In [1]:

```
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_matr
from sklearn import tree
from sklearn.metrics import roc_auc_score
```

In [2]:

```
loan_data=pd.read_csv("loan_data.csv")
```

In [3]:

```
loan_data
```

Out[3]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapplic
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	
...	...	...	...	...	...	...	...	
609	LP002978	Female	No	0	Graduate	No	2900	
610	LP002979	Male	Yes	3+	Graduate	No	4106	
611	LP002983	Male	Yes	1	Graduate	No	8072	
612	LP002984	Male	Yes	2	Graduate	No	7583	
613	LP002990	Female	No	0	Graduate	Yes	4583	

614 rows × 13 columns

In [4]:
```
loan_data.head()
```

Out[4]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapplican
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 [5]:
```
loan_data.isnull().sum()
```

Out[5]:
```
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 [6]:
```
loan_data.dtypes
```

Out[6]:
```
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 [7]:

```
loan_data.nunique()
```

Out[7]:

```
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 [8]:

```
loan_data.isnull().sum()
```

Out[8]:

```
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 [9]:

```
loan_data['Loan_Status'].value_counts()
```

Out[9]:

```
Y    422
N    192
Name: Loan_Status, dtype: int64
```

In [10]:

```
loan_data['Credit_History'].value_counts()
```

Out[10]:

```
1.0    475
0.0     89
Name: Credit_History, dtype: int64
```

In [11]:

```
loan_data['Dependents'].value_counts()
```

Out[11]:

```
0     345
1     102
2     101
3+     51
Name: Dependents, dtype: int64
```

In [12]:

```
loan_data['Gender'].value_counts()
```

Out[12]:

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

In [13]:

```
loan_data['Loan_Amount_Term'].value_counts()
```

Out[13]:

```
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 [14]:

```
loan_data['Self_Employed'].value_counts()
```

Out[14]:

```
No     500
Yes     82
Name: Self_Employed, dtype: int64
```

In [15]:

```
loan_data['Gender'].value_counts()
```

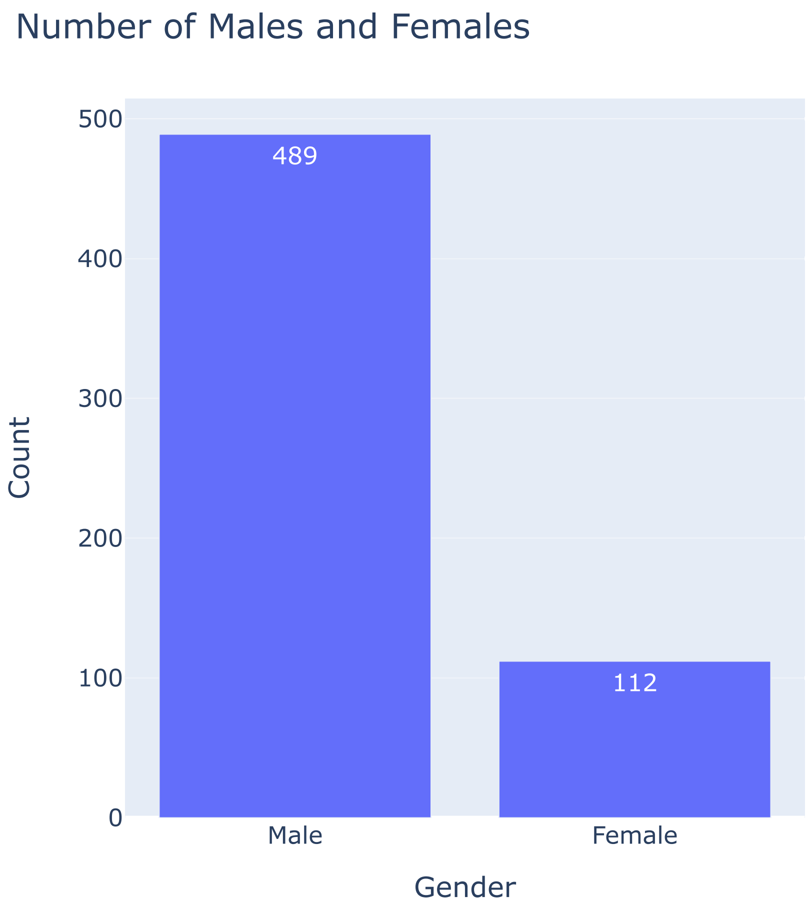
Out[15]:

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

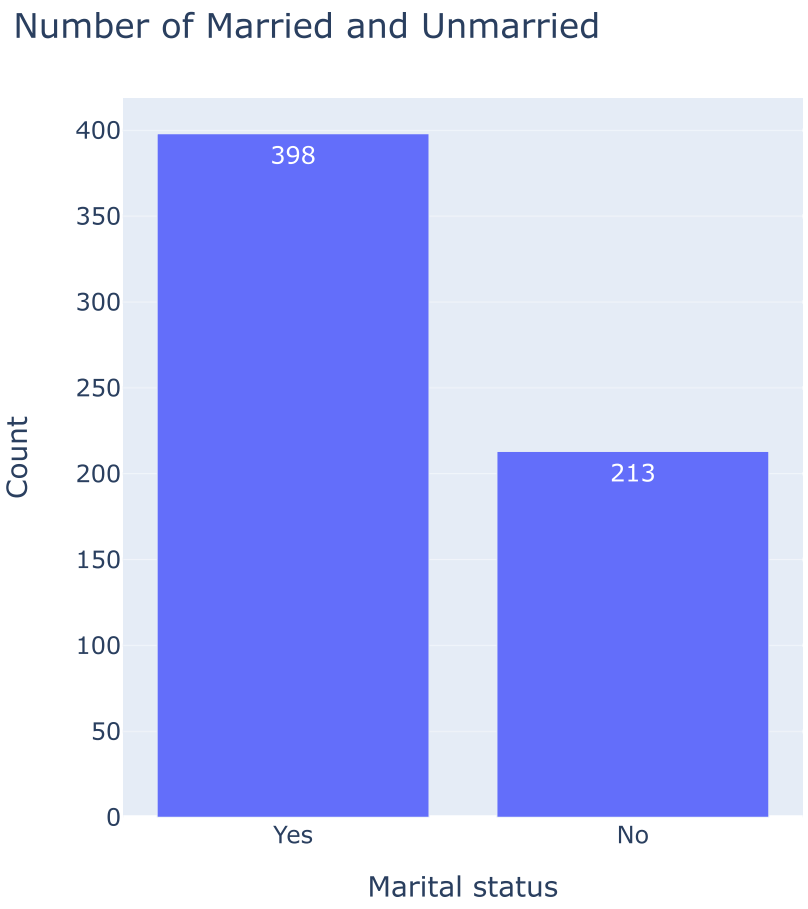
In [ ]:

In [16]:

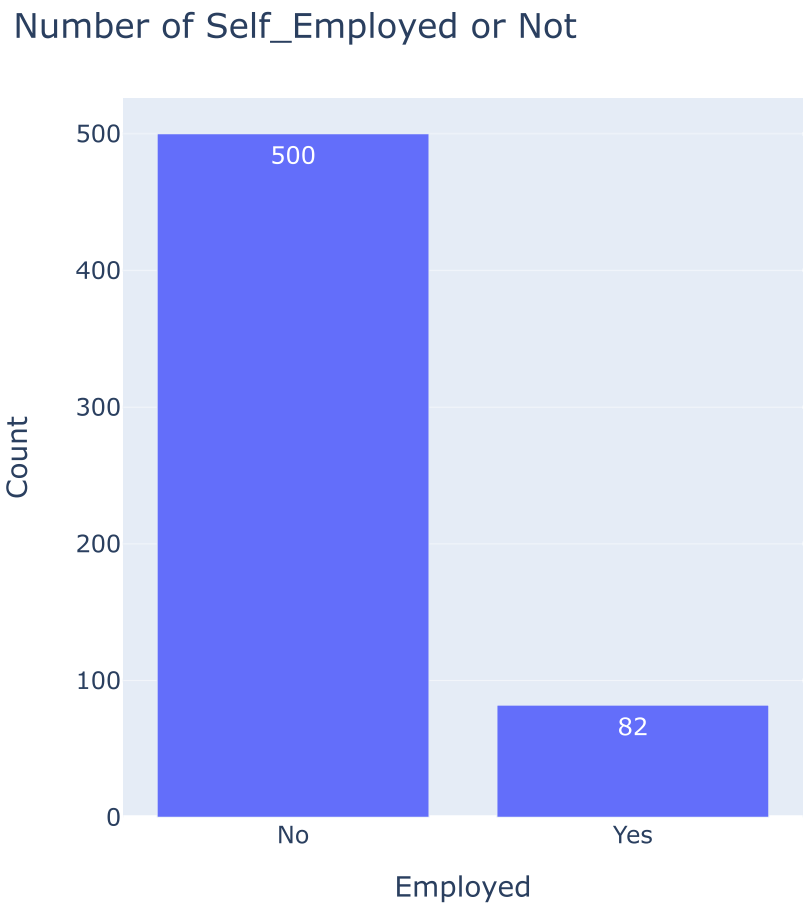
```
fig = px.bar(data_frame=loan_data, x=loan_data['Gender'].value_counts().index, y=
fig.update_layout(title='Number of Males and Females',xaxis_title='Gender',yaxis_
fig.show()
```



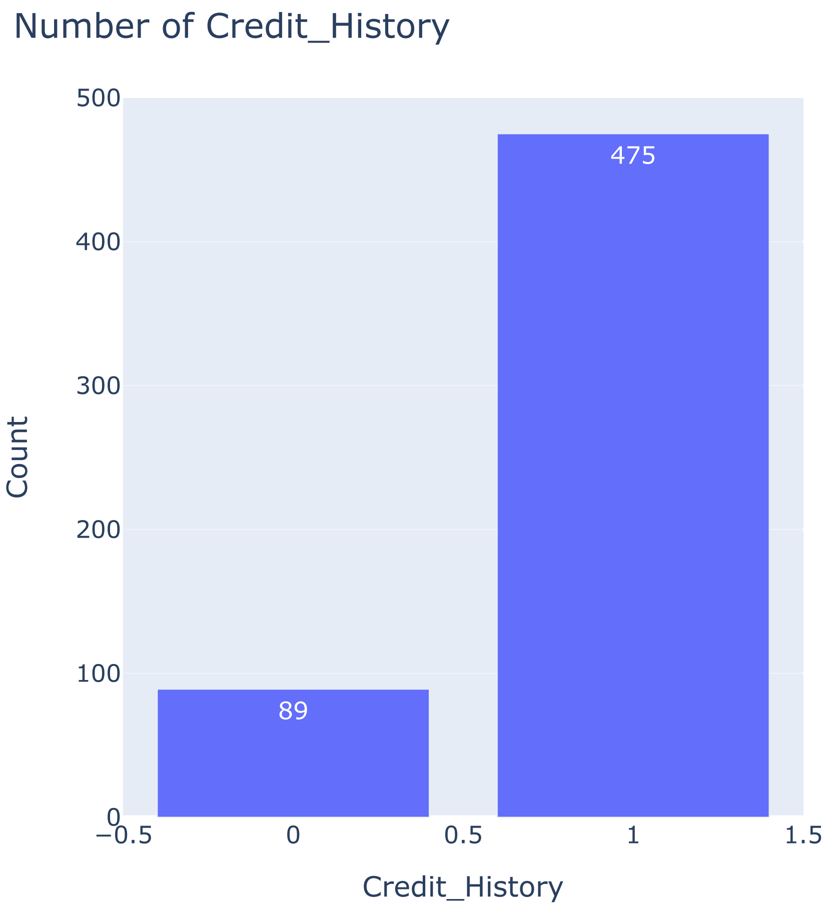
In [17]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Married'].value_counts().index, y
fig.update_layout(title='Number of Married and Unmarried',xaxis_title='Marital st
fig.show()
```



