Import libraries

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score, confusion_matrix,
roc_curve, roc_auc_score
from sklearn.ensemble import RandomForestClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.neural_network import MLPClassifier
from sklearn.model_selection import GridSearchCV
```

Read Dataset

```
df=pd.read_csv("credit_risk_dataset.csv")
df.head(3)
```

```
   person_age  person_income person_home_ownership  person_emp_length
\
0          22          59000                  RENT               123.0

1          21           9600                   OWN                 5.0

2          25           9600              MORTGAGE                 1.0


  loan_intent loan_grade  loan_amnt  loan_int_rate  loan_status  \
0    PERSONAL          D      35000          16.02            1
1   EDUCATION          B       1000          11.14            0
2     MEDICAL          C       5500          12.87            1

   loan_percent_income cb_person_default_on_file
cb_person_cred_hist_length
0                 0.59                         Y
3
1                 0.10                         N
2
2                 0.57                         N
3
```

Check NULL values

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

```
person_age                        0
person_income                     0
person_home_ownership             0
person_emp_length               895
loan_intent                       0
loan_grade                        0
loan_amnt                         0
loan_int_rate                  3116
loan_status                       0
loan_percent_income               0
cb_person_default_on_file         0
cb_person_cred_hist_length        0
dtype: int64
```

```
df["person_emp_length"].value_counts()
```

```
person_emp_length
0.0      4105
2.0      3849
3.0      3456
5.0      2946
1.0      2915
4.0      2874
6.0      2666
7.0      2196
8.0      1687
9.0      1367
11.0      740
10.0      696
12.0      575
13.0      426
14.0      335
15.0      238
16.0      165
17.0      129
18.0      104
19.0       64
20.0       42
21.0       38
22.0       19
24.0       10
23.0       10
25.0        8
26.0        6
27.0        5
31.0        4
28.0        3
123.0       2
30.0        2
41.0        1
```

```
34.0        1
29.0        1
38.0        1
Name: count, dtype: int64
```

```
df["loan_int_rate"].value_counts()
```

```
loan_int_rate
7.51     756
10.99    749
7.49     645
7.88     642
5.42     594
        ...
21.64      1
20.48      1
17.46      1
21.14      1
20.53      1
Name: count, Length: 348, dtype: int64
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32581 entries, 0 to 32580
Data columns (total 12 columns):
 #   Column                      Non-Null Count  Dtype  
---  ------                      --------------  -----  
 0   person_age                  32581 non-null  int64  
 1   person_income               32581 non-null  int64  
 2   person_home_ownership       32581 non-null  object 
 3   person_emp_length           31686 non-null  float64
 4   loan_intent                 32581 non-null  object 
 5   loan_grade                  32581 non-null  object 
 6   loan_amnt                   32581 non-null  int64  
 7   loan_int_rate               29465 non-null  float64
 8   loan_status                 32581 non-null  int64  
 9   loan_percent_income         32581 non-null  float64
 10  cb_person_default_on_file   32581 non-null  object 
 11  cb_person_cred_hist_length  32581 non-null  int64  
dtypes: float64(3), int64(5), object(4)
memory usage: 3.0+ MB
```

```
df.describe()
```

```
         person_age  person_income  person_emp_length     loan_amnt  \
count  32581.000000   3.258100e+04       31686.000000  32581.000000   
mean      27.734600   6.607485e+04           4.789686   9589.371106   
std        6.348078   6.198312e+04           4.142630   6322.086646   
min       20.000000   4.000000e+03           0.000000    500.000000   
25%       23.000000   3.850000e+04           2.000000   5000.000000   
```

```
50%       26.000000   5.500000e+04           4.000000   8000.000000
75%       30.000000   7.920000e+04           7.000000  12200.000000
max      144.000000   6.000000e+06         123.000000  35000.000000

       loan_int_rate   loan_status  loan_percent_income  \
count   29465.000000  32581.000000         32581.000000
mean       11.011695      0.218164             0.170203
std         3.240459      0.413006             0.106782
min         5.420000      0.000000             0.000000
25%         7.900000      0.000000             0.090000
50%        10.990000      0.000000             0.150000
75%        13.470000      0.000000             0.230000
max        23.220000      1.000000             0.830000

       cb_person_cred_hist_length
count                32581.000000
mean                     5.804211
std                      4.055001
min                      2.000000
25%                      3.000000
50%                      4.000000
75%                      8.000000
max                     30.000000
```

Fill missing values by mean

```
df1= df.copy()

df1.isnull().sum()
```

```
person_age                        0
person_income                     0
person_home_ownership             0
person_emp_length               895
loan_intent                       0
loan_grade                        0
loan_amnt                         0
loan_int_rate                  3116
loan_status                       0
loan_percent_income               0
cb_person_default_on_file         0
cb_person_cred_hist_length        0
dtype: int64
```

```
df1["person_emp_length"].fillna(df1["person_emp_length"].mean(),inplac
e=True)
df1["loan_int_rate"].fillna(df1["loan_int_rate"].mean(),inplace=True)
```

```
C:\Users\HMHSM\AppData\Local\Temp\ipykernel_15092\273060775.py:1:
FutureWarning: A value is trying to be set on a copy of a DataFrame or
```

```
Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never
work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try
using 'df.method({col: value}, inplace=True)' or df[col] =
df[col].method(value) instead, to perform the operation inplace on the
original object.



df1["person_emp_length"].fillna(df1["person_emp_length"].mean(),inplac
e=True)
C:\Users\HMHSM\AppData\Local\Temp\ipykernel_15092\273060775.py:2:
FutureWarning: A value is trying to be set on a copy of a DataFrame or
Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never
work because the intermediate object on which we are setting values
always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try
using 'df.method({col: value}, inplace=True)' or df[col] =
df[col].method(value) instead, to perform the operation inplace on the
original object.



