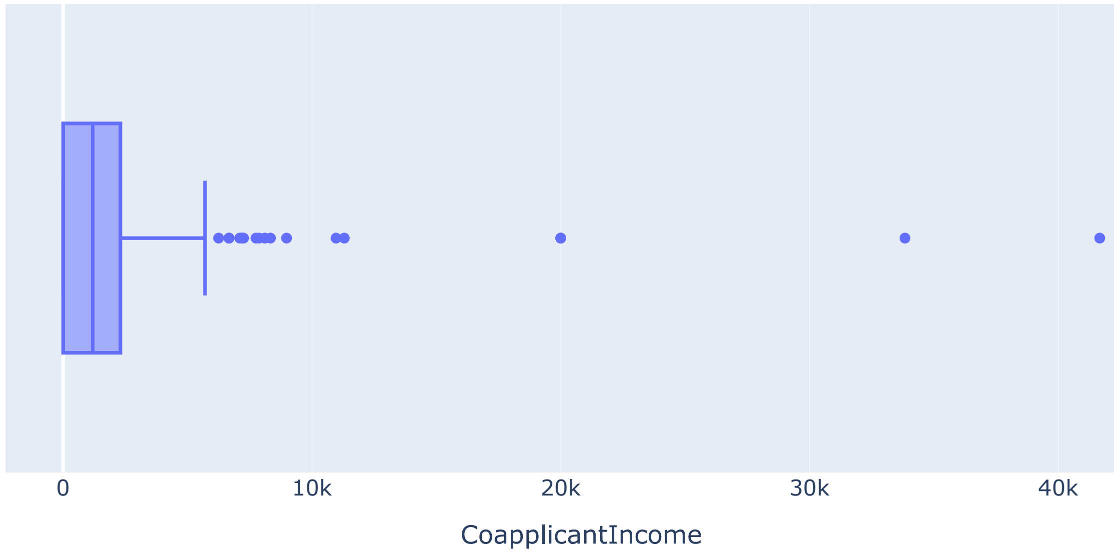
In [159]:
```
fig=px.box(data_frame=loan_data,x='ApplicantIncome',y='Education',orientation='h', color='E
fig.update_layout(title='Applicant Income',width=800,height=500)
fig.show()
```



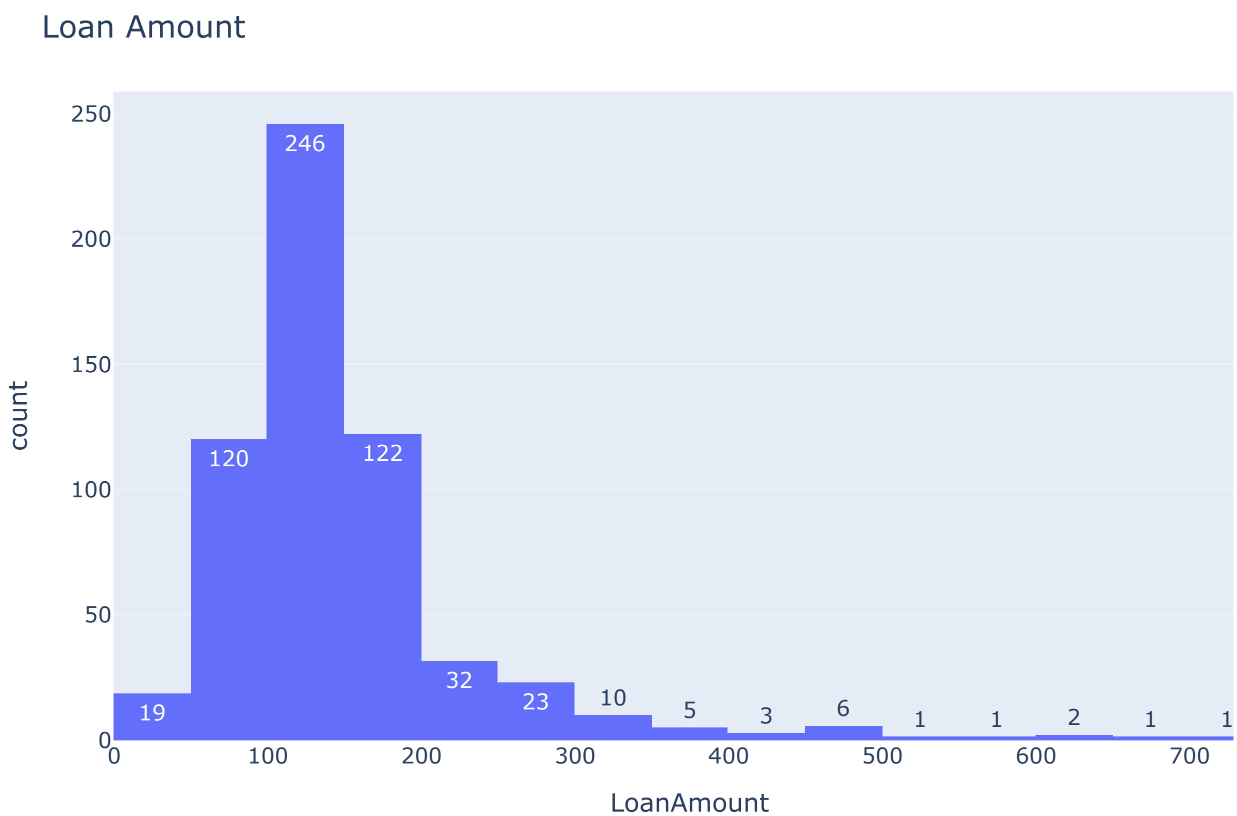
In [160]:
```
fig=px.histogram(data_frame=loan_data,x='CoapplicantIncome',text_auto=True,nbins=20)
fig.update_layout(title='Coapplicant Income',width=800,height=500)
fig.show()
```