In [18]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Self_Employed'].value_counts().ir
fig.update_layout(title='Number of Self_Employed or Not',xaxis_title='Employed',y
fig.show()
```



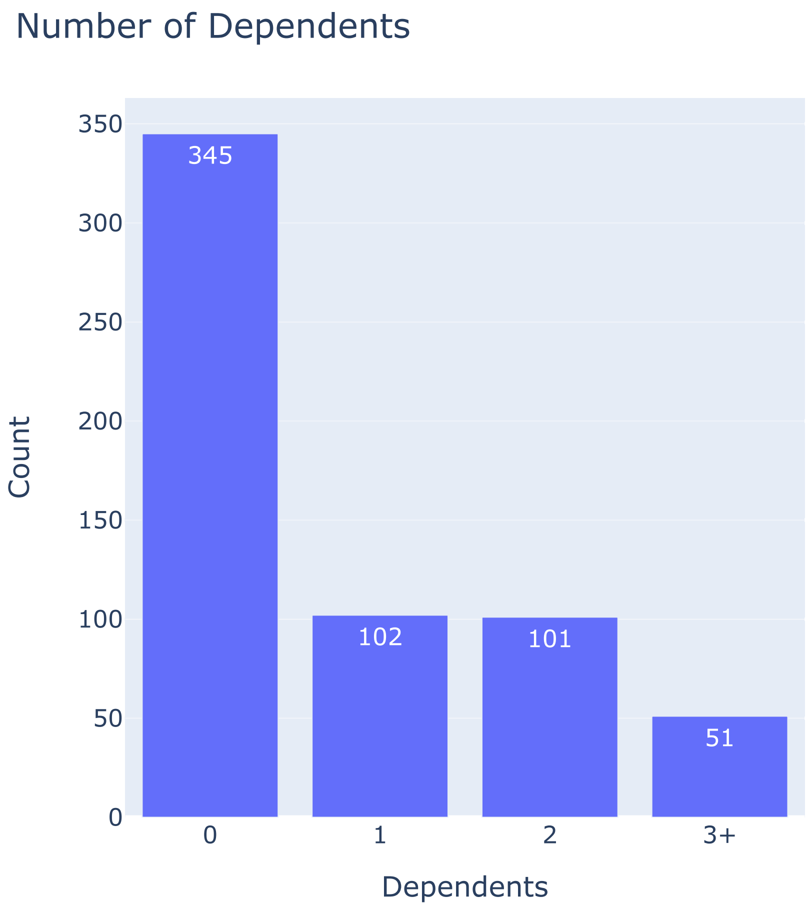
In [19]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Credit_History'].value_counts().i
fig.update_layout(title='Number of Credit_History',xaxis_title='Credit_History',y
fig.show()
```



In [20]:
```
loan_data.dtypes
```

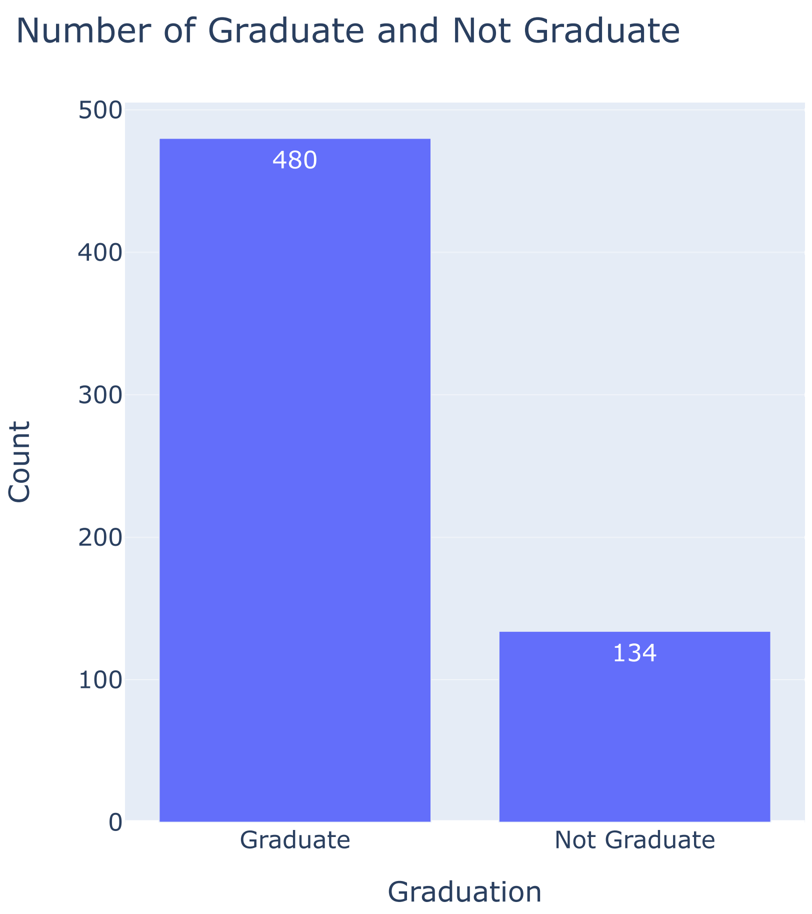
Out[20]:
```
Loan_ID               object
Gender                object
Married               object
Dependents            object
Education             object
Self_Employed         object
ApplicantIncome        int64
CoapplicantIncome    float64
LoanAmount           float64
Loan_Amount_Term     float64
Credit_History       float64
Property_Area         object
Loan_Status           object
dtype: object
```

In [21]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Dependents'].value_counts().index
fig.update_layout(title='Number of Dependents',xaxis_title='Dependents',yaxis_tit
fig.show()
```



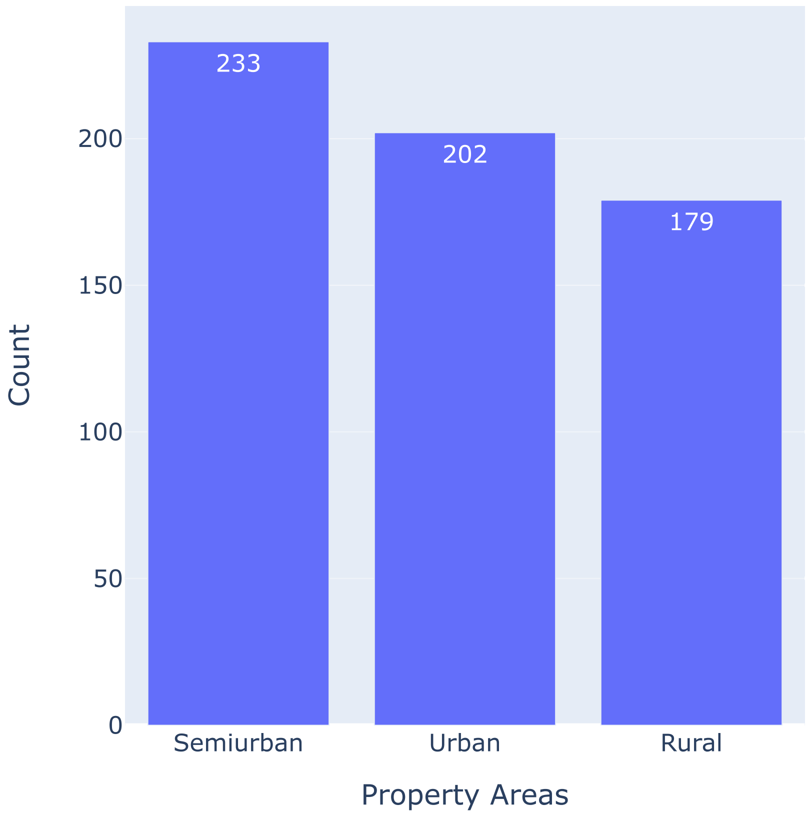
Number of Dependents

In [22]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Education'].value_counts().index,
fig.update_layout(title='Number of Graduate and Not Graduate',xaxis_title='Gradua
fig.show()
```

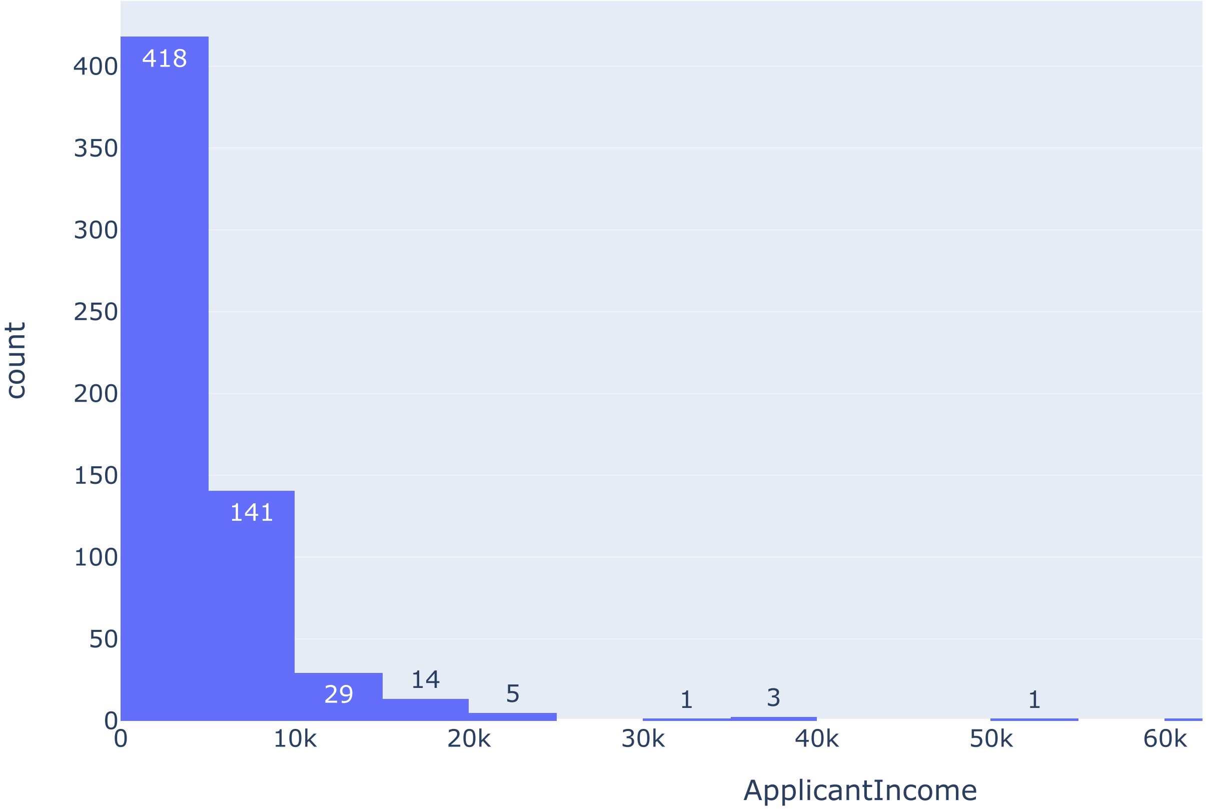


In [23]:
```
fig = px.bar(data_frame=loan_data, x=loan_data['Property_Area'].value_counts().ir
fig.update_layout(title='Number of Property Areas',xaxis_title='Property Areas',y
fig.show()
```