df1["loan_int_rate"].fillna(df1["loan_int_rate"].mean(),inplace=True)
```

```
df1.isnull().sum()
```

```
person_age                    0
person_income                 0
person_home_ownership         0
person_emp_length             0
loan_intent                   0
loan_grade                    0
loan_amnt                     0
loan_int_rate                 0
loan_status                   0
loan_percent_income           0
cb_person_default_on_file     0
cb_person_cred_hist_length    0
dtype: int64
```

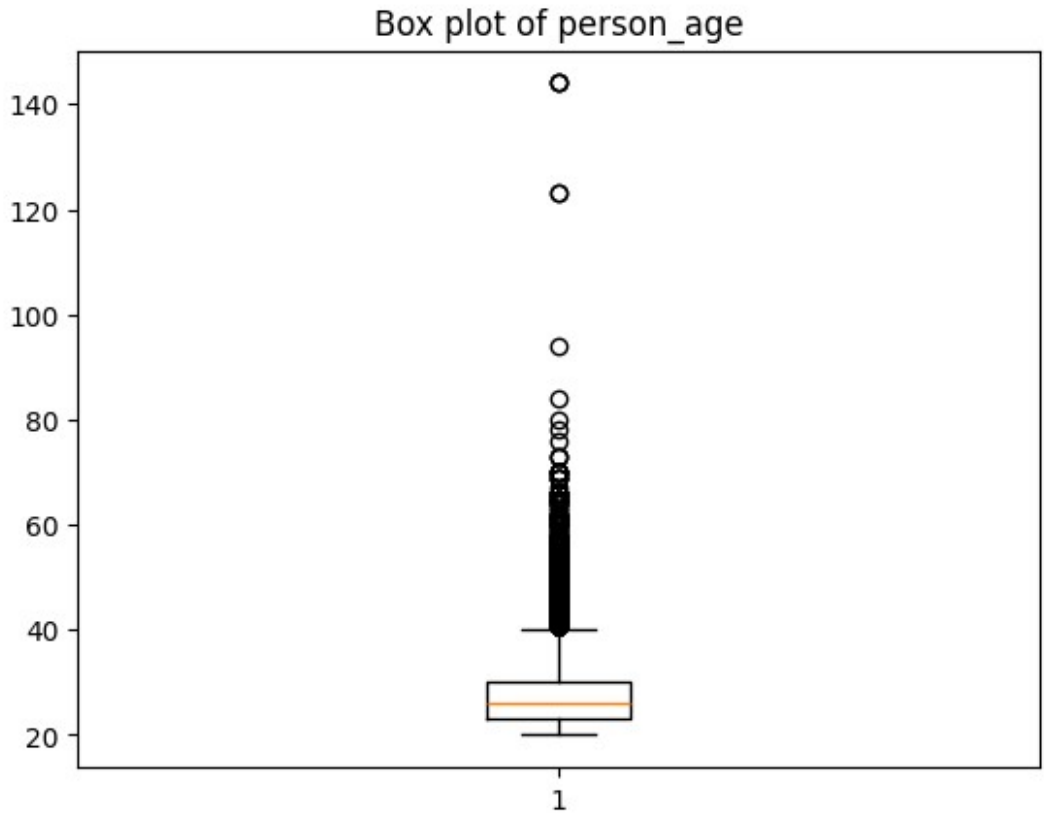
Handling the Outliers

```
a=df1.columns[df1.dtypes!=object]
a
```

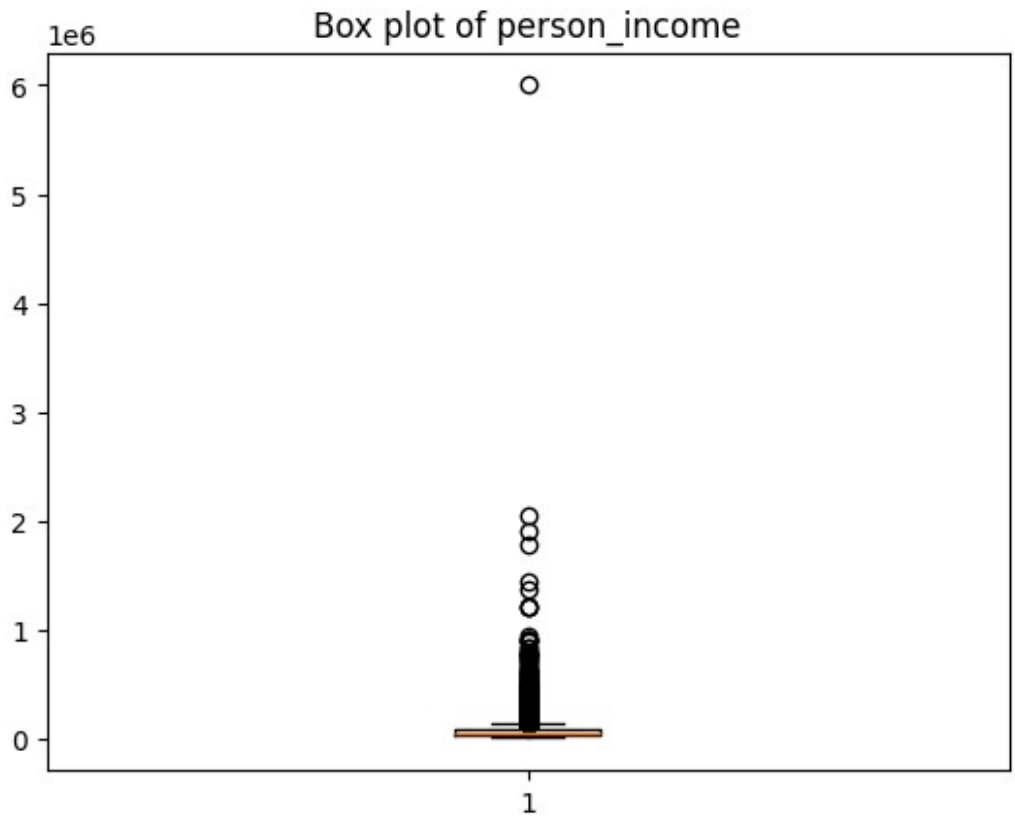
```
Index(['person_age', 'person_income', 'person_emp_length',
'loan_amnt',
       'loan_int_rate', 'loan_status', 'loan_percent_income',
       'cb_person_cred_hist_length'],
      dtype='object')
```