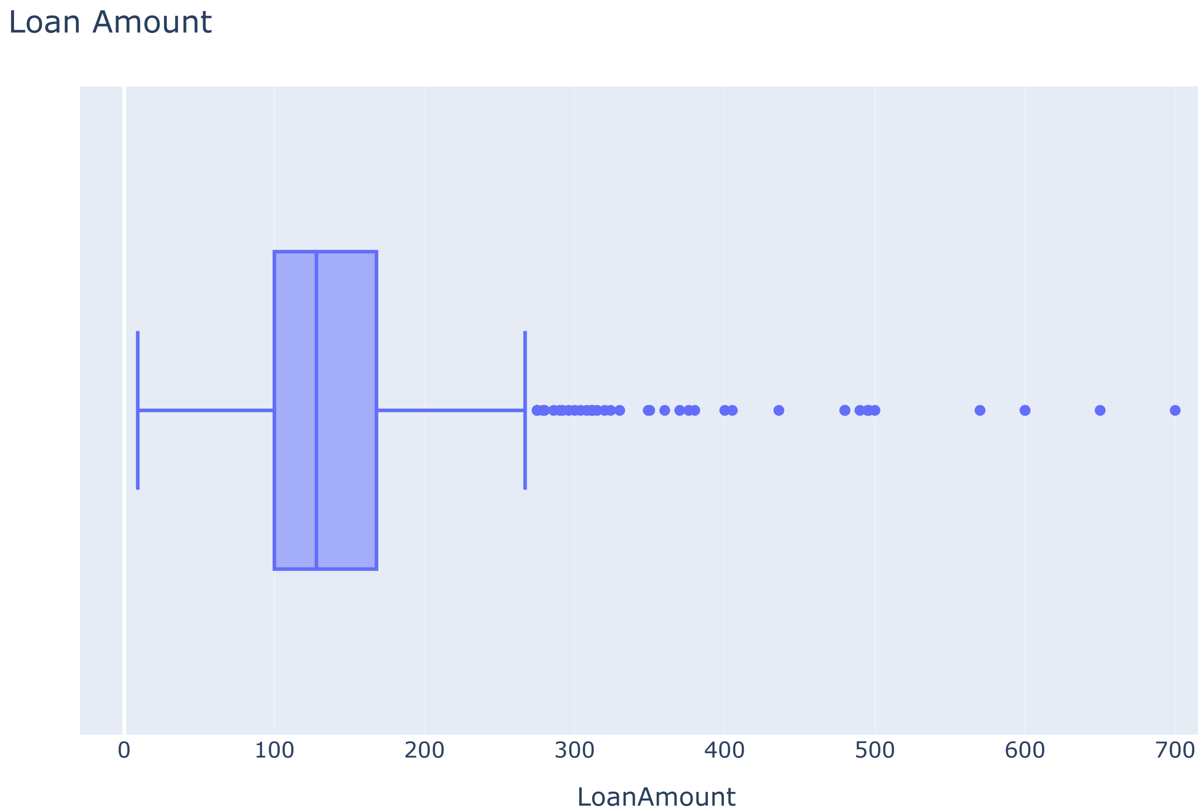
In [161]:
```
fig=px.box(data_frame=loan_data,x='CoapplicantIncome')
fig.update_layout(width=800,height=400)
fig.show()
```



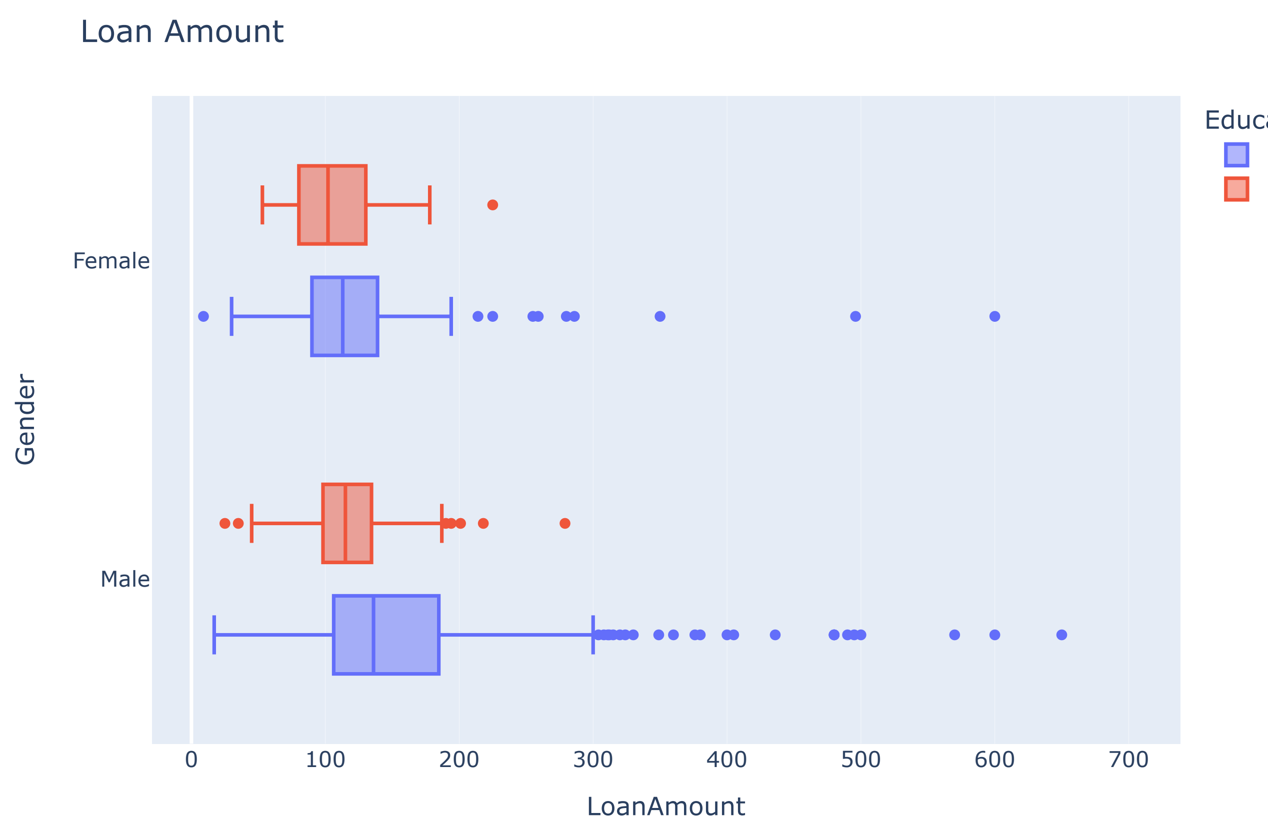
In [162]:
```
fig=px.histogram(data_frame=loan_data,x='LoanAmount',text_auto=True,nbins=20)
fig.update_layout(title='Loan Amount',width=800,height=500)
fig.show()
```



In [163]:
```
fig=px.box(data_frame=loan_data,x='LoanAmount',orientation='h', )
fig.update_layout(title='Loan Amount',width=800,height=500)
fig.show()
```



In [164]:
```
fig=px.box(data_frame=loan_data,x='LoanAmount',y='Gender',orientation='h', color='Education
fig.update_layout(title='Loan Amount',width=800,height=500)
fig.show()
```



In [165]:
```
Gender_vise_Loan_Status= loan_data.groupby(['Gender', 'Loan_Status']).size().reset_index(na
Gender_vise_Loan_Status
```

Out[165]:

	Gender	Loan_Status	Count
0	Female	N	37
1	Female	Y	75
2	Male	N	150
3	Male	Y	339

In [166]:
```
Married_vise_Loan_Status= loan_data.groupby(['Married', 'Loan_Status']).size().reset_index(
Married_vise_Loan_Status
```

Out[166]:

	Married	Loan_Status	Count
0	No	N	79
1	No	Y	134
2	Yes	N	113
3	Yes	Y	285

In [167]:
```
loan_data.dtypes
```

Out[167]:
```
Loan_ID               object
Gender                object
Married               object
Dependents            object
Education             object
Self_Employed         object
ApplicantIncome        int64
CoapplicantIncome    float64
LoanAmount           float64
Loan_Amount_Term     float64
Credit_History       float64
Property_Area         object
Loan_Status           object
dtype: object
```

In [168]:
```
Dependents_vise_Loan_Status= loan_data.groupby(['Dependents', 'Loan_Status']).size().reset_
Dependents_vise_Loan_Status
```

Out[168]:

	Dependents	Loan_Status	Count
0	0	N	107
1	0	Y	238
2	1	N	36
3	1	Y	66
4	2	N	25
5	2	Y	76
6	3+	N	18
7	3+	Y	33