Number of Property Areas

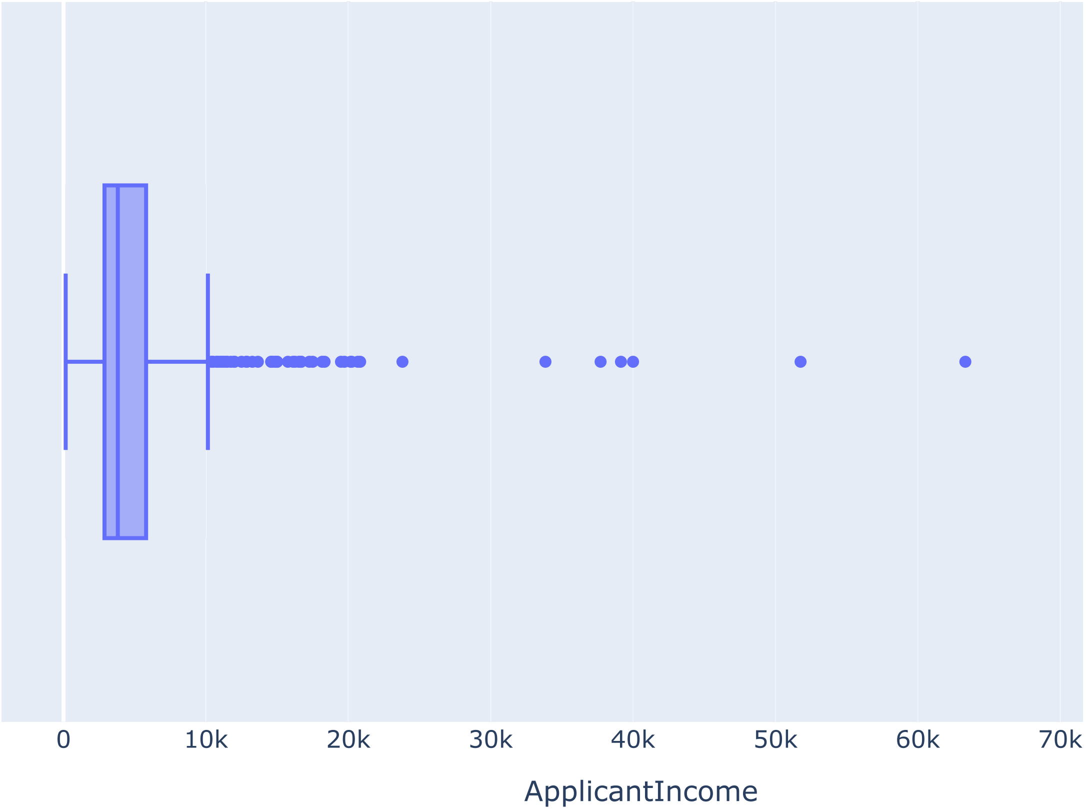


In [24]:
```
fig=px.histogram(data_frame=loan_data,x='ApplicantIncome',text_auto=True,nbins=20
fig.update_layout(width=900,height=500)
fig.show()
```

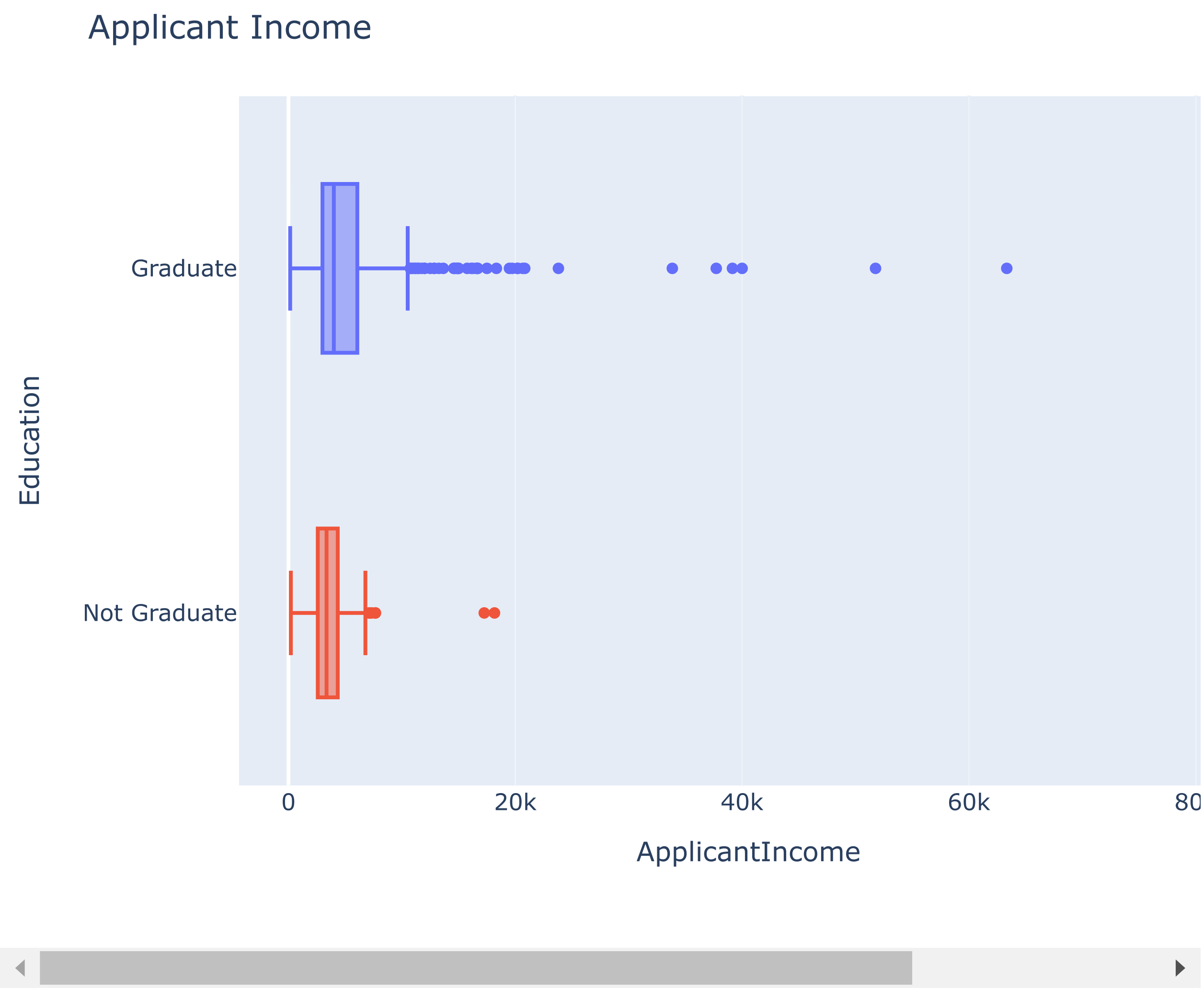


In [25]:

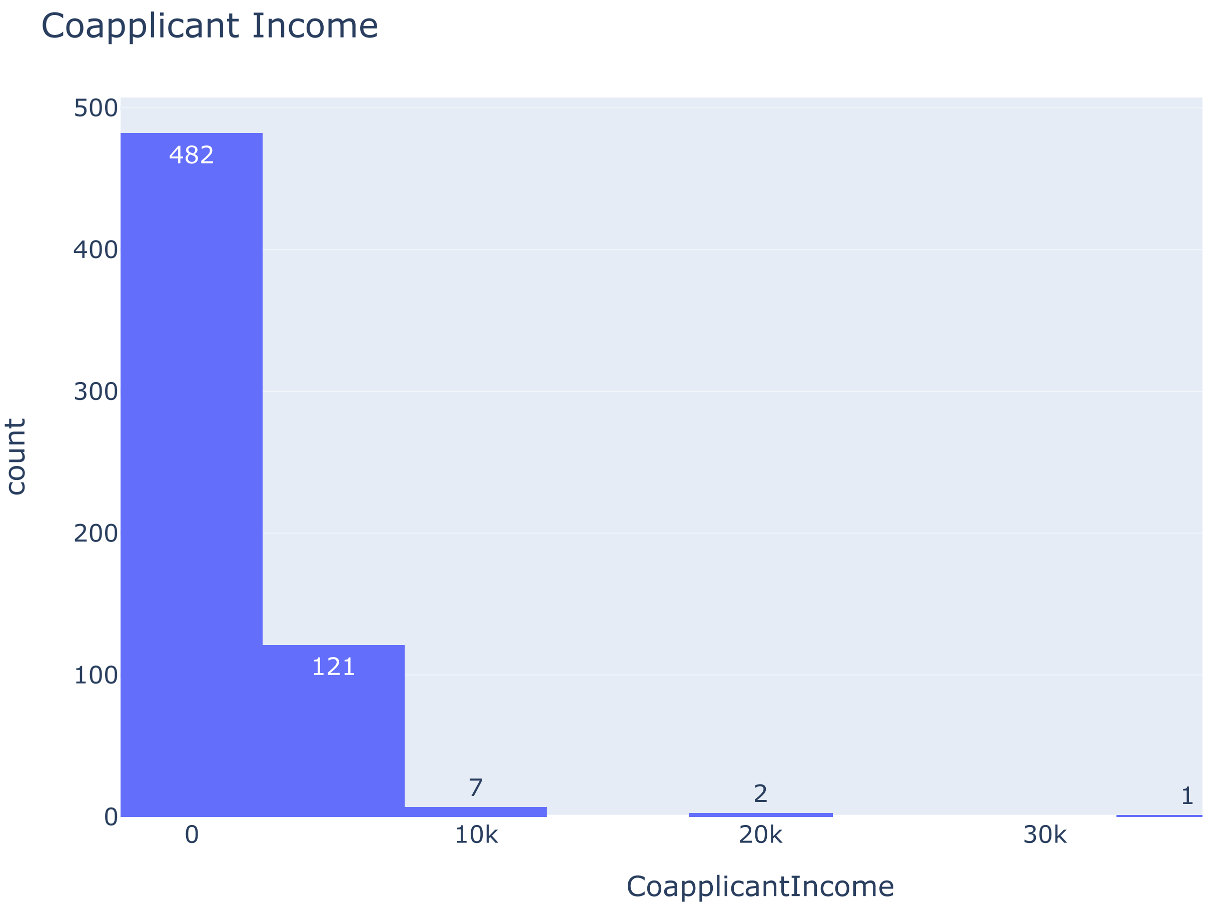
```
fig=px.box(data_frame=loan_data,x='ApplicantIncome')
fig.update_layout(width=800,height=500)
fig.show()
```