```
for i in df1.columns[df1.dtypes!=object]:
    print(i)
    plt.boxplot(df1[i])
    plt.title(f'Box plot of {i}')
    plt.show()
```

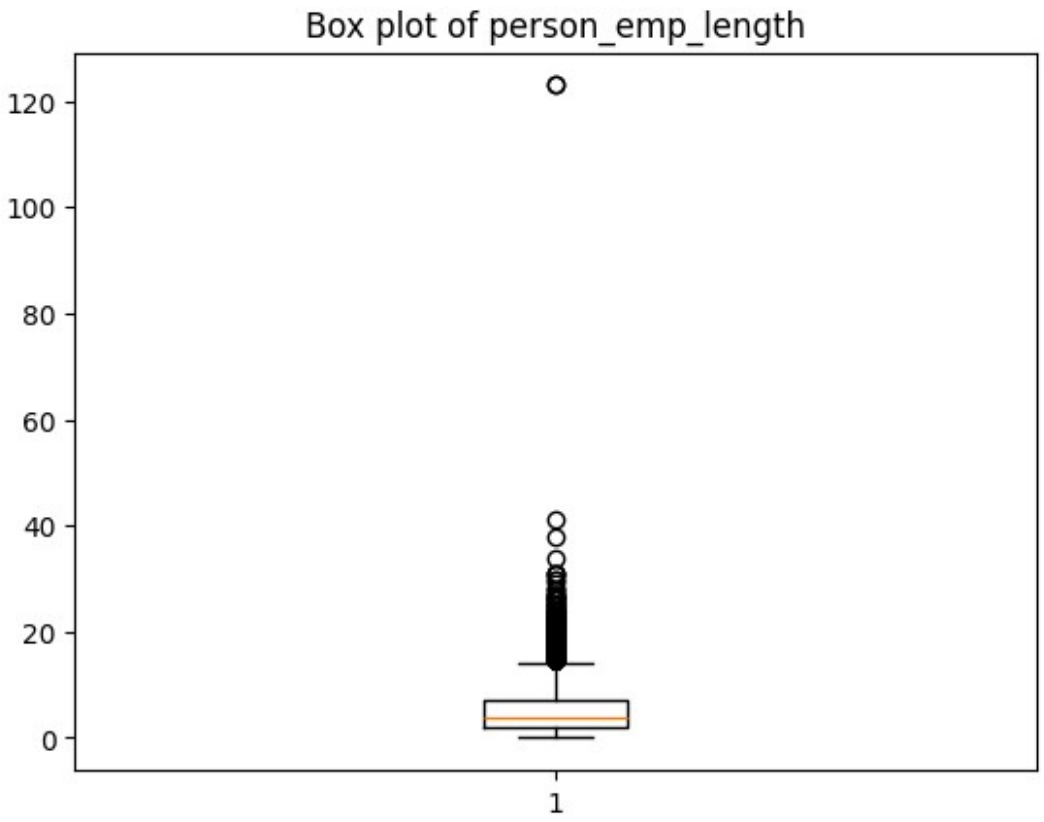
```
person_age
```



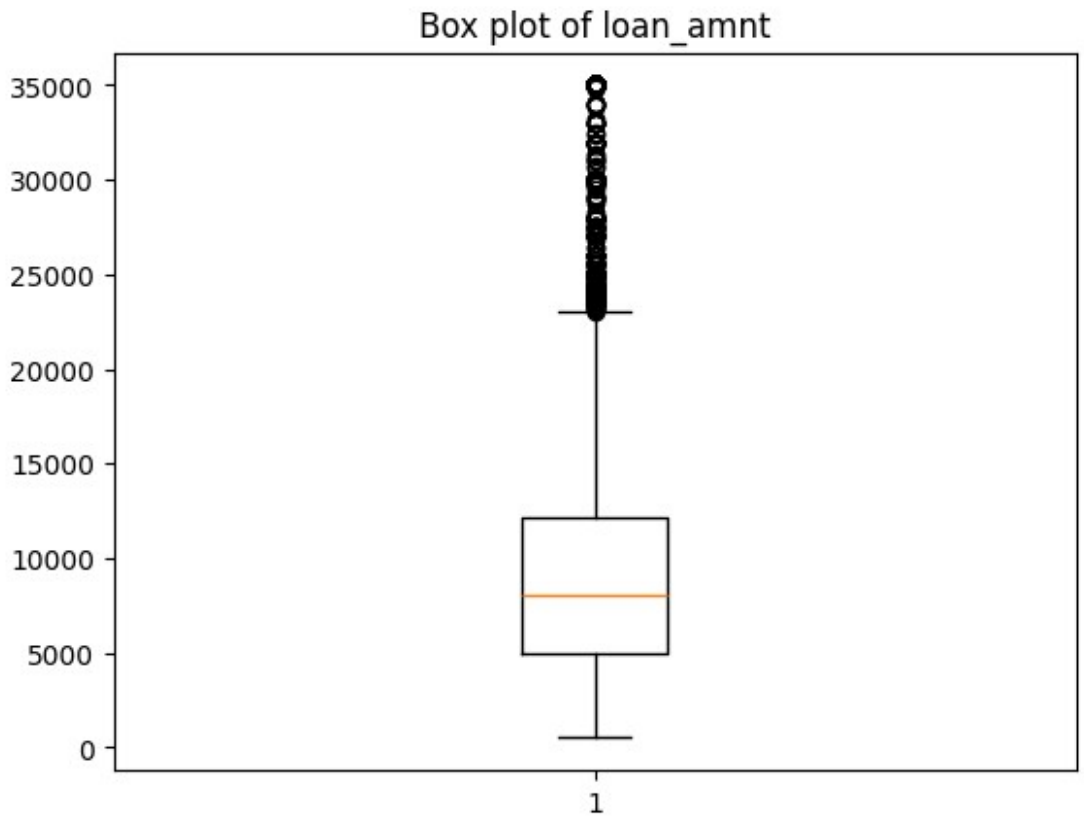