In [169]:
```
Education_vise_Loan_Status= loan_data.groupby(['Education', 'Loan_Status']).size().reset_in
Education_vise_Loan_Status
```

Out[169]:

	Education	Loan_Status	Count
0	Graduate	N	140
1	Graduate	Y	340
2	Not Graduate	N	52
3	Not Graduate	Y	82

In [170]:
```
Self_Employed_vise_Loan_Status= loan_data.groupby(['Self_Employed', 'Loan_Status']).size().
Self_Employed_vise_Loan_Status
```

Out[170]:

	Self_Employed	Loan_Status	Count
0	No	N	157
1	No	Y	343
2	Yes	N	26
3	Yes	Y	56

In [171]:
```
Credit_History_vise_Loan_Status= loan_data.groupby(['Credit_History', 'Loan_Status']).size(
Credit_History_vise_Loan_Status
```

Out[171]:

	Credit_History	Loan_Status	Count
0	0.0	N	82
1	0.0	Y	7
2	1.0	N	97
3	1.0	Y	378

In [172]:
```
Property_Area_vise_Loan_Status= loan_data.groupby(['Property_Area', 'Loan_Status']).size().
Property_Area_vise_Loan_Status
```

Out[172]:

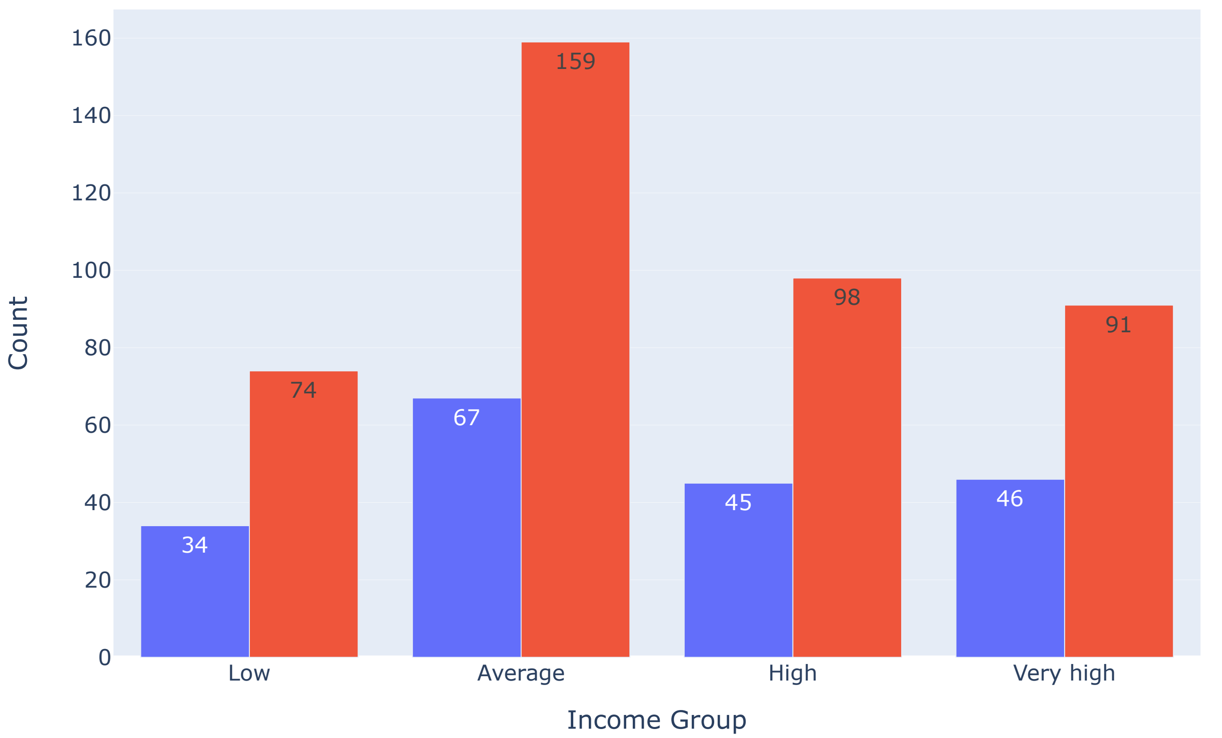
	Property_Area	Loan_Status	Count
0	Rural	N	69
1	Rural	Y	110
2	Semiurban	N	54
3	Semiurban	Y	179
4	Urban	N	69
5	Urban	Y	133

In [173]:
```
bins=[0,2500,4000,6000,81000]
group=['Low','Average','High','Very high']
loan_data['Income_Group']=pd.cut(loan_data['ApplicantIncome'],bins=bins,labels=group,includ
Income_Group_vise_Loan_Status= loan_data.groupby(['Income_Group', 'Loan_Status']).size().re
Income_Group_vise_Loan_Status
```

Out[173]:

	Income_Group	Loan_Status	Count
0	Low	N	34
1	Low	Y	74
2	Average	N	67
3	Average	Y	159
4	High	N	45
5	High	Y	98
6	Very high	N	46
7	Very high	Y	91

In [174]:
```
fig = px.bar(Income_Group_vise_Loan_Status,x='Income_Group',y='Count',color='Loan_Status',ba
fig.update_layout(xaxis_title='Income Group',yaxis_title='Count',width=800,height=500)
fig.show()
```