In [26]:
```
fig=px.box(data_frame=loan_data,x='ApplicantIncome',y='Education',orientation='h'
fig.update_layout(title='Applicant Income',width=800,height=500)
fig.show()
```

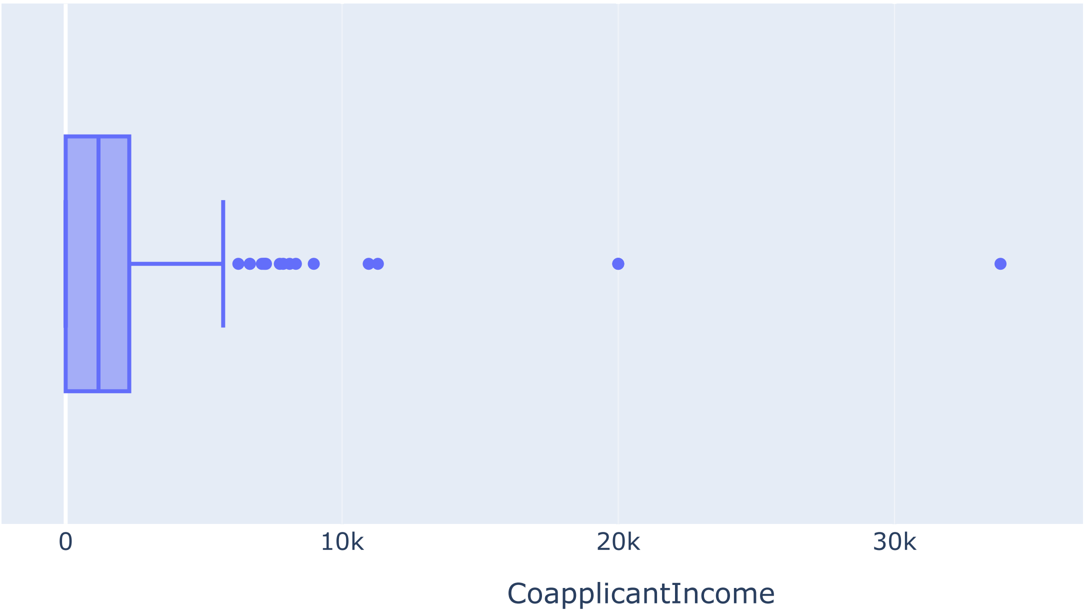


In [27]:
```
fig=px.histogram(data_frame=loan_data,x='CoapplicantIncome',text_auto=True,nbins=
fig.update_layout(title='Coapplicant Income',width=800,height=500)
fig.show()
```

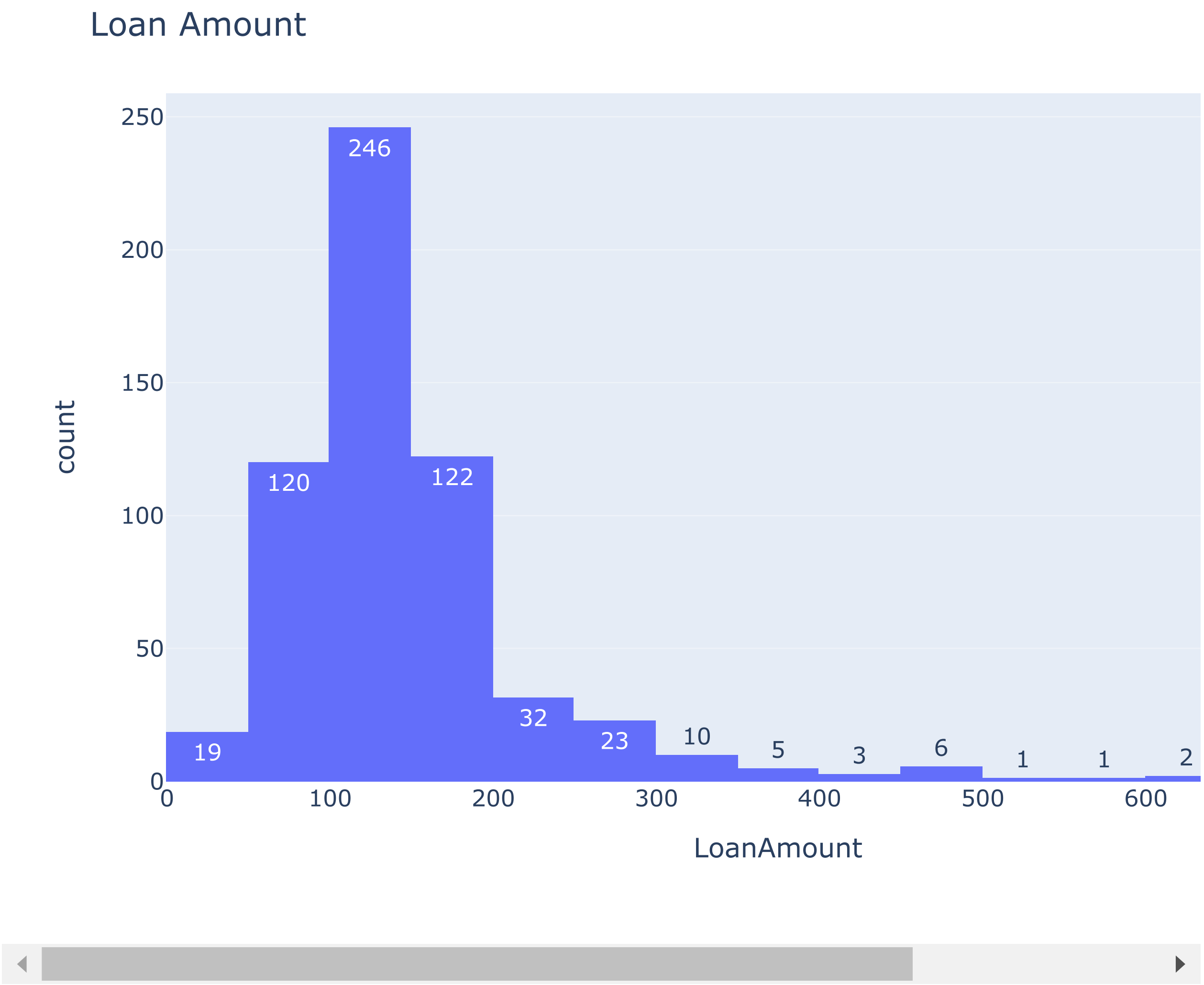


In [28]:

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

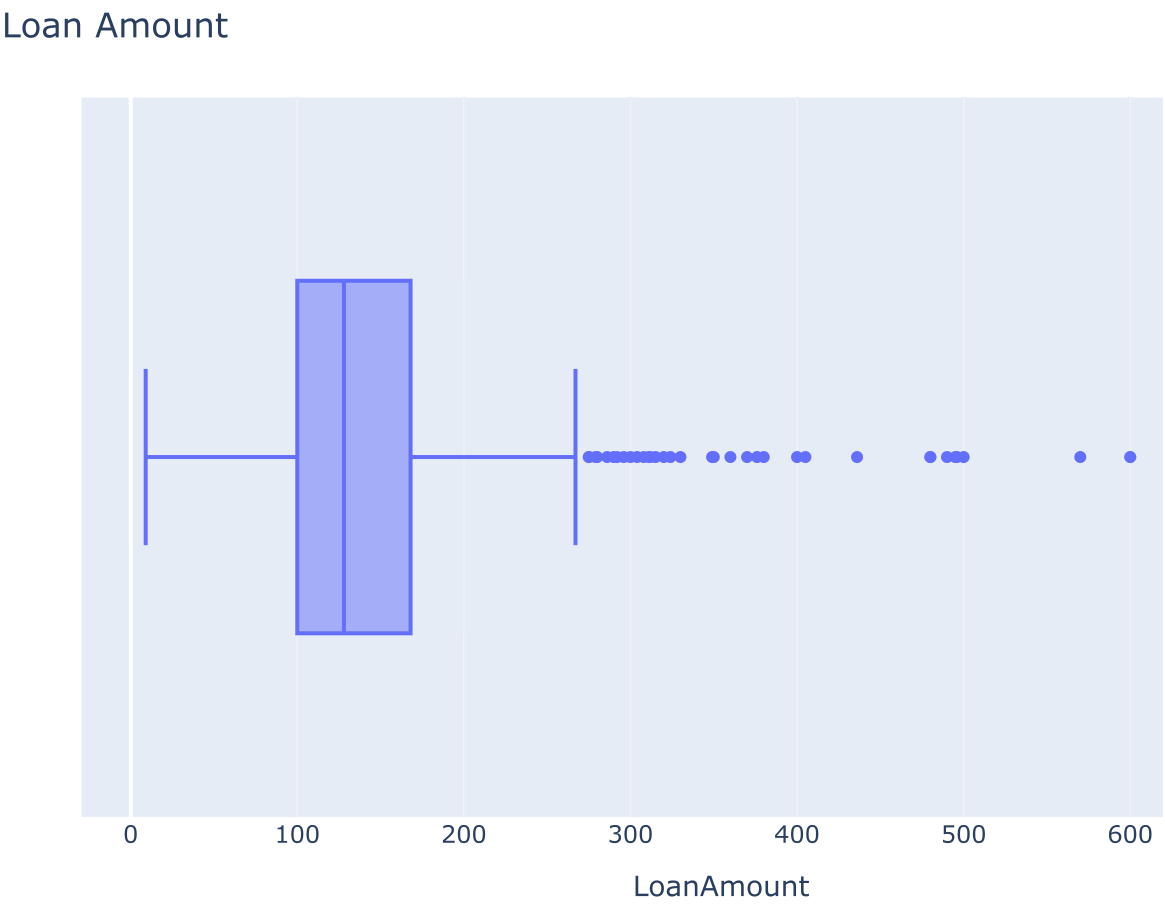


In [29]:
```
fig=px.histogram(data_frame=loan_data,x='LoanAmount',text_auto=True,nbins=20)
fig.update_layout(title='Loan Amount',width=800,height=500)
fig.show()
```