```
person_income
```



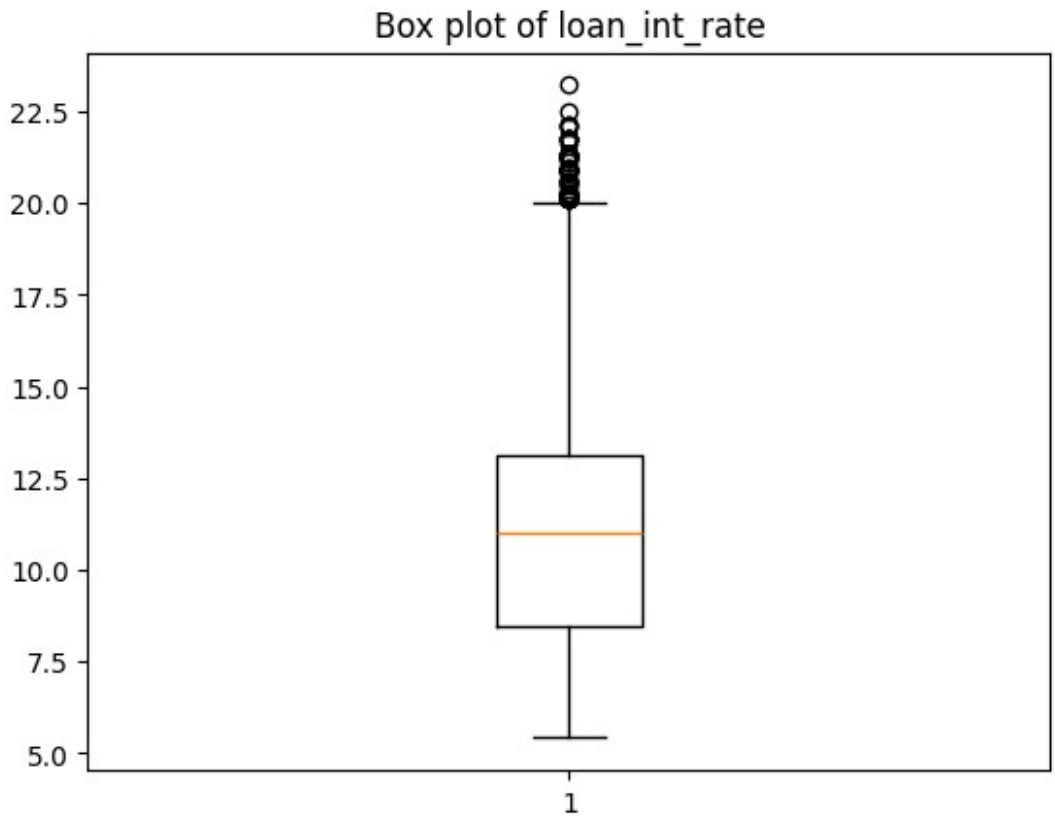

```
person_emp_length
```



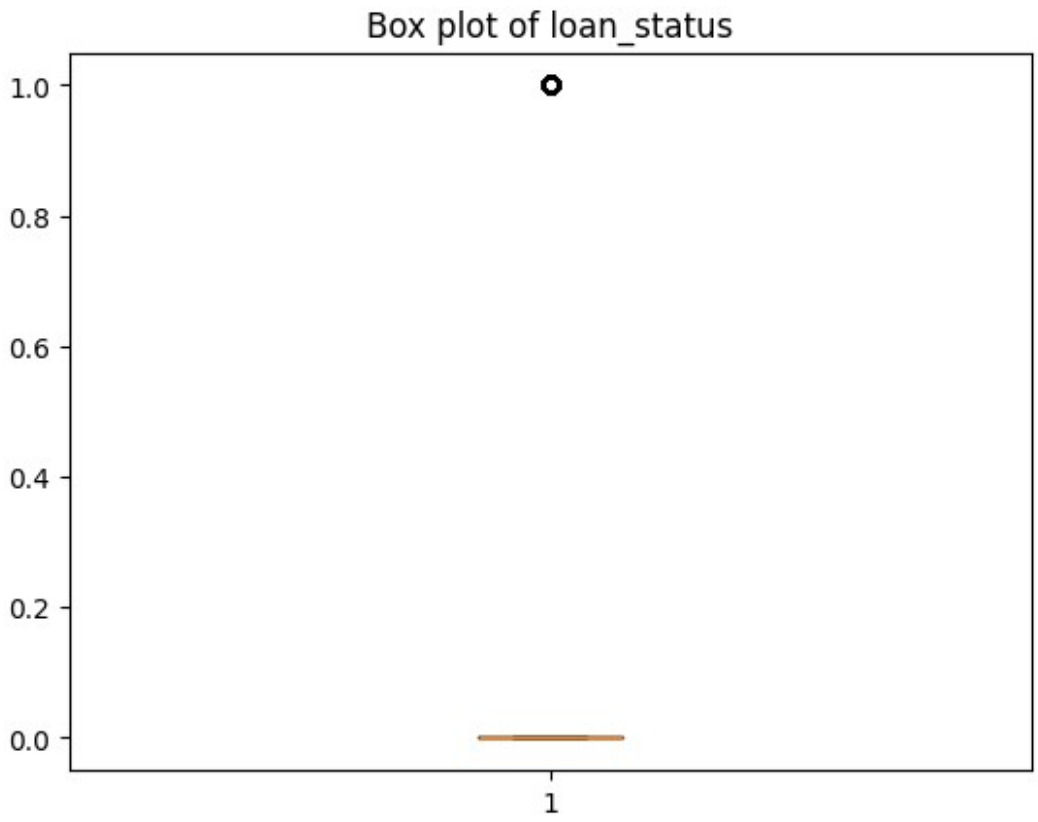

```
loan_amnt
```



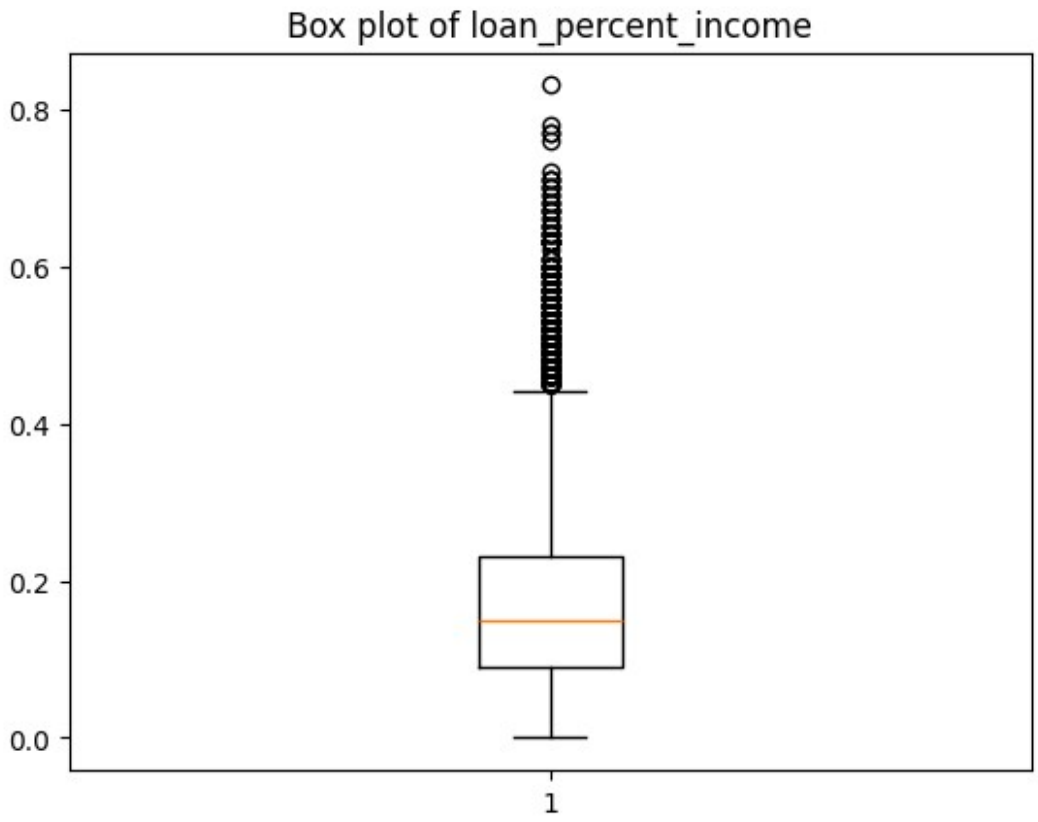

```
loan_int_rate
```



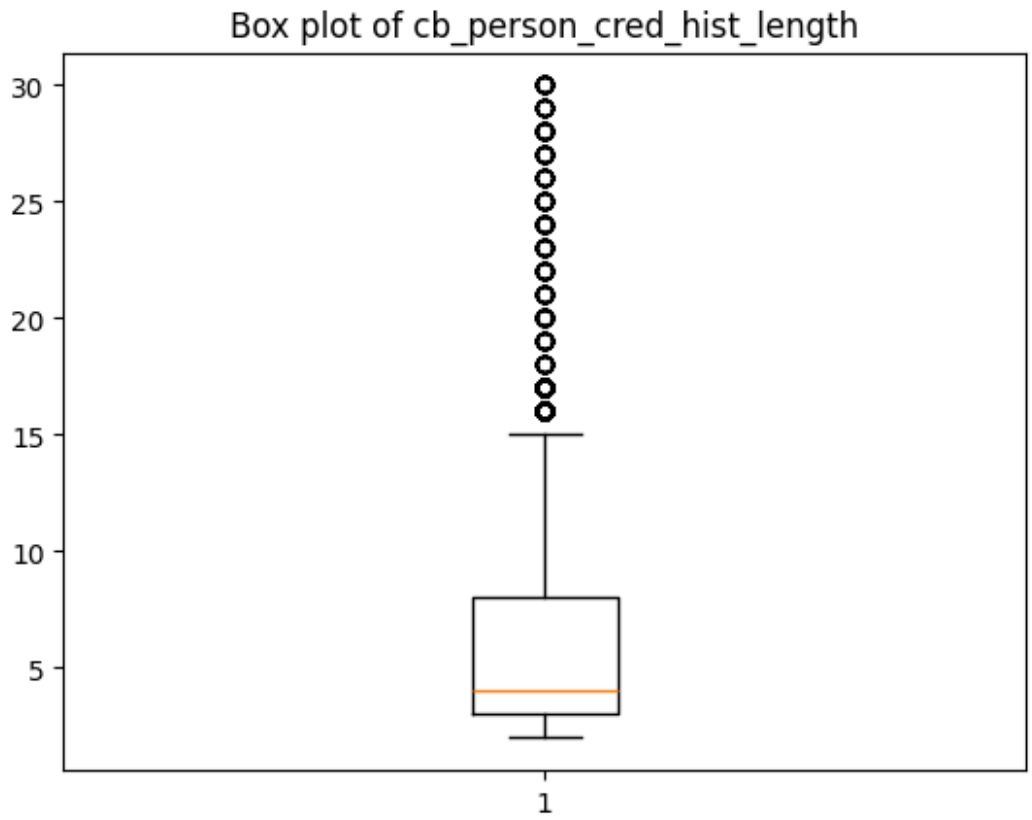

```
loan_status
```




```
loan_percent_income
```




```
cb_person_cred_hist_length
```




```
# for i in df1.columns[df1.dtypes!=object]:
#     print(i)
#     sns.boxplot(df1[i])
#     plt.title(f'Box plot of Value {i}')
#     plt.show()

df2=df1.copy()
df2.tail(3)
```

```
       person_age  person_income person_home_ownership
person_emp_length  \
32578          65          76000                  RENT