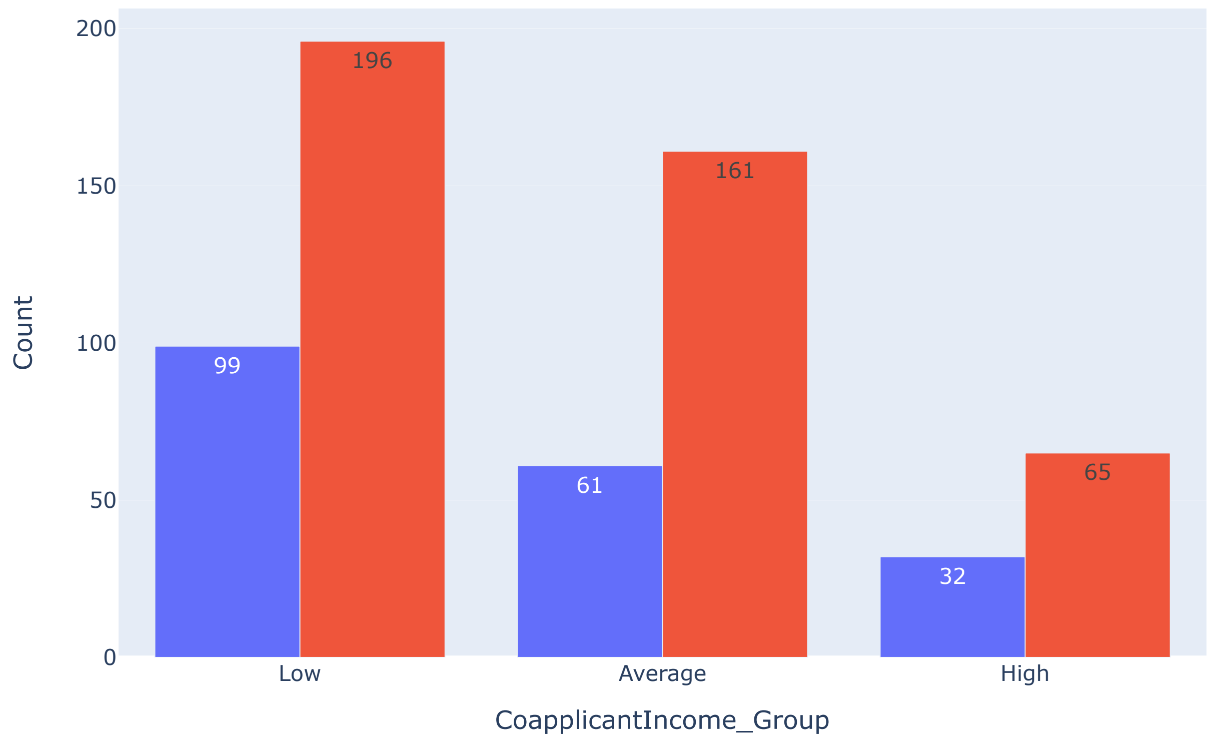


In [175]:
```
bins=[0,1000,3000,42000]
group=['Low','Average','High']
loan_data['CoapplicantIncome_Group']=pd.cut(loan_data['CoapplicantIncome'],bins=bins,labels
CoapplicantIncome_Group_vise_Loan_Status= loan_data.groupby(['CoapplicantIncome_Group', 'Lo
CoapplicantIncome_Group_vise_Loan_Status
```

Out[175]:

	CoapplicantIncome_Group	Loan_Status	Count
0	Low	N	99
1	Low	Y	196
2	Average	N	61
3	Average	Y	161
4	High	N	32
5	High	Y	65

In [176]:
```
fig = px.bar(CoapplicantIncome_Group_vise_Loan_Status,x='CoapplicantIncome_Group',y='Count'
fig.update_layout(xaxis_title='CoapplicantIncome_Group',yaxis_title='Count',width=800,heigh
fig.show()
```

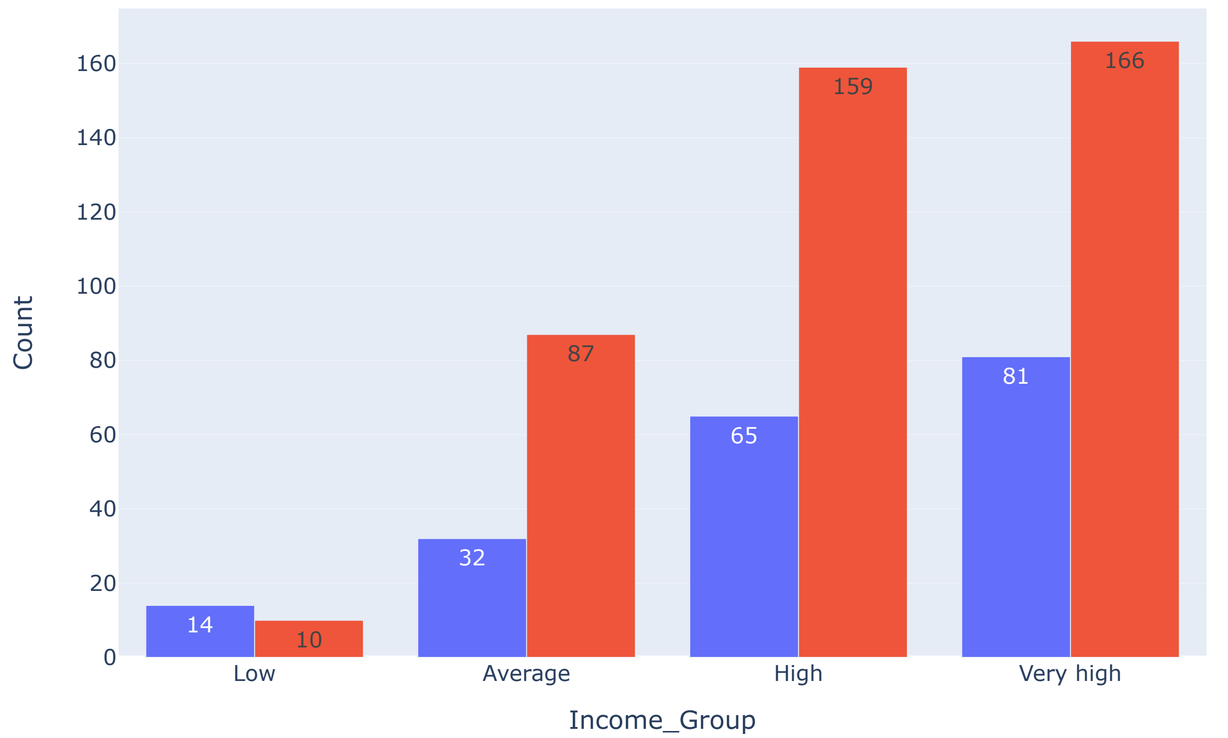


In [177]:
```
loan_data['Total_Income']=loan_data['ApplicantIncome']+loan_data['CoapplicantIncome']
bins=[0,2500,4000,6000,81000]
group=['Low','Average','High','Very high']
loan_data['Total_Income_Group']=pd.cut(loan_data['Total_Income'],bins=bins,labels=group,inc
Total_Income_Group_vise_Loan_Status= loan_data.groupby(['Total_Income_Group', 'Loan_Status'
Total_Income_Group_vise_Loan_Status
```

Out[177]:

	Total_Income_Group	Loan_Status	Count
0	Low	N	14
1	Low	Y	10
2	Average	N	32
3	Average	Y	87
4	High	N	65
5	High	Y	159
6	Very high	N	81
7	Very high	Y	166

In [178]:
```
fig = px.bar(Total_Income_Group_vise_Loan_Status,x='Total_Income_Group',y='Count',color='Lo
fig.update_layout(xaxis_title='Income_Group',yaxis_title='Count',width=800,height=500)
fig.show()
```