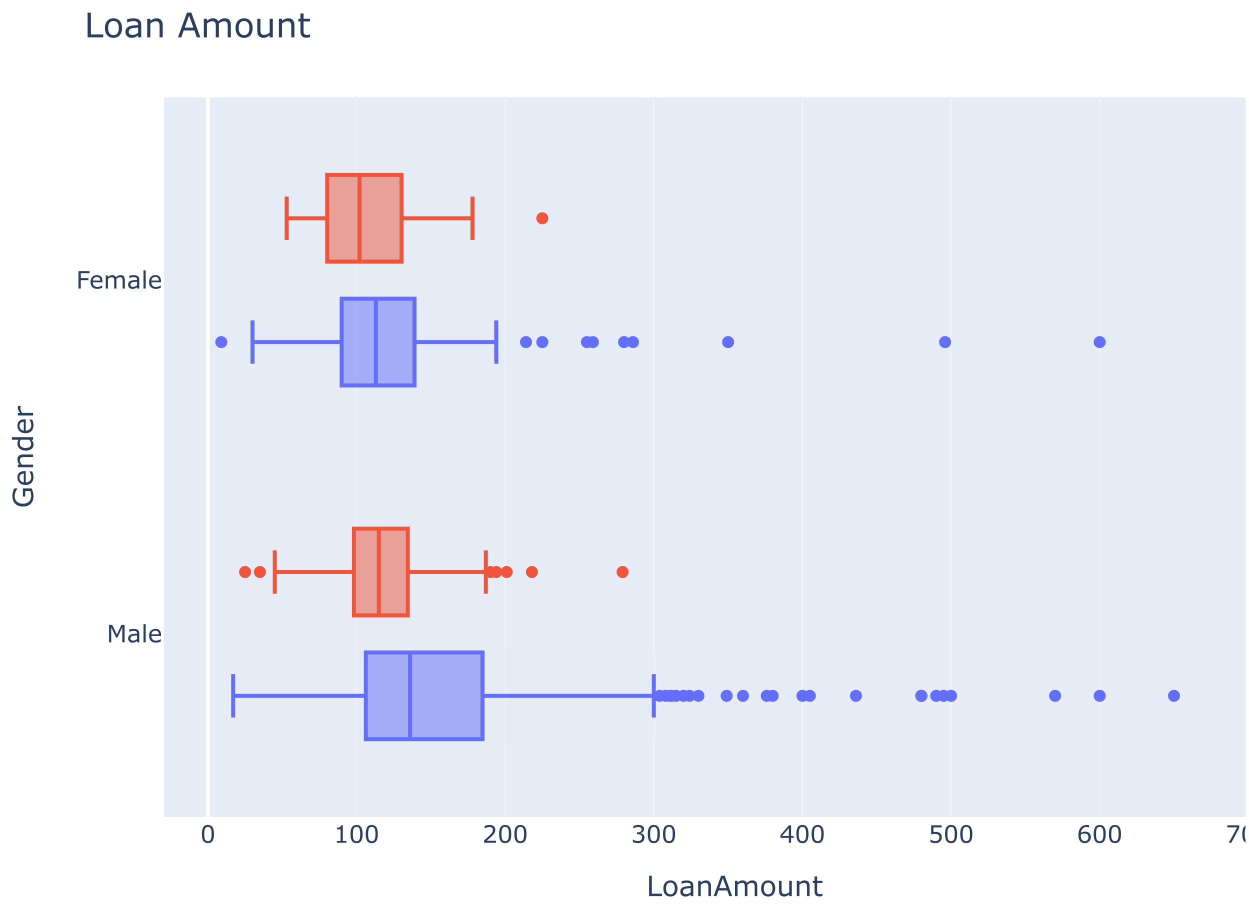
In [30]:

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



In [31]:

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



In [32]:

```
Gender_vise_Loan_Status= loan_data.groupby(['Gender', 'Loan_Status']).size().rese
Gender_vise_Loan_Status
```

Out[32]:

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

In [33]:

```
Married_vise_Loan_Status= loan_data.groupby(['Married', 'Loan_Status']).size().re
Married_vise_Loan_Status
```

Out[33]:

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

In [34]:

```
loan_data.dtypes
```

Out[34]:

```
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 [35]:

```
Dependents_vise_Loan_Status= loan_data.groupby(['Dependents', 'Loan_Status']).siz
Dependents_vise_Loan_Status
```

Out[35]:

	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 [36]:

```
Education_vise_Loan_Status= loan_data.groupby(['Education', 'Loan_Status']).size(
Education_vise_Loan_Status
```

Out[36]:

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

In [37]:

```
Self_Employed_vise_Loan_Status= loan_data.groupby(['Self_Employed', 'Loan_Status'
Self_Employed_vise_Loan_Status
```

Out[37]:

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

In [38]:

```
Credit_History_vise_Loan_Status= loan_data.groupby(['Credit_History', 'Loan_Statu
Credit_History_vise_Loan_Status
```

Out[38]:

	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 [39]:

```
Property_Area_vise_Loan_Status= loan_data.groupby(['Property_Area', 'Loan_Status'
Property_Area_vise_Loan_Status
```

Out[39]:

	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

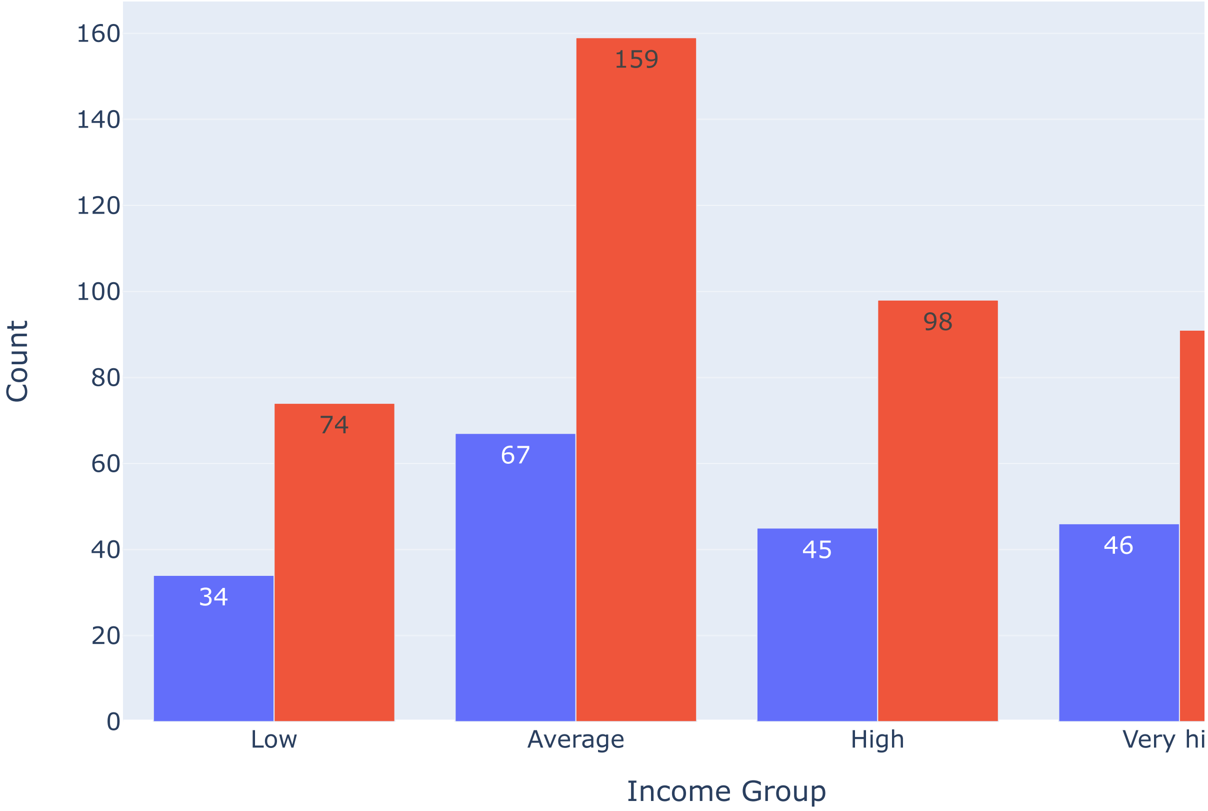
In [40]:

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

Out[40]:

	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 [41]:
```
fig = px.bar(Income_Group_vise_Loan_Status,x='Income_Group',y='Count',color='Loar
fig.update_layout(xaxis_title='Income Group',yaxis_title='Count',width=800,height
fig.show()
```

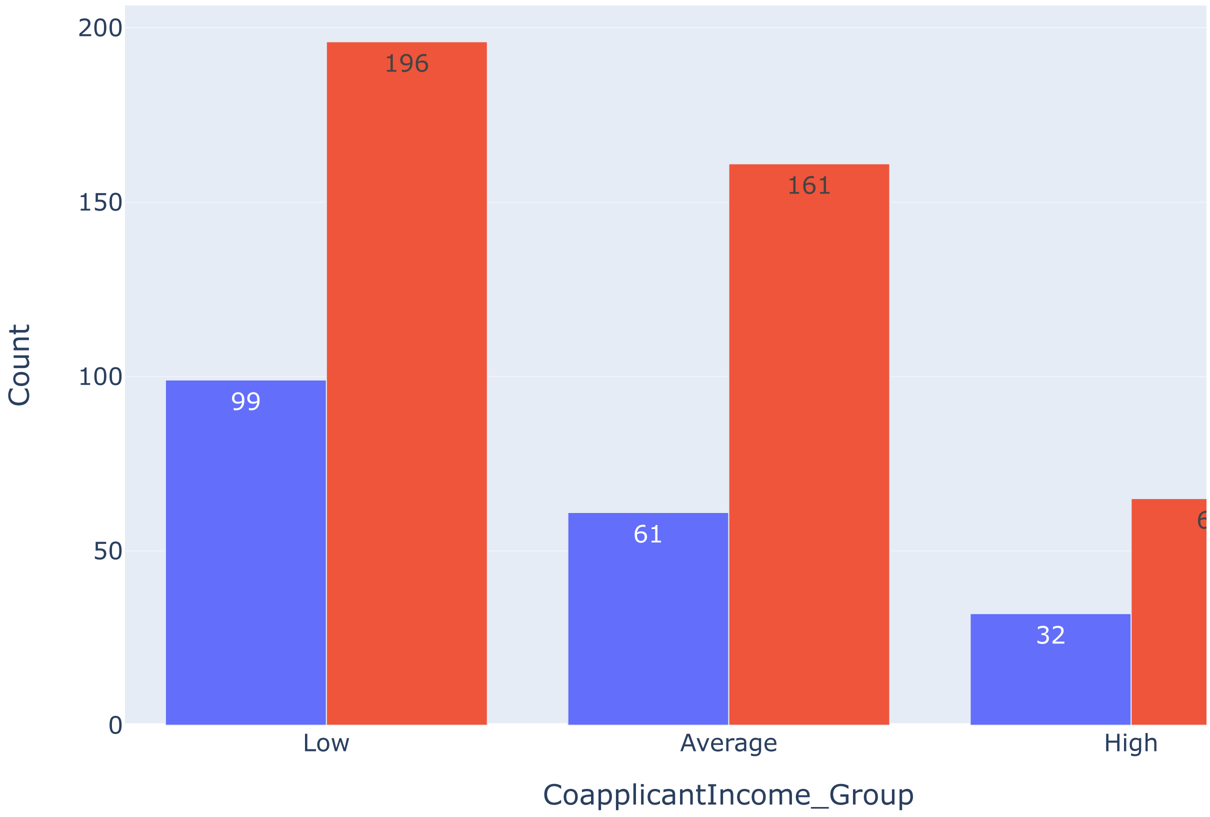


In [42]:
```
bins=[0,1000,3000,42000]
group=['Low','Average','High']
loan_data['CoapplicantIncome_Group']=pd.cut(loan_data['CoapplicantIncome'],bins=b
CoapplicantIncome_Group_vise_Loan_Status= loan_data.groupby(['CoapplicantIncome_G
CoapplicantIncome_Group_vise_Loan_Status
```

Out[42]:

	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 [43]:
```
fig = px.bar(CoapplicantIncome_Group_vise_Loan_Status,x='CoapplicantIncome_Group'
fig.update_layout(xaxis_title='CoapplicantIncome_Group',yaxis_title='Count',width
fig.show()
```



In [44]:

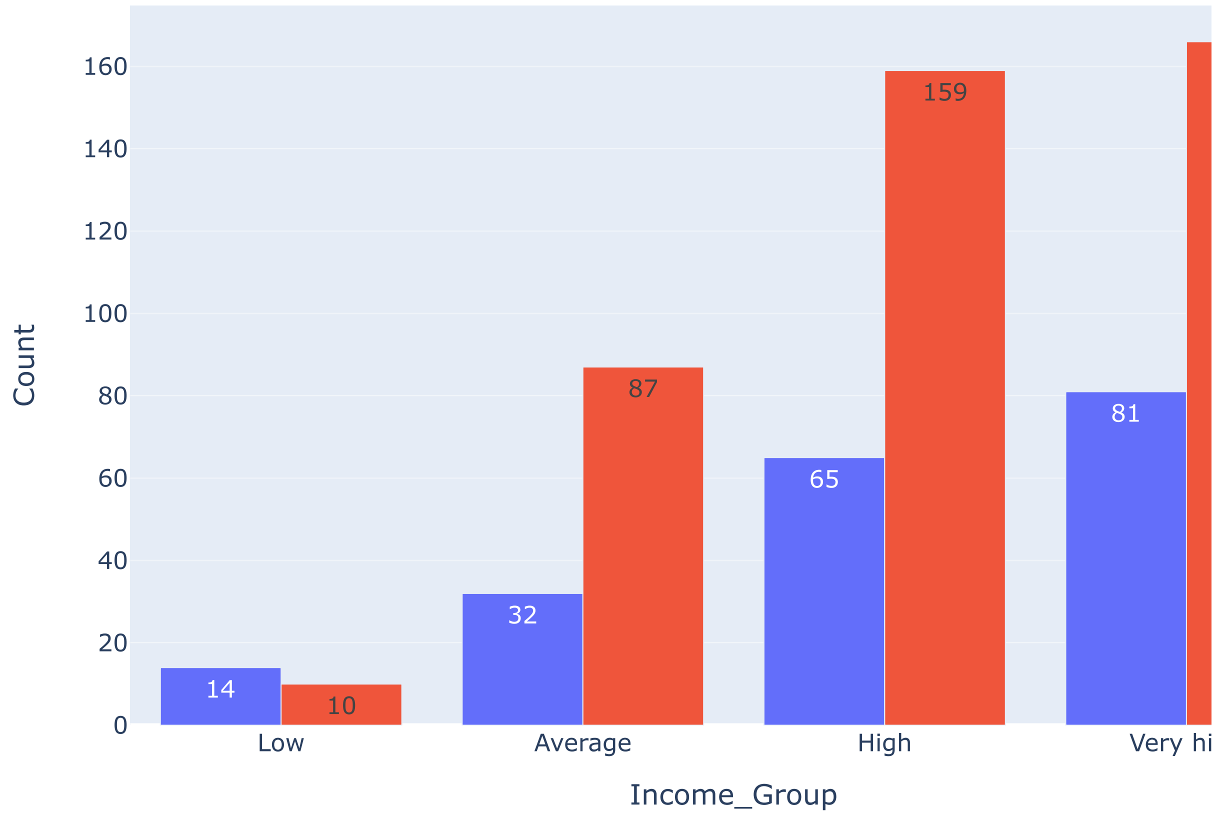
```
loan_data['Total_Income']=loan_data['ApplicantIncome']+loan_data['CoapplicantInco
bins=[0,2500,4000,6000,81000]
group=['Low','Average','High','Very high']
loan_data['Total_Income_Group']=pd.cut(loan_data['Total_Income'],bins=bins,labels
Total_Income_Group_vise_Loan_Status= loan_data.groupby(['Total_Income_Group', 'Lo
Total_Income_Group_vise_Loan_Status
```

Out[44]:

	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 [45]:

