```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import missingno as mso
import seaborn as sns
import warnings
import os
import scipy

from scipy import stats
from scipy.stats import pearsonr
from scipy.stats import ttest_ind
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
from sklearn.preprocessing import MinMaxScaler
from sklearn.model_selection import train_test_split
from imblearn.over_sampling import SMOTE

from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.svm import SVC
from sklearn.naive_bayes import CategoricalNB
from sklearn.naive_bayes import GaussianNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import GradientBoostingClassifier
from xgboost import XGBClassifier
from sklearn.model_selection import GridSearchCV, RandomizedSearchCV


df = pd.read_csv("train_data_file.csv")
df.head()
```

	Loan_ID	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome
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

```
print(df.shape)
```

```
(614, 13)
```

```
df.Loan_ID.value_counts(dropna=False)
```

```
LP001002    1
LP002328    1
LP002305    1
LP002308    1
LP002314    1
           ..
LP001692    1
LP001693    1
LP001698    1
LP001699    1
LP002990    1
Name: Loan_ID, Length: 614, dtype: int64
```

```
df.Gender.value_counts(dropna=False)
```

```
Male      489
Female    112
NaN        13
Name: Gender, dtype: int64
```

```
df.Married.value_counts(dropna=False)
```

```
Yes    398
No     213
NaN      3
Name: Married, dtype: int64
```

```
df.Education.value_counts(dropna=False)
```

```
Graduate        480
Not Graduate    134
Name: Education, dtype: int64
```

```
df.Self_Employed.value_counts(dropna=False)
```

```
No     500
Yes     82
NaN     32
Name: Self_Employed, dtype: int64
```

```
df.Credit_History.value_counts(dropna=False)
```

```
1.0    475
0.0     89
NaN     50
Name: Credit_History, dtype: int64
```

```
df.Property_Area.value_counts(dropna=False)
```

```
Semiurban    233
Urban        202
```

```
Rural        179
Name: Property_Area, dtype: int64
```

```
df.Loan_Amount_Term.value_counts(dropna=False)
```

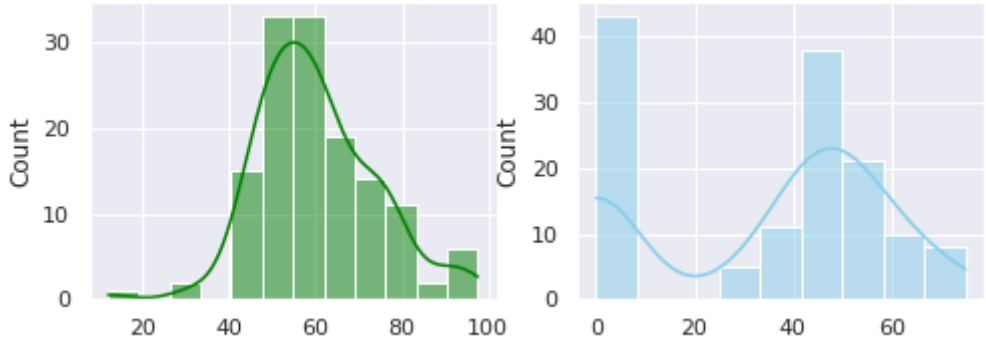
```
360.0    512
180.0     44
480.0     15
NaN       14
300.0     13
240.0      4
84.0       4
120.0      3
60.0       2
36.0       2
12.0       1
Name: Loan_Amount_Term, dtype: int64
```

```
df[['ApplicantIncome','CoapplicantIncome','LoanAmount']].describe()
```

	ApplicantIncome	CoapplicantIncome	LoanAmount
count	614.000000	614.000000	592.000000
mean	5403.459283	1621.245798	146.412162
std	6109.041673	2926.248369	85.587325
min	150.000000	0.000000	9.000000
25%	2877.500000	0.000000	100.000000
50%	3812.500000	1188.500000	128.000000
75%	5795.000000	2297.250000	168.000000
max	81000.000000	41667.000000	700.000000