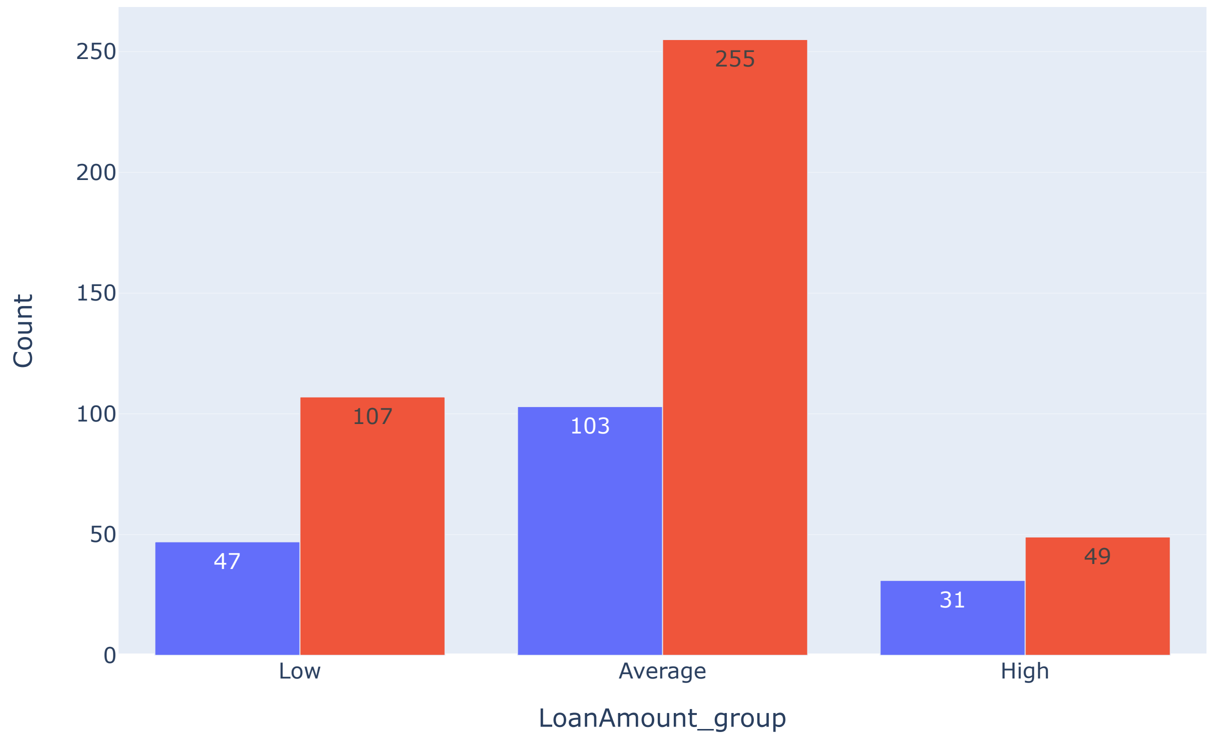


In [179]:
```
bins=[0,100,200,700]
group=['Low','Average','High']
loan_data['LoanAmount_group']=pd.cut(loan_data['LoanAmount'],bins,labels=group)
LoanAmount_group_vise_Loan_Status= loan_data.groupby(['LoanAmount_group', 'Loan_Status']).s
LoanAmount_group_vise_Loan_Status
```

Out[179]:

	LoanAmount_group	Loan_Status	Count
0	Low	N	47
1	Low	Y	107
2	Average	N	103
3	Average	Y	255
4	High	N	31
5	High	Y	49

In [180]:
```
fig = px.bar(LoanAmount_group_vise_Loan_Status,x='LoanAmount_group',y='Count',color='Loan_S
fig.update_layout(xaxis_title='LoanAmount_group',yaxis_title='Count',width=800,height=500)
fig.show()
```



In [181]:
```
loan_data=loan_data.drop(['Income_Group', 'CoapplicantIncome_Group',  'Total_Income_Group',
```

In [182]:
```
loan_data['Dependents'].replace('3+', 3,inplace=True)
loan_data['Loan_Status'].replace('N', 0,inplace=True)
loan_data['Loan_Status'].replace('Y', 1,inplace=True)
```

In [183]:
```
loan_data.head()
```

Out[183]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome	Loa
0	LP001002	Male	No	0	Graduate	No	5849	0.0	
1	LP001003	Male	Yes	1	Graduate	No	4583	1508.0	
2	LP001005	Male	Yes	0	Graduate	Yes	3000	0.0	
3	LP001006	Male	Yes	0	Not Graduate	No	2583	2358.0	
4	LP001008	Male	No	0	Graduate	No	6000	0.0	

In [184]:
```
Correlation=loan_data.corr(method='pearson')
print(Correlation)
```

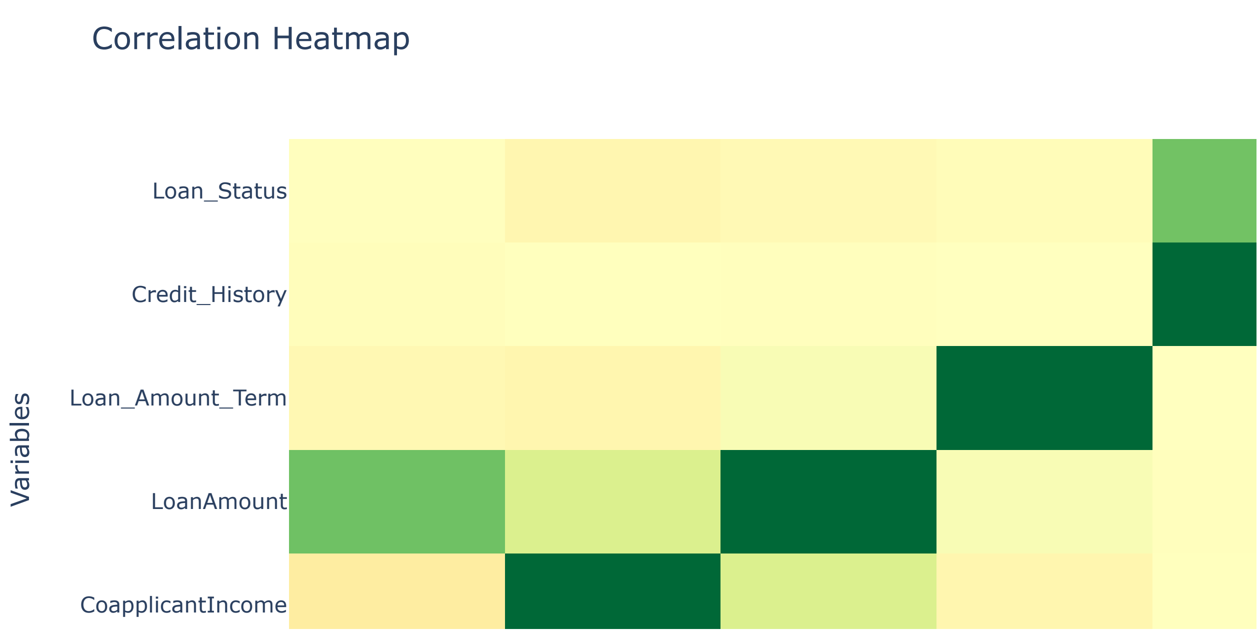
```
                   ApplicantIncome  CoapplicantIncome  LoanAmount  \
ApplicantIncome           1.000000          -0.116605    0.570909   
CoapplicantIncome        -0.116605           1.000000    0.188619   
LoanAmount                0.570909           0.188619    1.000000   
Loan_Amount_Term         -0.045306          -0.059878    0.039447   
Credit_History           -0.014715          -0.002056   -0.008433   
Loan_Status              -0.004710          -0.059187   -0.037318   

                   Loan_Amount_Term  Credit_History  Loan_Status  
ApplicantIncome           -0.045306       -0.014715    -0.004710  
CoapplicantIncome         -0.059878       -0.002056    -0.059187  
LoanAmount                 0.039447       -0.008433    -0.037318  
Loan_Amount_Term           1.000000        0.001470    -0.021268  
Credit_History             0.001470        1.000000     0.561678  
Loan_Status               -0.021268        0.561678     1.000000  

C:\Users\Suyash\AppData\Local\Temp\ipykernel_25672\4188836588.py:1: FutureWarning:

The default value of numeric_only in DataFrame.corr is deprecated. In a future version, it
will default to False. Select only valid columns or specify the value of numeric_only to s
ilence this warning.
```

In [185]:
```
fig=go.Figure(go.Heatmap(x=Correlation.columns,y=Correlation.columns,z=Correlation.values.t
fig.update_layout(title='Correlation Heatmap',xaxis_title='Variables',yaxis_title='Variable
fig.show()
```