```
fig = px.bar(Total_Income_Group_vise_Loan_Status,x='Total_Income_Group',y='Count'
fig.update_layout(xaxis_title='Income_Group',yaxis_title='Count',width=800,height
fig.show()
```



In [46]:

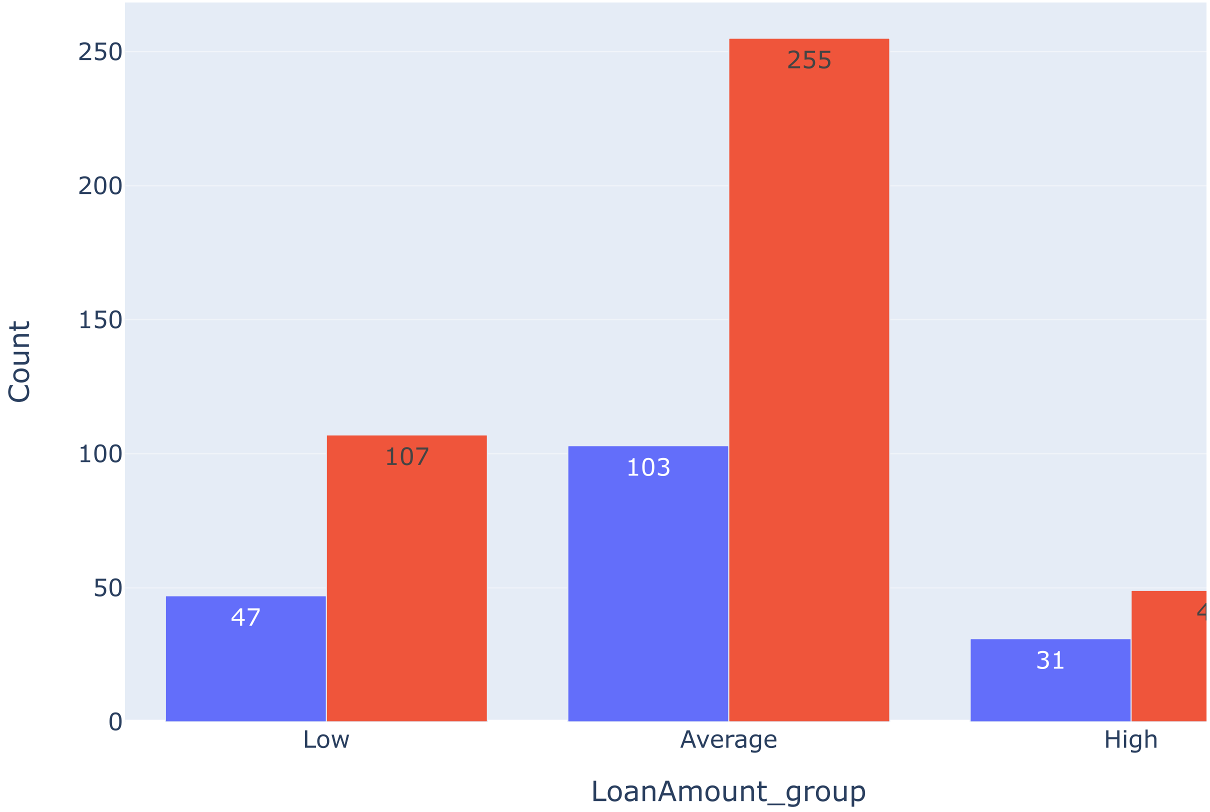
```
bins=[0,100,200,700]
group=['Low','Average','High']
loan_data['LoanAmount_group']=pd.cut(loan_data['LoanAmount'],bins,labels=group)
LoanAmount_group_vise_Loan_Status= loan_data.groupby(['LoanAmount_group', 'Loan_S
LoanAmount_group_vise_Loan_Status
```

Out[46]:

	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 [47]:

```
fig = px.bar(LoanAmount_group_vise_Loan_Status,x='LoanAmount_group',y='Count',col
fig.update_layout(xaxis_title='LoanAmount_group',yaxis_title='Count',width=800,he
fig.show()
```



In [48]:
```
loan_data=loan_data.drop(['Income_Group', 'CoapplicantIncome_Group',  'Total_Inco
```

In [49]:
```
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 [50]:
```
loan_data.head()
```

Out[50]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapplican
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 [51]:
```
Correlation=loan_data.corr(method='pearson')
print(Correlation)
```