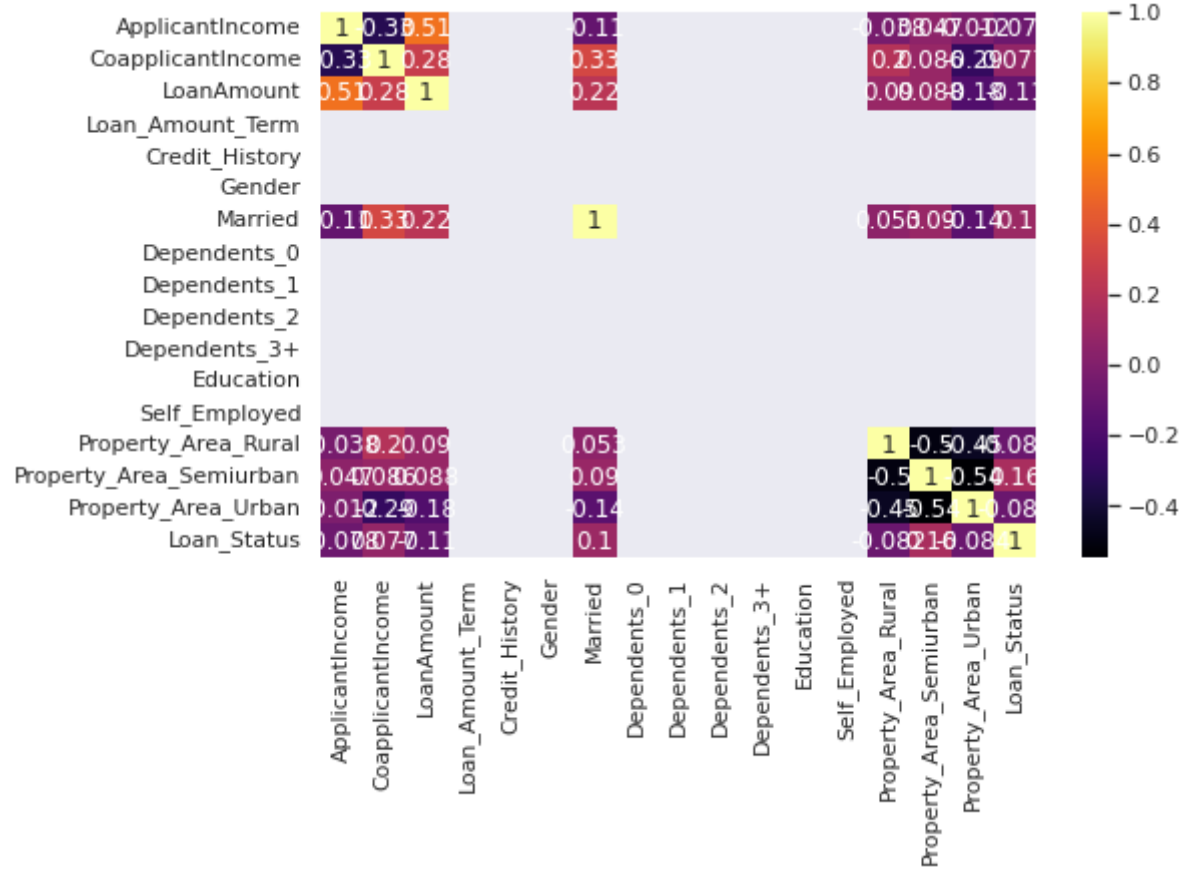
Histogram Distribution

```
sns.set(style="darkgrid")
fig, axs = plt.subplots(2, 2, figsize=(8,6))
sns.histplot(data=df, x="ApplicantIncome", kde=True, ax=axs[0, 0], color='green')
sns.histplot(data=df, x="CoapplicantIncome", kde=True, ax=axs[0, 1], color='skyblue')
sns.histplot(data=df, x="LoanAmount", kde=True, ax=axs[1, 0], color='orange');
```



Heatmap

```
plt.figure(figsize=(8,5))
sns.heatmap(df.corr(), annot=True, cmap='inferno');
```




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

```
Loan_ID               0
Gender               13
Married               3
Dependents           15
Education             0
Self_Employed        32
ApplicantIncome       0
CoapplicantIncome     0
LoanAmount           22
Loan_Amount_Term     14
Credit_History       50
Property_Area         0
```

```
Loan_Status           0
dtype: int64
```

```
df = df.drop(['Loan_ID'], axis = 1)
```

```
df['Gender'].fillna(df['Gender'].mode()[0],inplace=True)
df['Married'].fillna(df['Married'].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['Credit_History'].fillna(df['Credit_History'].mode()[0],inplace=True)
df['Loan_Amount_Term'].fillna(df['Loan_Amount_Term'].mode()[0],inplace=True)
```

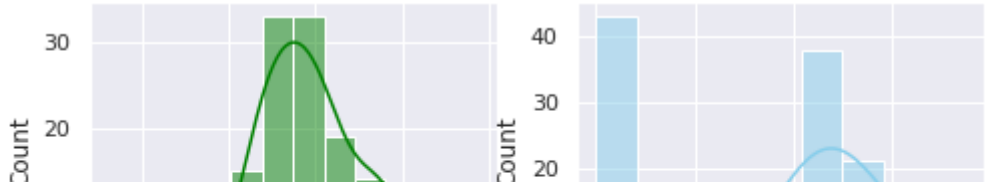
```
df['LoanAmount'].fillna(df['LoanAmount'].mean(),inplace=True)
```

```
df = pd.get_dummies(df)
# Drop columns
df = df.drop(['Gender_Female', 'Married_No', 'Education_Not Graduate', 'Self_Employed_No',
# Rename columns name
new = {'Gender_Male': 'Gender', 'Married_Yes': 'Married', 'Education_Graduate': 'Education
df.rename(columns=new, inplace=True)
```

```
Q1 = df.quantile(0.25)
Q3 = df.quantile(0.75)
IQR = Q3 - Q1
df = df[~((df < (Q1 - 1.5 * IQR)) |(df > (Q3 + 1.5 * IQR))).any(axis=1)]
```

```
df.ApplicantIncome = np.sqrt(df.ApplicantIncome)
df.CoapplicantIncome = np.sqrt(df.CoapplicantIncome)
df.LoanAmount = np.sqrt(df.LoanAmount)
```

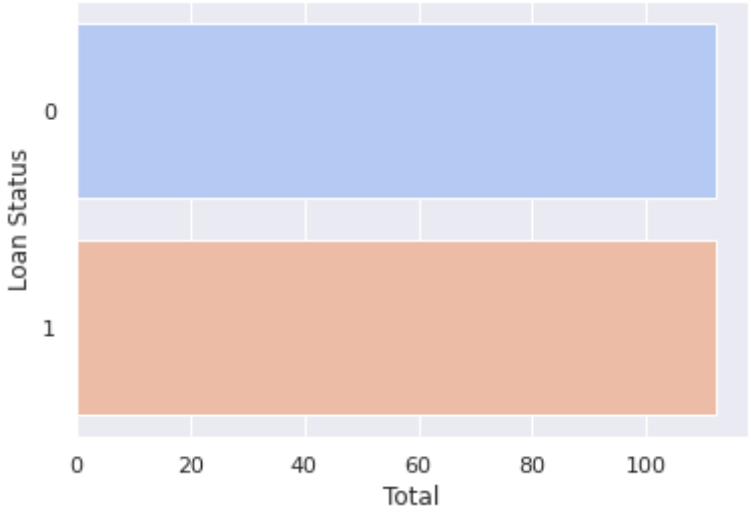
```
sns.set(style="darkgrid")
fig, axs = plt.subplots(2, 2, figsize=(8, 6))
sns.histplot(data=df, x="ApplicantIncome", kde=True, ax=axs[0, 0], color='green')
sns.histplot(data=df, x="CoapplicantIncome", kde=True, ax=axs[0, 1], color='skyblue')
sns.histplot(data=df, x="LoanAmount", kde=True, ax=axs[1, 0], color='orange');
```




```
X = df.drop(["Loan_Status"], axis=1)
y = df["Loan_Status"]
```

```
X, y = SMOTE().fit_resample(X, y)
```

```
sns.set_theme(style="darkgrid")
sns.countplot(y=y, data=df, palette="coolwarm")
plt.ylabel('Loan Status')
plt.xlabel('Total')
plt.show()
```




```
X = MinMaxScaler().fit_transform(X)
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state =
```

Logistic Regression

```
LRclassifier = LogisticRegression(solver='saga', max_iter=500, random_state=1)
LRclassifier.fit(X_train, y_train)
y_pred = LRclassifier.predict(X_test)
print(classification_report(y_test, y_pred))
print(confusion_matrix(y_test, y_pred))
from sklearn.metrics import accuracy_score
LRAcc = accuracy_score(y_pred,y_test)
print('LR accuracy: {:.2f}%'.format(LRAcc*100))
```

```
                precision    recall  f1-score   support

             0       0.83      0.87      0.85        23
             1       0.86      0.82      0.84        22
```

```
          accuracy                           0.84        45
         macro avg       0.85      0.84      0.84        45
      weighted avg       0.84      0.84      0.84        45

      [[20  3]
       [ 4 18]]
      LR accuracy: 84.44%
```

K-Nearest Neighbour (KNN)

```
scoreListknn = []
for i in range(1,21):
    KNclassifier = KNeighborsClassifier(n_neighbors = i)
    KNclassifier.fit(X_train, y_train)
    scoreListknn.append(KNclassifier.score(X_test, y_test))
plt.plot(range(1,21), scoreListknn)
plt.xticks(np.arange(1,21,1))
plt.xlabel("K value")
plt.ylabel("Score")
plt.show()
KNAcc = max(scoreListknn)
print("KNN best accuracy: {:.2f}%".format(KNAcc*100))
```

Support Vector Machine (SVM)

```
SVCclassifier = SVC(kernel='rbf', max_iter=500)
SVCclassifier.fit(X_train, y_train)
y_pred = SVCclassifier.predict(X_test)
print(classification_report(y_test, y_pred))
print(confusion_matrix(y_test, y_pred))
from sklearn.metrics import accuracy_score
SVCAcc = accuracy_score(y_pred,y_test)
print('SVC accuracy: {:.2f}%'.format(SVCAcc*100))
```

```
                   precision    recall  f1-score   support

                0       0.87      0.87      0.87        23
                1       0.86      0.86      0.86        22

          accuracy                           0.87        45
         macro avg       0.87      0.87      0.87        45
      weighted avg       0.87      0.87      0.87        45

      [[20  3]
       [ 3 19]]
      SVC accuracy: 86.67%
```

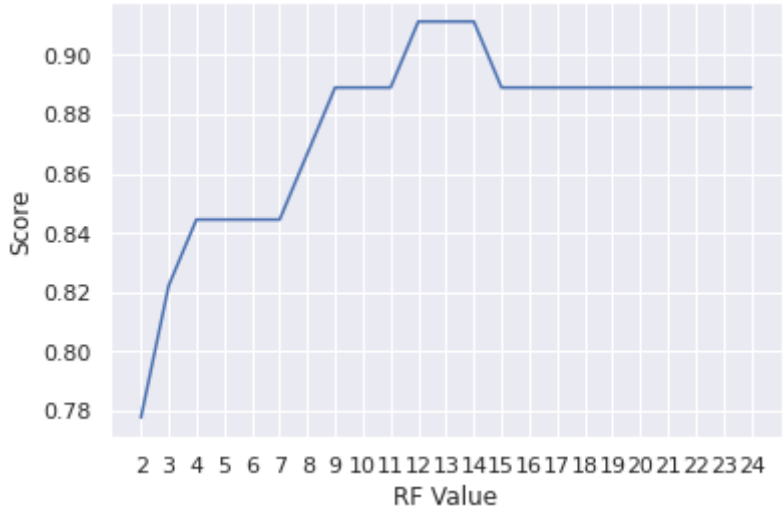
Decision Tree

```
scoreListDT = []
for i in range(2,21):
```

```
    DTclassifier = DecisionTreeClassifier(max_leaf_nodes=i)
    DTclassifier.fit(X_train, y_train)
    scoreListDT.append(DTclassifier.score(X_test, y_test))
plt.plot(range(2,21), scoreListDT)
plt.xticks(np.arange(2,21,1))
plt.xlabel("Leaf")
plt.ylabel("Score")
plt.show()
DTAcc = max(scoreListDT)
print("Decision Tree Accuracy: {:.2f}%".format(DTAcc*100))
```

Random Forest

```
scoreListRF = []
for i in range(2,25):
    RFclassifier = RandomForestClassifier(n_estimators = 1000, random_state = 1, max_leaf_
    RFclassifier.fit(X_train, y_train)
    scoreListRF.append(RFclassifier.score(X_test, y_test))
plt.plot(range(2,25), scoreListRF)
plt.xticks(np.arange(2,25,1))
plt.xlabel("RF Value")
plt.ylabel("Score")
plt.show()
RFAcc = max(scoreListRF)
print("Random Forest Accuracy:  {:.2f}%".format(RFAcc*100))
```




```
Random Forest Accuracy:  91.11%
```

```
compare = pd.DataFrame({'Model': ['Logistic Regression', 'K Neighbors', 'SVM', 'Decision T
compare.sort_values(by='Accuracy', ascending=False)
```

	Model	Accuracy
4	Random Forest	91.111111
1	K Neighbors	88.888889
2	SVM	86.666667
3	Decision Tree	86.666667
0	Logistic Regression	84.444444