In [186]:
```
loan_data.isnull().sum()
```

Out[186]:
```
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 [187]:
```
loan_data['Gender'].fillna(method='ffill', inplace=True)
```

In [188]:
```
loan_data['Dependents'].fillna( loan_data['Dependents'].mode()[0], inplace=True)
```

In [189]:
```
loan_data['Married'].fillna(loan_data['Married'].mode()[0], inplace=True)
```

In [190]:
```
loan_data['Self_Employed'].fillna(method='ffill', inplace=True)
```

In [191]:
```
loan_data['Credit_History'].fillna(method='bfill', inplace=True)
```

In [192]:
```
loan_data['LoanAmount'].fillna(loan_data['LoanAmount'].median(), inplace=True)
```

In [193]:
```
loan_data['Loan_Amount_Term'].fillna( loan_data['Loan_Amount_Term'].mode()[0], inplace=True
```

In [194]:
```
loan_data.isnull().sum()
```

Out[194]:
```
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 [195]:
```
loan_data.describe()
```

Out[195]:

	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term	Credit_History	Loan_Status
count	614.000000	614.000000	614.000000	614.000000	614.00000	614.000000
mean	5403.459283	1621.245798	145.752443	342.410423	0.84202	0.687296
std	6109.041673	2926.248369	84.107233	64.428629	0.36502	0.463973
min	150.000000	0.000000	9.000000	12.000000	0.00000	0.000000
25%	2877.500000	0.000000	100.250000	360.000000	1.00000	0.000000
50%	3812.500000	1188.500000	128.000000	360.000000	1.00000	1.000000
75%	5795.000000	2297.250000	164.750000	360.000000	1.00000	1.000000
max	81000.000000	41667.000000	700.000000	480.000000	1.00000	1.000000

In [196]:
```
loan_data
```

Out[196]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome	L
0	LP001002	Male	No	0	Graduate	No	5849	0.0	
1	LP001003	Male	Yes	1	Graduate	No	4583	1508.0	
2	LP001005	Male	Yes	0	Graduate	Yes	3000	0.0	
3	LP001006	Male	Yes	0	Not Graduate	No	2583	2358.0	
4	LP001008	Male	No	0	Graduate	No	6000	0.0	
...	...	...	...	...	...	...	...	...	
609	LP002978	Female	No	0	Graduate	No	2900	0.0	
610	LP002979	Male	Yes	3	Graduate	No	4106	0.0	
611	LP002983	Male	Yes	1	Graduate	No	8072	240.0	
612	LP002984	Male	Yes	2	Graduate	No	7583	0.0	
613	LP002990	Female	No	0	Graduate	Yes	4583	0.0	

614 rows × 13 columns

In [197]:
```
loan_data['NormLoanAmount']=np.log(loan_data['LoanAmount'])
```

In [198]:
```
loan_data
```

Out[198]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome	L
0	LP001002	Male	No	0	Graduate	No	5849	0.0	
1	LP001003	Male	Yes	1	Graduate	No	4583	1508.0	
2	LP001005	Male	Yes	0	Graduate	Yes	3000	0.0	
3	LP001006	Male	Yes	0	Not Graduate	No	2583	2358.0	
4	LP001008	Male	No	0	Graduate	No	6000	0.0	
...	...	...	...	...	...	...	...	...	
609	LP002978	Female	No	0	Graduate	No	2900	0.0	
610	LP002979	Male	Yes	3	Graduate	No	4106	0.0	
611	LP002983	Male	Yes	1	Graduate	No	8072	240.0	
612	LP002984	Male	Yes	2	Graduate	No	7583	0.0	
613	LP002990	Female	No	0	Graduate	Yes	4583	0.0	

614 rows × 14 columns

In [199]:
```
loan_data=loan_data.drop('Loan_ID',axis=1)
```

In [200]:
```
X = loan_data.drop(labels='Loan_Status',axis=1)
Y = loan_data['Loan_Status']
```

In [201]:
```
X
```

Out[201]:

	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome	LoanAmount
0	Male	No	0	Graduate	No	5849	0.0	128.0
1	Male	Yes	1	Graduate	No	4583	1508.0	128.0
2	Male	Yes	0	Graduate	Yes	3000	0.0	66.0
3	Male	Yes	0	Not Graduate	No	2583	2358.0	120.0
4	Male	No	0	Graduate	No	6000	0.0	141.0
...	...	...	...	...	...	...	...	...
609	Female	No	0	Graduate	No	2900	0.0	71.0
610	Male	Yes	3	Graduate	No	4106	0.0	40.0
611	Male	Yes	1	Graduate	No	8072	240.0	253.0
612	Male	Yes	2	Graduate	No	7583	0.0	187.0
613	Female	No	0	Graduate	Yes	4583	0.0	133.0

614 rows × 12 columns

In [202]:
```
Y
```

Out[202]:
```
0      1
1      0
2      1
3      1
4      1
      ..
609    1
610    1
611    1
612    1
613    0
Name: Loan_Status, Length: 614, dtype: int64
```

In [203]:
```
columns = X.columns

cat_col= [col for col in X.columns if X[col].dtypes=='O']
cat_col
```

Out[203]:
```
['Gender',
 'Married',
 'Dependents',
 'Education',
 'Self_Employed',
 'Property_Area']
```

In [204]:
```
dummy = pd.get_dummies(X[cat_col])
dummy.shape
```

Out[204]:
```
(614, 15)
```

In [205]:
```
dummy
```

Out[205]:

	Gender_Female	Gender_Male	Married_No	Married_Yes	Dependents_3	Dependents_0	Dependents_1	Deper
0	0	1	1	0	0	1	0	
1	0	1	0	1	0	0	1	
2	0	1	0	1	0	1	0	
3	0	1	0	1	0	1	0	
4	0	1	1	0	0	1	0	
...	...	...	...	...	...	...	...	
609	1	0	1	0	0	1	0	
610	0	1	0	1	1	0	0	
611	0	1	0	1	0	0	1	
612	0	1	0	1	0	0	0	
613	1	0	1	0	0	1	0	

614 rows × 15 columns

In [206]:
```
final = pd.concat([X,dummy],axis=1)
final.shape
```

Out[206]: (614, 27)

In [207]:
```
final.drop(cat_col,inplace=True,axis=1)
```

In [208]:
```
final.shape
```

Out[208]: (614, 21)

In [209]:
```
final
```

Out[209]:

	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term	Credit_History	NormLoanAmount	G
0	5849	0.0	128.0	360.0	1.0	4.852030	
1	4583	1508.0	128.0	360.0	1.0	4.852030	
2	3000	0.0	66.0	360.0	1.0	4.189655	
3	2583	2358.0	120.0	360.0	1.0	4.787492	
4	6000	0.0	141.0	360.0	1.0	4.948760	
...	...	...	...	...	...	...	
609	2900	0.0	71.0	360.0	1.0	4.262680	
610	4106	0.0	40.0	180.0	1.0	3.688879	
611	8072	240.0	253.0	360.0	1.0	5.533389	
612	7583	0.0	187.0	360.0	1.0	5.231109	
613	4583	0.0	133.0	360.0	0.0	4.890349	