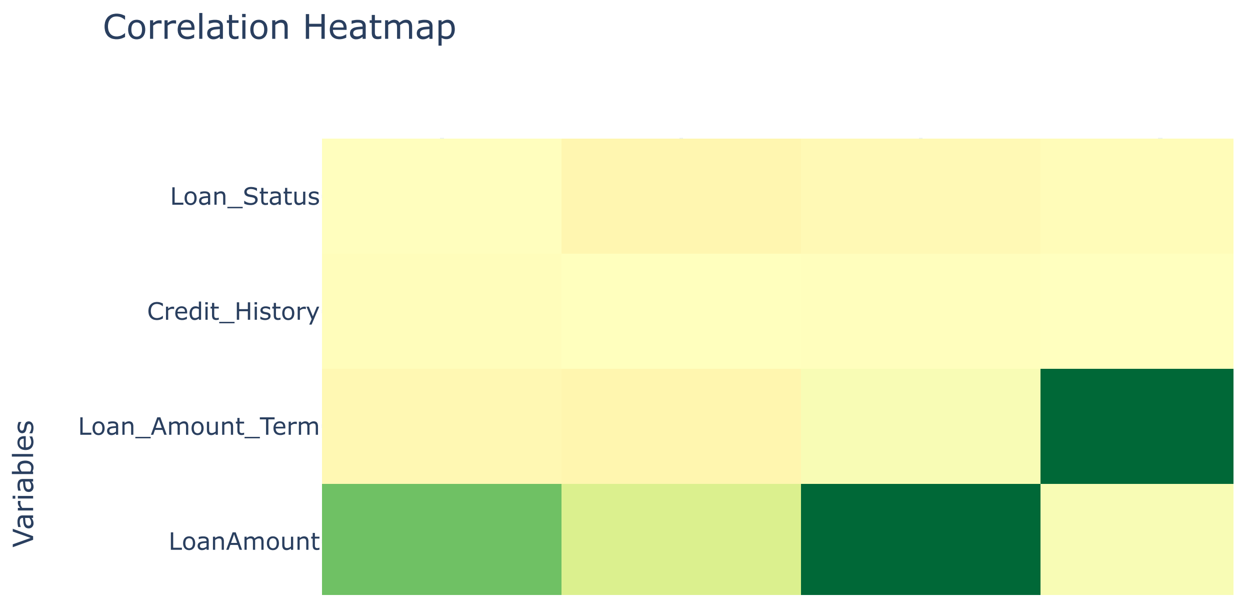
```
                   ApplicantIncome  CoapplicantIncome  LoanAmount  \
ApplicantIncome           1.000000          -0.116605    0.570909
CoapplicantIncome        -0.116605           1.000000    0.188619
LoanAmount                0.570909           0.188619    1.000000
Loan_Amount_Term         -0.045306          -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_10128\4188836588.py:1: FutureWarnin
g:

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

In [52]:
```
fig=go.Figure(go.Heatmap(x=Correlation.columns,y=Correlation.columns,z=Correlatic
fig.update_layout(title='Correlation Heatmap',xaxis_title='Variables',yaxis_title
fig.show()
```



In [53]:
```
loan_data.isnull().sum()
```

Out[53]:
```
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 [54]:
```
loan_data['Gender'].fillna(method='ffill', inplace=True)
```

In [55]:
```
loan_data['Dependents'].fillna( loan_data['Dependents'].mode()[0], inplace=True)
```

In [56]:
```
loan_data['Married'].fillna(loan_data['Married'].mode()[0], inplace=True)
```

In [57]:
```
loan_data['Self_Employed'].fillna(method='ffill', inplace=True)
```

In [58]:
```
loan_data['Credit_History'].fillna(method='bfill', inplace=True)
```

In [59]:
```
loan_data['LoanAmount'].fillna(loan_data['LoanAmount'].median(), inplace=True)
```

In [60]:
```
loan_data['Loan_Amount_Term'].fillna( loan_data['Loan_Amount_Term'].mode()[0], ir
```

In [61]:
```
loan_data.isnull().sum()
```

Out[61]:
```
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 [62]:
```
loan_data.describe()
```

Out[62]:

	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term	Credit_History	Loan_
count	614.000000	614.000000	614.000000	614.000000	614.00000	614.
mean	5403.459283	1621.245798	145.752443	342.410423	0.84202	0.
std	6109.041673	2926.248369	84.107233	64.428629	0.36502	0.
min	150.000000	0.000000	9.000000	12.000000	0.00000	0.
25%	2877.500000	0.000000	100.250000	360.000000	1.00000	0.
50%	3812.500000	1188.500000	128.000000	360.000000	1.00000	1.
75%	5795.000000	2297.250000	164.750000	360.000000	1.00000	1.
max	81000.000000	41667.000000	700.000000	480.000000	1.00000	1.

In [63]:

```
loan_data
```

Out[63]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapplic
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	
...	...	...	...	...	...	...	...	
609	LP002978	Female	No	0	Graduate	No	2900	
610	LP002979	Male	Yes	3	Graduate	No	4106	
611	LP002983	Male	Yes	1	Graduate	No	8072	
612	LP002984	Male	Yes	2	Graduate	No	7583	
613	LP002990	Female	No	0	Graduate	Yes	4583	

614 rows × 13 columns

In [64]:

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

In [65]:

```
loan_data
```

Out[65]:

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapplic
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	
...	...	...	...	...	...	...	...	
609	LP002978	Female	No	0	Graduate	No	2900	
610	LP002979	Male	Yes	3	Graduate	No	4106	
611	LP002983	Male	Yes	1	Graduate	No	8072	
612	LP002984	Male	Yes	2	Graduate	No	7583	
613	LP002990	Female	No	0	Graduate	Yes	4583	

614 rows × 14 columns

In [66]:

```
loan_data=loan_data.drop('Loan_ID',axis=1)
```

In [67]:

```
loan_data=loan_data.drop('LoanAmount',axis=1)
```

In [68]:

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

In [69]:

```
X
```

Out[69]:

	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome
0	Male	No	0	Graduate	No	5849	0.0
1	Male	Yes	1	Graduate	No	4583	1508.0
2	Male	Yes	0	Graduate	Yes	3000	0.0
3	Male	Yes	0	Not Graduate	No	2583	2358.0
4	Male	No	0	Graduate	No	6000	0.0
...	...	...	...	...	...	...	...
609	Female	No	0	Graduate	No	2900	0.0
610	Male	Yes	3	Graduate	No	4106	0.0
611	Male	Yes	1	Graduate	No	8072	240.0
612	Male	Yes	2	Graduate	No	7583	0.0
613	Female	No	0	Graduate	Yes	4583	0.0

614 rows × 11 columns

In [70]:

```
Y
```

Out[70]:

```
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 [71]:

```
columns = X.columns

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

Out[71]:

```
['Gender',
 'Married',
 'Dependents',
 'Education',
 'Self_Employed',
 'Property_Area']
```

In [72]:

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

Out[72]:

```
(614, 15)
```

In [73]:

```
dummy
```

Out[73]:

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

614 rows × 15 columns

In [74]:

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

Out[74]:

```
(614, 26)
```

In [75]:

```
final.drop(cat_col,inplace=True,axis=1)
```

In [76]:
```
final.shape
```

Out[76]:
```
(614, 20)
```

In [77]:
```
final
```

Out[77]:

	ApplicantIncome	CoapplicantIncome	Loan_Amount_Term	Credit_History	NormLoanAmount	Ge
0	5849	0.0	360.0	1.0	4.852030	
1	4583	1508.0	360.0	1.0	4.852030	
2	3000	0.0	360.0	1.0	4.189655	
3	2583	2358.0	360.0	1.0	4.787492	
4	6000	0.0	360.0	1.0	4.948760	
...	...	...	...	...	...	
609	2900	0.0	360.0	1.0	4.262680	
610	4106	0.0	180.0	1.0	3.688879	
611	8072	240.0	360.0	1.0	5.533389	
612	7583	0.0	360.0	1.0	5.231109	
613	4583	0.0	360.0	0.0	4.890349	

614 rows × 20 columns

In [78]:
```
X=final
X
```

Out[78]:

	ApplicantIncome	CoapplicantIncome	Loan_Amount_Term	Credit_History	NormLoanAmount	Ge
0	5849	0.0	360.0	1.0	4.852030	
1	4583	1508.0	360.0	1.0	4.852030	
2	3000	0.0	360.0	1.0	4.189655	
3	2583	2358.0	360.0	1.0	4.787492	
4	6000	0.0	360.0	1.0	4.948760	
...	...	...	...	...	...	
609	2900	0.0	360.0	1.0	4.262680	
610	4106	0.0	180.0	1.0	3.688879	
611	8072	240.0	360.0	1.0	5.533389	
612	7583	0.0	360.0	1.0	5.231109	
613	4583	0.0	360.0	0.0	4.890349	

614 rows × 20 columns

In [79]:
```
Y
```

Out[79]:
```
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 [80]:
```
x_train,x_test,y_train,y_test = train_test_split(X,Y, test_size = 0.2)
```

LogisticRegression

In [81]:
```
clf = LogisticRegression()
```

In [82]:
```
x_train.shape,x_test.shape
```

Out[82]:
```
((491, 20), (123, 20))
```

In [83]:
```
clf.fit(x_train,y_train)
```

Out[83]:
```
▾ LogisticRegression
LogisticRegression()
```

In [84]:
```
pred = clf.predict(x_test)
```

In [85]:
```
pred
```

Out[85]:
```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1,
       1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 0, 1, 1,
       1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 0,
       1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1], dtype=int64)
```