3.0
32579          56         150000              MORTGAGE
5.0
32580          66          42000                  RENT
2.0

           loan_intent loan_grade  loan_amnt  loan_int_rate
loan_status  \
32578  HOMEIMPROVEMENT          B      35000          10.99
1
32579         PERSONAL          B      15000          11.48
0
```

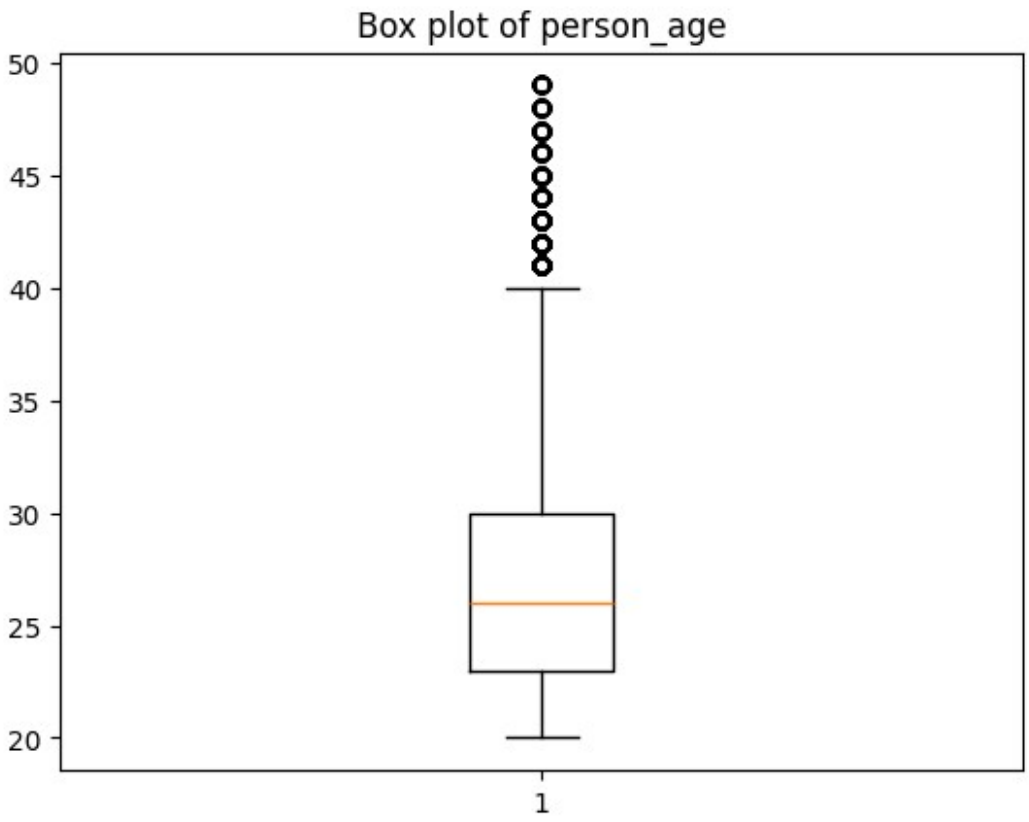
```
32580          MEDICAL           B       6475            9.99
0

       loan_percent_income cb_person_default_on_file  \
32578                 0.46                         N
32579                 0.10                         N
32580                 0.15                         N

       cb_person_cred_hist_length
32578                          28
32579                          26
32580                          30
```

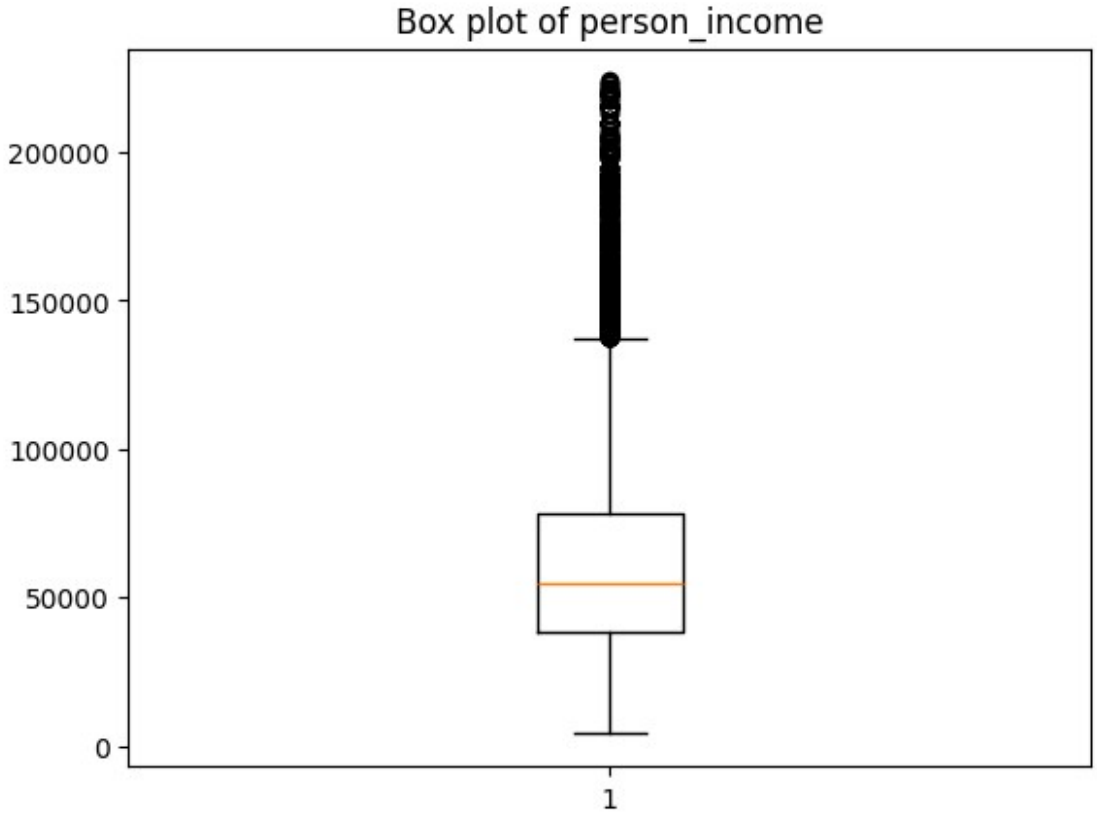
Removing outliers

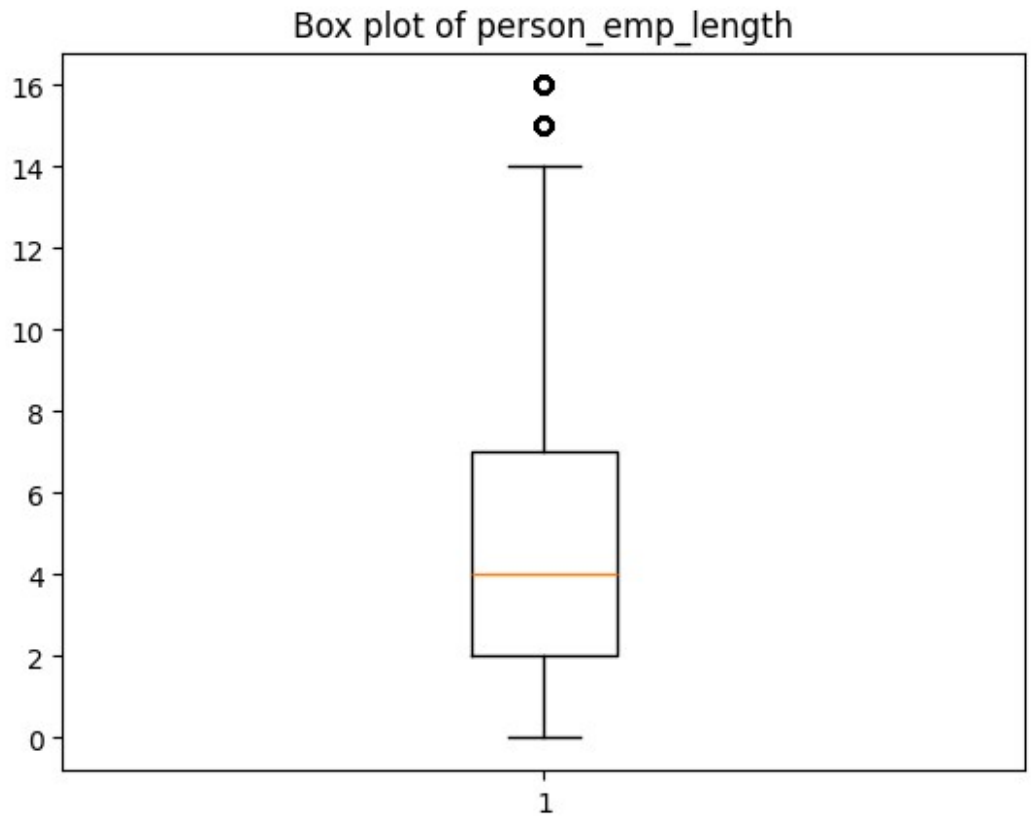
```
q = df2['person_age'].quantile(0.99)
data_cleaned = df2[df2['person_age']<q]

q=data_cleaned["person_income"].quantile(0.99)
data_cleaned = data_cleaned[data_cleaned['person_income']<q]

q=data_cleaned["person_emp_length"].quantile(0.99)
data_cleaned = data_cleaned[data_cleaned['person_emp_length']<q]

data_cleaned.head(2)
```

```
   person_age  person_income person_home_ownership  person_emp_length
\
1          21           9600                    OWN                5.0

2          25           9600               MORTGAGE                1.0


  loan_intent loan_grade  loan_amnt  loan_int_rate  loan_status  \
1   EDUCATION          B       1000          11.14            0
2     MEDICAL          C       5500          12.87            1

   loan_percent_income cb_person_default_on_file
cb_person_cred_hist_length
1                 0.10                         N
2
2                 0.57                         N
3
```

```
a=["person_age","person_income","person_emp_length"]
for i in a:
    plt.boxplot(data_cleaned[i])
    plt.title(f'Box plot of {i}')
    plt.show()
```


Box plot of person_age
50
45
40
35
30
25
20
1


Box plot of person_income
200000
150000
100000
50000
0
1




```
data_cleaned.describe()
```

	person_age	person_income	person_emp_length	loan_amnt	\
count	31489.000000	31489.000000	31489.000000	31489.000000	
mean	27.247737	62282.423894	4.563900	9479.432500	
std	5.355124	33833.120036	3.569489	6200.516988	
min	20.000000	4000.000000	0.000000	500.000000	
25%	23.000000	38200.000000	2.000000	5000.000000	
50%	26.000000	55000.000000	4.000000	8000.000000	
75%	30.000000	78000.000000	7.000000	12000.000000	
max	49.000000	224000.000000	16.000000	35000.000000	

	loan_int_rate	loan_status	loan_percent_income	\
count	31489.000000	31489.000000	31489.000000	
mean	11.000872	0.219473	0.171721	
std	3.075038	0.413896	0.106653	
min	5.420000	0.000000	0.010000	
25%	8.490000	0.000000	0.090000	
50%	11.011695	0.000000	0.150000	
75%	13.110000	0.000000	0.230000	
max	23.220000	1.000000	0.830000	

	cb_person_cred_hist_length
count	31489.000000

```
mean                      5.529201
std                       3.599184
min                       2.000000
25%                       3.000000
50%                       4.000000
75%                       8.000000
max                      17.000000
```

```
data_cleaned['cb_person_default_on_file'].value_counts()
```

```
cb_person_default_on_file
N    25965
Y     5524
Name: count, dtype: int64
```

Machine learning

```
data_cleaned.head()
```

```
   person_age  person_income person_home_ownership  person_emp_length
\
1          21           9600                    OWN                5.0

2          25           9600               MORTGAGE                1.0

3          23          65500                   RENT                4.0

4          24          54400                   RENT                8.0

5          21           9900                    OWN                2.0


  loan_intent loan_grade  loan_amnt  loan_int_rate  loan_status  \
1   EDUCATION          B       1000          11.14            0
2     MEDICAL          C       5500          12.87            1
3     MEDICAL          C      35000          15.23            1
4     MEDICAL          C      35000          14.27            1
5     VENTURE          A       2500           7.14            1

   loan_percent_income cb_person_default_on_file
cb_person_cred_hist_length
1                  0.10                       N
2
2                  0.57                       N
3
3                  0.53                       N
2
4                  0.55                       Y
4
```

```
5                  0.25                            N
2
```

Convert categorical into Numerical

```
data_cleaned["loan_grade"]=pd.Categorical(data_cleaned["loan_grade"]).
codes
data_cleaned["person_home_ownership"]=pd.Categorical(data_cleaned["per
son_home_ownership"]).codes
data_cleaned["loan_intent"]=pd.Categorical(data_cleaned["loan_intent"]
).codes
data_cleaned["cb_person_default_on_file"]=pd.Categorical(data_cleaned[
"cb_person_default_on_file"]).codes

X = data_cleaned.drop(columns = ['cb_person_default_on_file'])
y = data_cleaned['cb_person_default_on_file']

X
```

```
       person_age  person_income  person_home_ownership
person_emp_length  \
1              21           9600                      2
5.0
2              25           9600                      0
1.0
3              23          65500                      3
4.0
4              24          54400                      3
8.0
5              21           9900                      2
2.0
...           ...            ...                    ...
...
32290          37          90000                      0
11.0
32292          38         200000                      0
0.0
32293          38         110000                      0
5.0
32295          42         101000                      0
6.0
32296          40          52000                      3
2.0

       loan_intent  loan_grade  loan_amnt  loan_int_rate  loan_status
\
1                1           1       1000          11.14            0

2                3           2       5500          12.87            1
```

```
3                3           2      35000           15.23             1

4                3           2      35000           14.27             1

5                5           0       2500            7.14             1

...            ...         ...        ...             ...           ...

32290            0           0       4000            6.62             0

32292            0           0       3000            7.68             0

32293            3           1      16000           11.99             0

32295            0           5      25000           16.15             1

32296            1           5      15000           18.62             1


       loan_percent_income  cb_person_cred_hist_length
1                     0.10                           2
2                     0.57                           3
3                     0.53                           2
4                     0.55                           4
5                     0.25                           2
...                    ...                         ...
32290                 0.04                          15
32292                 0.01                          12
32293                 0.15                          13
32295                 0.25                          14
32296                 0.29                          16

[31489 rows x 11 columns]

X.info()

<class 'pandas.core.frame.DataFrame'>
Index: 31489 entries, 1 to 32296
Data columns (total 11 columns):
 #   Column                      Non-Null Count  Dtype
---  ------                      --------------  -----
 0   person_age                  31489 non-null  int64
 1   person_income               31489 non-null  int64
 2   person_home_ownership       31489 non-null  int8
 3   person_emp_length           31489 non-null  float64
 4   loan_intent                 31489 non-null  int8
 5   loan_grade                  31489 non-null  int8
 6   loan_amnt                   31489 non-null  int64
 7   loan_int_rate               31489 non-null  float64
 8   loan_status                 31489 non-null  int64
 9   loan_percent_income         31489 non-null  float64
```

```
 10  cb_person_cred_hist_length  31489 non-null  int64
dtypes: float64(3), int64(5), int8(3)
memory usage: 2.3 MB

X["loan_grade"].unique()

array([1, 2, 0, 3, 4, 5, 6], dtype=int8)
```

Convert into Standard Scalar

```
scalar = StandardScaler()
X_scaled = scalar.fit_transform(X)

X_scaled

array([[-1.16670255, -1.55715052,  0.21493469, ..., -0.53027015,
        -0.67248132, -0.98057147],
       [-0.4197425 , -1.55715052, -1.18241817, ...,  1.88583123,
         3.73438949, -0.70272627],
       [-0.79322252,  0.09510288,  0.91361112, ...,  1.88583123,
         3.35933665, -0.98057147],
       ...,
       [ 2.00787768,  1.41040299, -1.18241817, ..., -0.53027015,
        -0.20366528,  2.07572575],
       [ 2.75483774,  1.14438724, -1.18241817, ...,  1.88583123,
         0.73396681,  2.35357095],
       [ 2.38135771, -0.30392075,  0.91361112, ...,  1.88583123,
         1.10901964,  2.90926135]])
```

Split Test and Train Dataset

```
x_train,x_test,y_train,y_test = train_test_split(X_scaled,y,
test_size= 0.25, random_state = 355)
```

Performance Matrics Method

```
import numpy as np
def evaluate_model(y_test, y_pred):
    conf_mat = confusion_matrix(y_test,y_pred)
    true_positive = conf_mat[0][0]
    false_positive = conf_mat[0][1]
    false_negative = conf_mat[1][0]
    true_negative = conf_mat[1][1]
    Accuracy = (true_positive + true_negative) / (true_positive
+false_positive + false_negative + true_negative)*100
    Precision = true_positive/(true_positive+false_positive)*100
    Recall = true_positive/(true_positive+false_negative)*100
    F1_Score = 2*(Recall * Precision) / (Recall + Precision)
```

```
    auc = roc_auc_score(y_test, y_pred)*100
    return Accuracy,Precision,Recall,F1_Score,auc
```

Hyperparameter Tunning

```
# Models and their Different Hyperparameter

models = [
        {"name": "LogisticRegression","estimator":
LogisticRegression(),
         "hyperparameters":{"solver": ["newton-cg", "lbfgs",
"liblinear"]}},

        {"name": "KNeighborsClassifier","estimator":
KNeighborsClassifier(),
         "hyperparameters":{"n_neighbors": range(1,20,2),
                            "weights": ["distance", "uniform"],
                            "algorithm": ["ball_tree", "kd_tree",
"brute"],
                            "p": [1,2]}},

        {"name": "RandomForestClassifier",
         "estimator": RandomForestClassifier(random_state=1),
         "hyperparameters":{"n_estimators": [4, 6, 9],
                            "criterion": ["entropy", "gini"],
                            "max_depth": [2, 5, 10],
                            "max_features": ["log2", "sqrt"],
                            "min_samples_leaf": [1, 5,
8],"min_samples_split": [2, 3, 5]}},

        {"name": "DecisionTreeClassifier",
        "estimator": DecisionTreeClassifier(),
        "hyperparameters":{"criterion": ["entropy", "gini"],
                            "max_depth": [2, 5, 10],
                            "max_features": ["log2", "sqrt"],
                            "min_samples_leaf": [1, 5, 8],
                            "min_samples_split": [2, 3, 5]}},

        {"name": "MLPClassifier",
        "estimator":MLPClassifier(),
        "hyperparameters":{"hidden_layer_sizes":[(8,8), (64,64),
(128,128)]}}
]


for model in models:
    print(model["name"])
    print("-"*len(model["name"]))
    search = GridSearchCV(model["estimator"],
                          param_grid = model["hyperparameters"],cv
```

```
=10)
    search.fit(x_train,y_train)
    print(search.best_score_)
    print(search.best_params_)
    print("")

LogisticRegression
------------------
0.8249071580556324
{'solver': 'newton-cg'}

KNeighborsClassifier
--------------------
0.8341802885658532
{'algorithm': 'kd_tree', 'n_neighbors': 17, 'p': 2, 'weights':
'distance'}

RandomForestClassifier
----------------------

c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\numpy\ma\
core.py:2820: RuntimeWarning: invalid value encountered in cast
  _data = np.array(data, dtype=dtype, copy=copy,

0.8316812757119735
{'criterion': 'entropy', 'max_depth': 10, 'max_features': 'log2',
'min_samples_leaf': 8, 'min_samples_split': 2, 'n_estimators': 9}

DecisionTreeClassifier
----------------------
0.8321898397649354
{'criterion': 'entropy', 'max_depth': 5, 'max_features': 'sqrt',
'min_samples_leaf': 1, 'min_samples_split': 3}

MLPClassifier
-------------

c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
```

```
  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
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  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
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c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
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  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
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  warnings.warn(
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neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
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Stochastic Optimizer: Maximum iterations (200) reached and the
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  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
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Stochastic Optimizer: Maximum iterations (200) reached and the
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  warnings.warn(
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neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
```

```
optimization hasn't converged yet.
  warnings.warn(
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neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
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Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
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neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(
c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
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optimization hasn't converged yet.
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c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(

0.8305811233274554
{'hidden_layer_sizes': (128, 128)}


c:\Users\HMHSM\anaconda3\envs\OCR\lib\site-packages\sklearn\
neural_network\_multilayer_perceptron.py:690: ConvergenceWarning:
Stochastic Optimizer: Maximum iterations (200) reached and the
optimization hasn't converged yet.
  warnings.warn(

## Train multiple models
```

```
models={
    'KNeighborsClassifier': KNeighborsClassifier(algorithm= 'kd_tree',
n_neighbors= 17, p= 2, weights= 'distance'),
    'RandomForestClassifier':RandomForestClassifier(criterion=
'entropy', max_depth= 10, max_features= 'log2', min_samples_leaf= 8,
min_samples_split= 2, n_estimators= 9),
    'LogisticRegression':LogisticRegression(solver= "newton-cg"),
    'DecisionTreeClassifier':DecisionTreeClassifier(criterion=
'entropy', max_depth= 10, max_features= 'log2', min_samples_leaf= 1,
min_samples_split= 2),
    'MLPClassifier': MLPClassifier(hidden_layer_sizes= (8, 8))
}
trained_model_list=[]
model_list=[]
F1_Score_list=[]

for i in range(len(list(models))):
    model=list(models.values())[i]
    model.fit(x_train,y_train)

    #Make Predictions
    y_pred=model.predict(x_test)


Accuracy,Precision,Recall,F1_Score,auc=evaluate_model(y_test,y_pred)

    print(list(models.keys())[i])
    model_list.append(list(models.keys())[i])

    print('Model Training Performance')
    print("Accuracy:",Accuracy)
    print("Precision:",Precision)
    print("Recall",Recall)
    print("F1_Score:",F1_Score)
    print("auc",auc)



    F1_Score_list.append(F1_Score)

    print('='*35)
    print('\n')
```

```
KNeighborsClassifier
Model Training Performance
Accuracy: 82.8273847326305
Precision: 91.07417666974453
Recall 88.46038863976084
F1_Score: 89.74825599029421
auc 67.464361062145
```

```
==================================


RandomForestClassifier
Model Training Performance
Accuracy: 82.91629620221008
Precision: 88.36565096952909
Recall 90.69657242141842
F1_Score: 89.5159404474238
auc 72.76464366658271
==================================


LogisticRegression
Model Training Performance
Accuracy: 82.67496507049408
Precision: 93.18251769775316
Recall 86.79759174311926
F1_Score: 89.87679976250556
auc 63.10034975796748
==================================


DecisionTreeClassifier
Model Training Performance
Accuracy: 82.56065032389178
Precision: 87.90397045244691
Recall 90.68106048579139
F1_Score: 89.27092287254825
auc 72.60653068076891
==================================


MLPClassifier
Model Training Performance
Accuracy: 82.92899784072145
Precision: 85.61095721760542
Recall 93.15137307434695
F1_Score: 89.22213311948677
auc 77.93275133607544
==================================
```

The best model is MLP with AUC/ROC score 77%. We consider AUC/ROC score because data is imbalanced.