614 rows × 21 columns

In [210]:
```
X=final
X
```

Out[210]:

	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term	Credit_History	NormLoanAmount	G
0	5849	0.0	128.0	360.0	1.0	4.852030	
1	4583	1508.0	128.0	360.0	1.0	4.852030	
2	3000	0.0	66.0	360.0	1.0	4.189655	
3	2583	2358.0	120.0	360.0	1.0	4.787492	
4	6000	0.0	141.0	360.0	1.0	4.948760	
...	...	...	...	...	...	...	
609	2900	0.0	71.0	360.0	1.0	4.262680	
610	4106	0.0	40.0	180.0	1.0	3.688879	
611	8072	240.0	253.0	360.0	1.0	5.533389	
612	7583	0.0	187.0	360.0	1.0	5.231109	
613	4583	0.0	133.0	360.0	0.0	4.890349	

614 rows × 21 columns

In [211]:
```
Y
```

Out[211]:
```
0      1
1      0
2      1
3      1
4      1
      ..
609    1
610    1
611    1
612    1
613    0
Name: Loan_Status, Length: 614, dtype: int64
```

In [212]:
```
x_train,x_test,y_train,y_test = train_test_split(X,Y, test_size = 0.2)
```

LogisticRegression

In [213]:
```
clf = LogisticRegression()
```

In [214]:
```
x_train.shape,x_test.shape
```

Out[214]:
```
((491, 21), (123, 21))
```

In [215]:
```
clf.fit(x_train,y_train)
```

```
D:\New folder\Lib\site-packages\sklearn\linear_model\_logistic.py:460: 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://scikit-learn.org/s
table/modules/preprocessing.html)
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (http
s://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)
```

Out[215]:
```
▾ LogisticRegression
LogisticRegression()
```

In [216]:
```
pred = clf.predict(x_test)
```

In [217]:
```
pred
```

Out[217]:
```
array([1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1,
       0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1,
       1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 1,
       1, 0, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0], dtype=int64)
```

In [218]:
```
accuracy_score(y_test,pred)
```

Out[218]:
```
0.7560975609756098
```

In [219]:
```
f1_score(y_test,pred)
```

Out[219]:
```
0.8295454545454545
```

In [220]:
```
precision_score(y_test,pred)
```

Out[220]:
```
0.73
```

In [221]:
```
recall_score(y_test,pred)
```

Out[221]:
```
0.9605263157894737
```

In [222]:
```
confusion_matrix(y_test,pred)
```

Out[222]:
```
array([[20, 27],
       [ 3, 73]], dtype=int64)
```

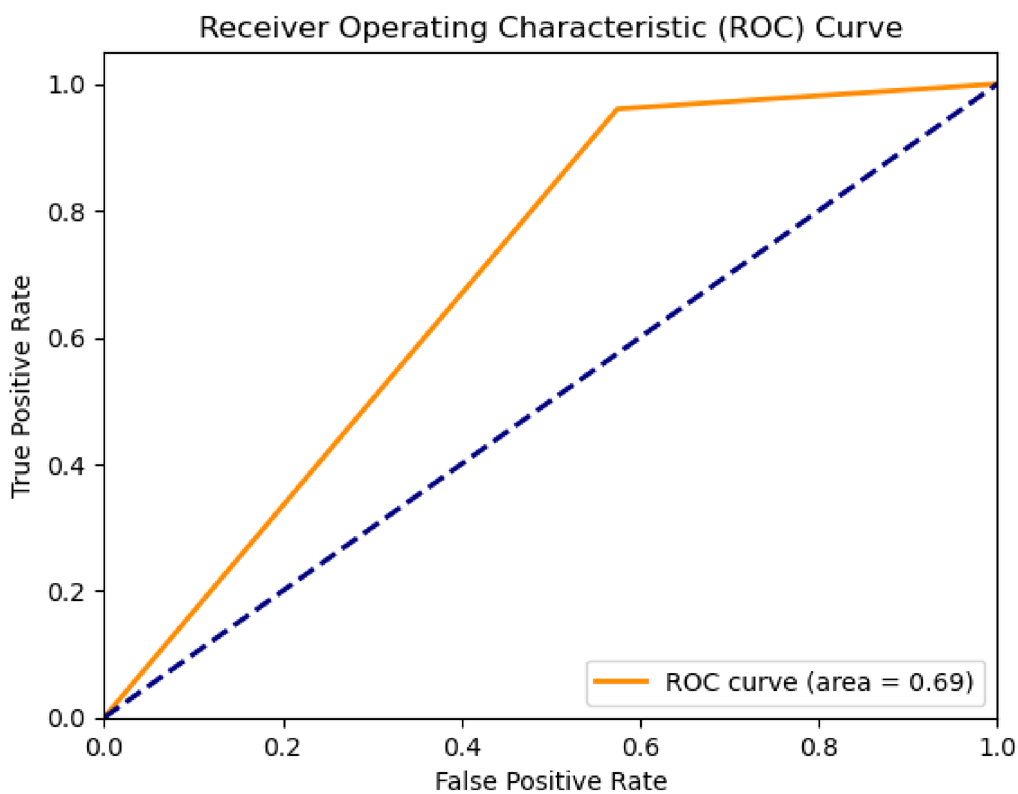
In [223]:
```
from sklearn.metrics import roc_curve, auc
import matplotlib.pyplot as plt
```

In [224]:
```
fpr, tpr, thresholds = roc_curve(y_test,pred)
```

In [225]:
```
roc_auc = auc(fpr, tpr)
print("ROC AUC:", roc_auc)
```

```
ROC AUC: 0.6930291153415453
```

In [226]:
```
plt.figure()
lw = 2
plt.plot(fpr, tpr, color='darkorange',
         lw=lw, label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', lw=lw, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curve')
plt.legend(loc="lower right")
plt.show()
```



Dicision_Tree

In [227]:
```
dct=tree.DecisionTreeClassifier()
```

In [228]:
```
dct.fit(x_train,y_train)
```

Out[228]:
```
▾ DecisionTreeClassifier
DecisionTreeClassifier()
```

In [229]:
```
pred = dct.predict(x_test)
```

In [230]:
```
pred
```

Out[230]:
```
array([1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 1,
       1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1, 1,
       1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1,
       1, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 1, 1,
       1, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1,
       1, 1, 1, 1, 0, 1, 1, 1, 1, 0, 0, 0, 0], dtype=int64)
```