In [86]:
```
accuracy_score(y_test,pred)
```

Out[86]:
```
0.8048780487804879
```

In [87]:
```
f1_score(y_test,pred)
```

Out[87]:
```
0.8695652173913043
```

In [88]:
```
precision_score(y_test,pred)
```

Out[88]:
```
0.8
```

In [89]:
```
recall_score(y_test,pred)
```

Out[89]:
```
0.9523809523809523
```

In [90]:
```
confusion_matrix(y_test,pred)
```

Out[90]:
```
array([[19, 20],
       [ 4, 80]], dtype=int64)
```

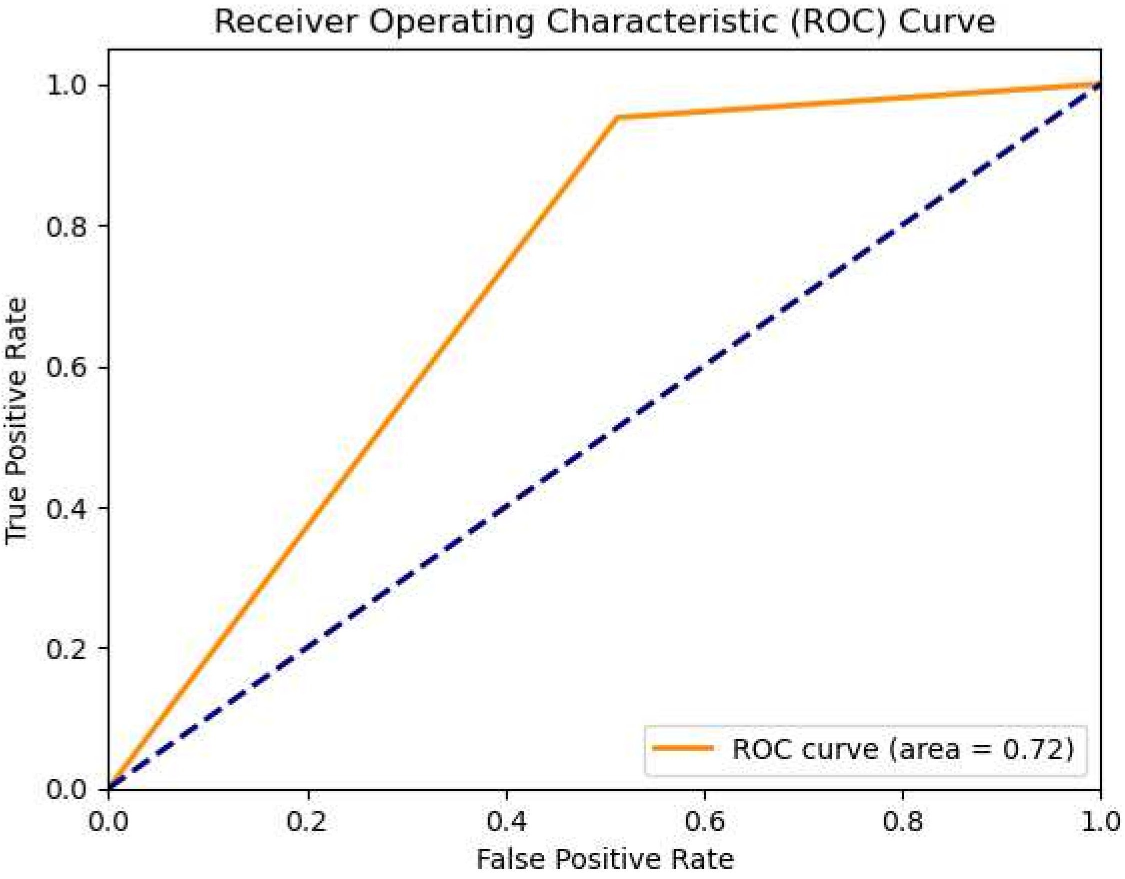
In [91]:
```
from sklearn.metrics import roc_curve, auc
import matplotlib.pyplot as plt
```

In [92]:
```
fpr, tpr, thresholds = roc_curve(y_test,pred)
```

In [93]:
```
roc_auc = auc(fpr, tpr)
print("ROC AUC:", roc_auc)
```

```
ROC AUC: 0.7197802197802198
```

In [94]:
```
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 [95]:
```
dct=tree.DecisionTreeClassifier()
```

In [96]:
```
dct.fit(x_train,y_train)
```

Out[96]:
```
▾ DecisionTreeClassifier

DecisionTreeClassifier()
```

In [97]:
```
pred = dct.predict(x_test)
```

In [98]:
```
pred
```

Out[98]:
```
array([1, 0, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1,
       0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 0, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
       0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1,
       1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1, 0,
       1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 0, 0], dtype=int64)
```

In [99]:
```
accuracy_score(y_test,pred)
```

Out[99]:
```
0.6829268292682927
```

In [100]:
```
f1_score(y_test,pred)
```

Out[100]:
```
0.7577639751552795
```

In [101]:
```
precision_score(y_test,pred)
```

Out[101]:
```
0.7922077922077922
```

In [102]:
```
recall_score(y_test,pred)
```

Out[102]:
```
0.7261904761904762
```

In [103]:
```
confusion_matrix(y_test,pred)
```

Out[103]:
```
array([[23, 16],
       [23, 61]], dtype=int64)
```

In [104]:
```
roc_auc_score(y_test,pred)
```

Out[104]:
```
0.6579670329670331
```

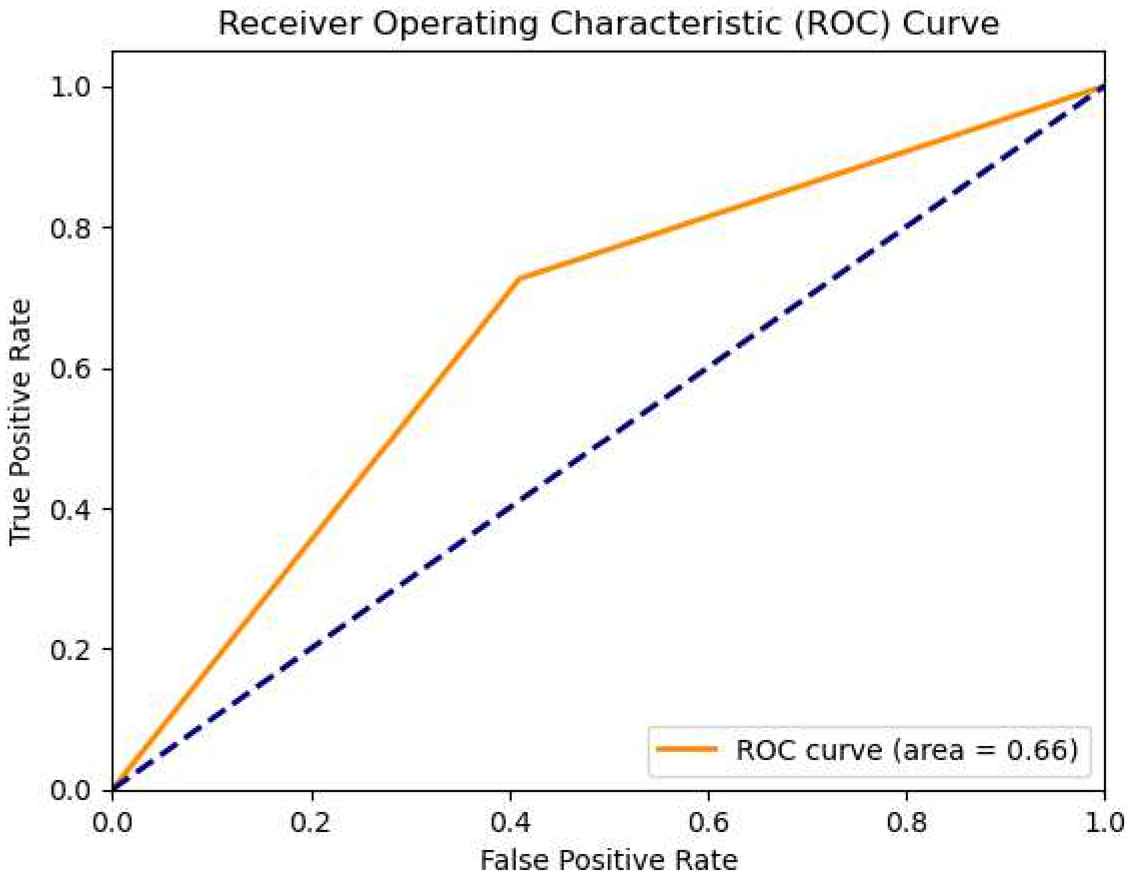
In [105]:
```
import matplotlib.pyplot as plt

from sklearn.metrics import RocCurveDisplay
```

In [106]:

```
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: 0.6579670329670331
```



In [ ]:

In [ ]:

Random Forest

In [107]:

```
rfc=RandomForestClassifier()
```

In [108]:

```
rfc.fit(x_train,y_train)
```

Out[108]:

```
▾ RandomForestClassifier
RandomForestClassifier()
```

In [109]:

```
pred=rfc.predict(x_test)
```

In [110]:

```
accuracy_score(y_test,pred)
```

Out[110]:

```
0.7967479674796748
```

In [111]:

```
precision_score(y_test,pred)
```

Out[111]:

```
0.8105263157894737
```

In [112]:

```
recall_score(y_test,pred)
```

Out[112]:

```
0.9166666666666666
```

In [113]:

```
f1_score(y_test,pred)
```

Out[113]:

```
0.8603351955307262
```

In [114]:

```
confusion_matrix(y_test,pred)
```

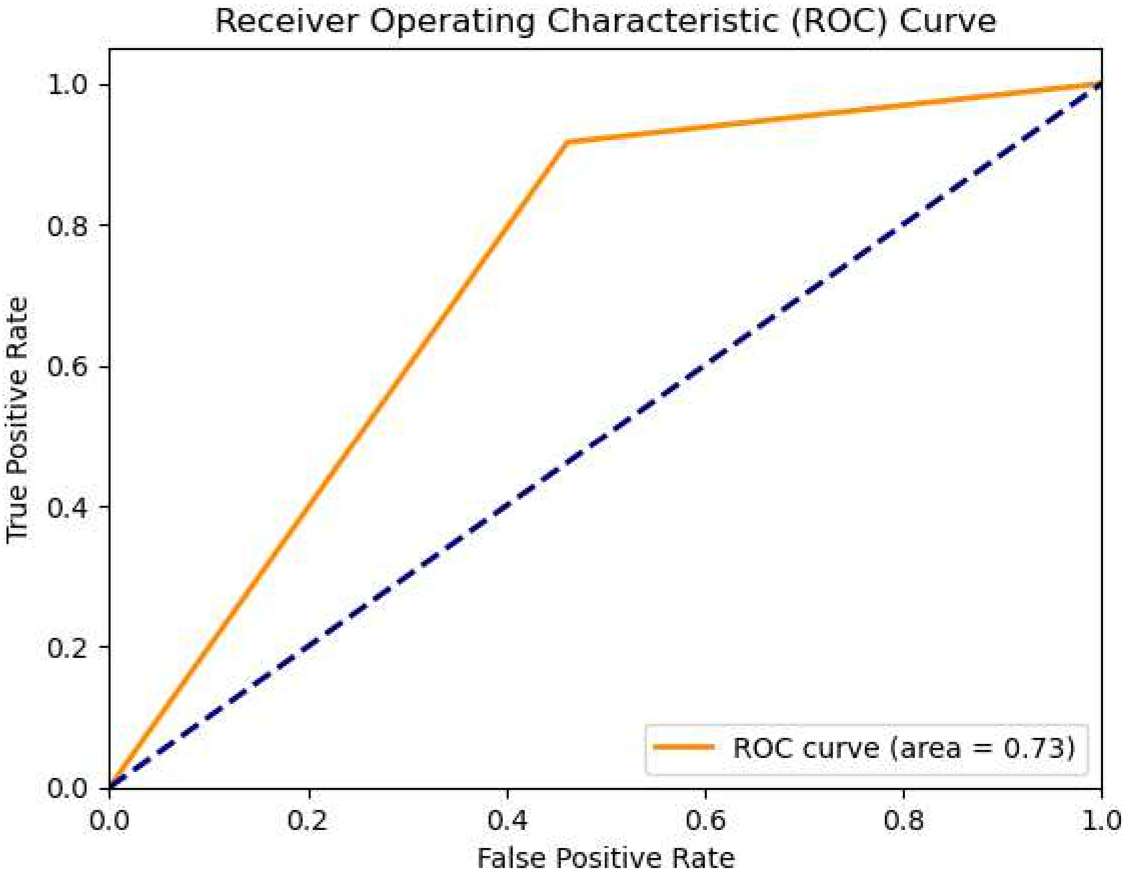
Out[114]:

```
array([[21, 18],
       [ 7, 77]], dtype=int64)
```

In [115]:

```
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: 0.7275641025641025
```


Receiver Operating Characteristic (ROC) Curve
True Positive Rate
False Positive Rate
ROC curve (area = 0.73)