In [231]:
```
accuracy_score(y_test,pred)
```

Out[231]:
```
0.6422764227642277
```

In [232]:
```
f1_score(y_test,pred)
```

Out[232]:
```
0.725
```

In [233]:
```
precision_score(y_test,pred)
```

Out[233]:
```
0.6904761904761905
```

In [234]:
```
recall_score(y_test,pred)
```

Out[234]:
```
0.7631578947368421
```

In [235]:
```
confusion_matrix(y_test,pred)
```

Out[235]:
```
array([[21, 26],
       [18, 58]], dtype=int64)
```

In [236]:
```
roc_auc_score(y_test,pred)
```

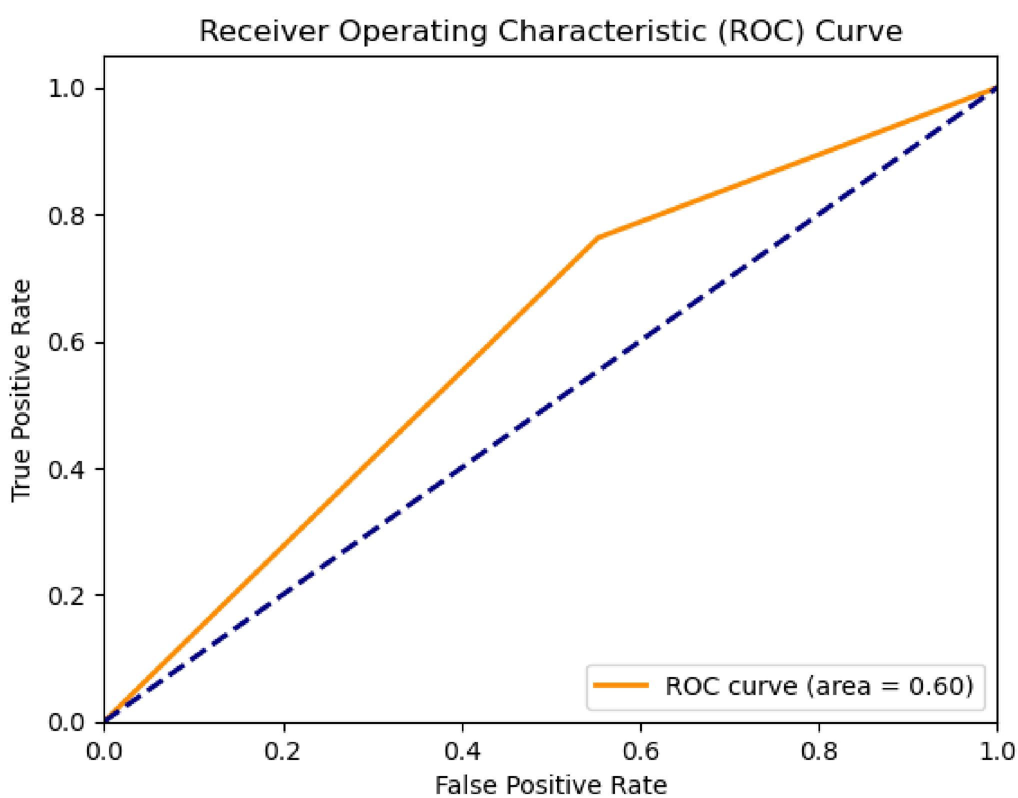
Out[236]:
```
0.6049832026875699
```

In [237]:
```
import matplotlib.pyplot as plt

from sklearn.metrics import RocCurveDisplay
```

In [238]:
```
fpr, tpr, thresholds = roc_curve(y_test,pred)
roc_auc = auc(fpr, tpr)
print("ROC AUC:", roc_auc)
plt.figure()
lw = 2
plt.plot(fpr, tpr, color='darkorange',
         lw=lw, label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', lw=lw, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curve')
plt.legend(loc="lower right")
plt.show()
```

```
ROC AUC: 0.6049832026875699
```



In [ ]:

In [ ]:

Random Forest

In [239]:
```
rfc=RandomForestClassifier()
```

In [240]:
```
rfc.fit(x_train,y_train)
```

Out[240]:
```
▾ RandomForestClassifier
RandomForestClassifier()
```

In [241]:
```
pred=rfc.predict(x_test)
```

In [242]:
```
accuracy_score(y_test,pred)
```

Out[242]:
```
0.7398373983739838
```

In [243]:
```
precision_score(y_test,pred)
```

Out[243]:
```
0.72
```

In [244]:
```
recall_score(y_test,pred)
```

Out[244]:
```
0.9473684210526315
```

In [245]:
```
f1_score(y_test,pred)
```

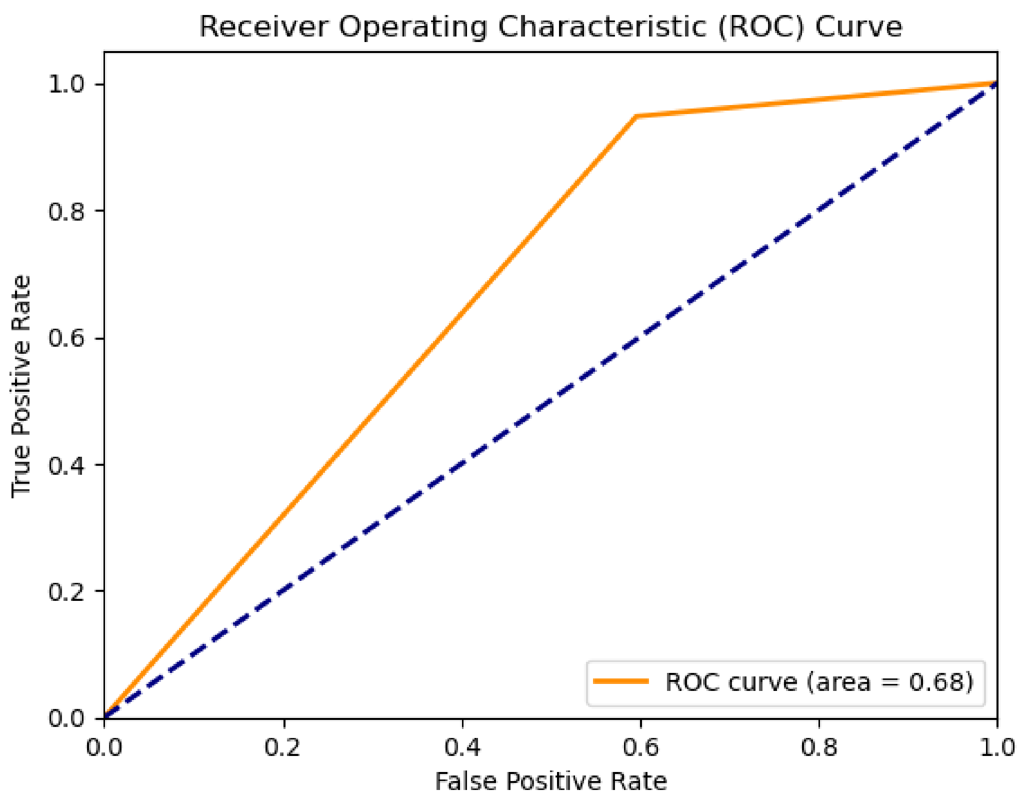
Out[245]:
```
0.8181818181818181
```

In [246]:
```
confusion_matrix(y_test,pred)
```

Out[246]:
```
array([[19, 28],
       [ 4, 72]], dtype=int64)
```

In [247]:
```
fpr, tpr, thresholds = roc_curve(y_test,pred)
roc_auc = auc(fpr, tpr)
print("ROC AUC:", roc_auc)
plt.figure()
lw = 2
plt.plot(fpr, tpr, color='darkorange',
         lw=lw, label='ROC curve (area = %0.2f)' % roc_auc)
plt.plot([0, 1], [0, 1], color='navy', lw=lw, linestyle='--')
plt.xlim([0.0, 1.0])
plt.ylim([0.0, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver Operating Characteristic (ROC) Curve')
plt.legend(loc="lower right")
plt.show()
```

```
ROC AUC: 0.6758118701007838
```



In [ ]:

In [ ]:

In [ ]:

In [ ]: