In [663...
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [664...
```
df = pd.read_csv("/Users/dev/Personal/DS & AI Class Notes/Data Sets/Adaboos
```

In [665...
```
df.drop("Loan_ID",axis=1,inplace=True)
df
```

Out[665...

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

614 rows × 12 columns

In [666...
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 614 entries, 0 to 613
Data columns (total 12 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   Gender             601 non-null    object 
 1   Married            611 non-null    object 
 2   Dependents         599 non-null    object 
 3   Education          614 non-null    object 
 4   Self_Employed      582 non-null    object 
 5   ApplicantIncome    614 non-null    int64  
 6   CoapplicantIncome  614 non-null    float64
 7   LoanAmount         592 non-null    float64
 8   Loan_Amount_Term   600 non-null    float64
 9   Credit_History     564 non-null    float64
 10  Property_Area      614 non-null    object 
 11  Loan_Status        614 non-null    object 
dtypes: float64(4), int64(1), object(7)
memory usage: 57.7+ KB
```

Replacing df["Dependents"] values by str to int. by Regex

In [667…

```
df["Dependents"].replace("[^0-9.]","",regex=True,inplace=True)
```

Removing Nans

In [668…

```
df.isna().sum()
```

Out[668…

```
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 [669…

```
df["Gender"].fillna(method='pad',inplace=True)
```

In [670…

```
df["Married"].fillna(method='pad',inplace=True)
```

In [671…

```
df["Dependents"].fillna(method='pad',inplace=True)
```

In [672…
```
df["Self_Employed"].fillna(method='pad',inplace=True)
```

In [673…
```
def nanremove(df):
    m = round(df.mean(),2)
    df.replace(np.nan,m,inplace = True)
```

In [674…
```
nanremove(df["LoanAmount"])
```

In [675…
```
nanremove(df["Loan_Amount_Term"])
```

In [676…
```
nanremove(df["Credit_History"])
```

In [677…
```
df.isna().sum()
```

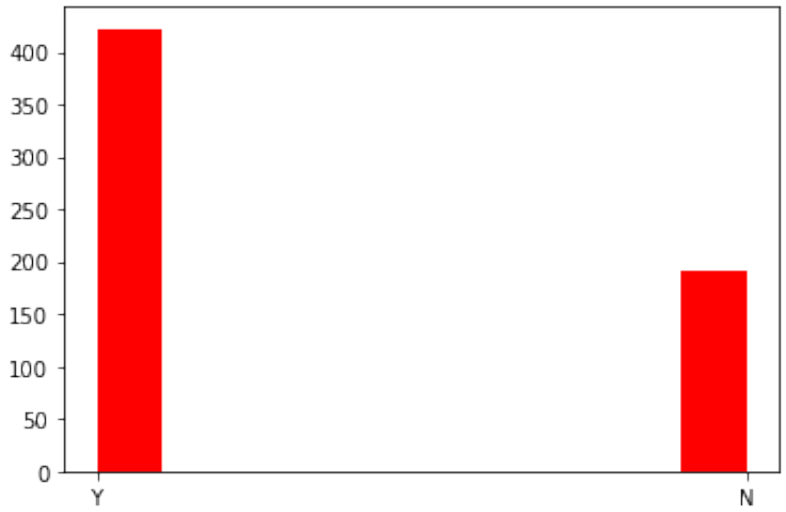
Out[677…
```
Gender               0
Married              0
Dependents           0
Education            0
Self_Employed        0
ApplicantIncome      0
CoapplicantIncome    0
LoanAmount           0
Loan_Amount_Term     0
Credit_History       0
Property_Area        0
Loan_Status          0
dtype: int64
```

Checking Balance of DF

In [678…
```
df["Loan_Status"].value_counts()
```

Out[678…
```
Y    422
N    192
Name: Loan_Status, dtype: int64
```

In [679…
```
plt.hist(df["Loan_Status"],color='Red')
plt.show()
```



Checking And Removing 0's

In [680…
```
def checkz(df):
    return df[df == 0].value_counts()
```

In [681…
```
for i in df.columns:
    print(checkz(df[i]))
```

```
Series([], Name: Gender, dtype: int64)
Series([], Name: Married, dtype: int64)
Series([], Name: Dependents, dtype: int64)
Series([], Name: Education, dtype: int64)
Series([], Name: Self_Employed, dtype: int64)
Series([], Name: ApplicantIncome, dtype: int64)
0.0    273
Name: CoapplicantIncome, dtype: int64
Series([], Name: LoanAmount, dtype: int64)
Series([], Name: Loan_Amount_Term, dtype: int64)
0.0    89
Name: Credit_History, dtype: int64
Series([], Name: Property_Area, dtype: int64)
Series([], Name: Loan_Status, dtype: int64)
```

In [682…
```
df.columns
```

Out[682…
```
Index(['Gender', 'Married', 'Dependents', 'Education', 'Self_Employed',
       'ApplicantIncome', 'CoapplicantIncome', 'LoanAmount',
       'Loan_Amount_Term', 'Credit_History', 'Property_Area', 'Loan_Status'
],
      dtype='object')
```

In [683…
```
clist = [ 'Dependents','ApplicantIncome', 'CoapplicantIncome',
          'LoanAmount','Loan_Amount_Term', 'Credit_History', ]
```

In [684…
```
for i in clist:
    zeroremove(df[i])
```

In [685…
```
for i in df.columns:
    print(checkz(df[i]))
```

```
Series([], Name: Gender, dtype: int64)
Series([], Name: Married, dtype: int64)
Series([], Name: Dependents, dtype: int64)
Series([], Name: Education, dtype: int64)
Series([], Name: Self_Employed, dtype: int64)
Series([], Name: ApplicantIncome, dtype: int64)
Series([], Name: CoapplicantIncome, dtype: int64)
Series([], Name: LoanAmount, dtype: int64)
Series([], Name: Loan_Amount_Term, dtype: int64)
Series([], Name: Credit_History, dtype: int64)
Series([], Name: Property_Area, dtype: int64)
Series([], Name: Loan_Status, dtype: int64)
```

OD_Tech With The help of Skew

In [686…
```
def odiqr(df):
    q1 = df.quantile(0.25)
    q3 = df.quantile(0.75)
    iqr = q3 - q1
    low = q1 - (1.5 * iqr)
    high = q3 + (1.5 * iqr)
    m = df.mean()
    df = df.apply(lambda x : m if x < low else (m if x > high else x ) )
    return df
```

In [687…
```
def odmsd(df):
    m = round(df.mean(),2)
    s = round(df.std(),2)
    low = round(m-(3*s),2)
    high = round(m+(3*s),2)
    ft1 = df[df<low]
    ft2 = df[df>high]
    df = df.map(lambda x : low if x < low else (high if x > high else x ))
```

In [688…
```
for i in clist:
    print(f'{i} is {df[i].skew()}')
```

```
Dependents is 0.9764220531079079
ApplicantIncome is 6.539513113994625
CoapplicantIncome is 9.677702794378638
LoanAmount is 2.7266039186591304
Loan_Amount_Term is -2.3896799467122745
Credit_History is -1.3108351339315514
```

In [689…
```
for i in clist:
    print(f'{i} is {df[i].dtype}')
```

```
Dependents is object
ApplicantIncome is int64
CoapplicantIncome is float64
LoanAmount is float64
Loan_Amount_Term is float64
Credit_History is float64
```

Bcz df["Dependents"] is str type

In [690…
```
df["Dependents"] = df["Dependents"].astype(int)
```

In [691…
```
for i in clist:
    if df[i].skew() <= 0.5:
        odmsd(df[i])
    else:
        df[i] = odiqr(df[i])
```

In [692…
```
for i in clist:
    print(f'{i} is {df[i].skew()}')
```

```
Dependents is 0.9764220531079079
ApplicantIncome is 0.9131963245496909
CoapplicantIncome is 0.6991764314798369
LoanAmount is 0.36795693965510146
Loan_Amount_Term is -2.3896799467122745
Credit_History is -1.3108351339315514
```

In [693…
```
df
```

Out[693...

	Gender	Married	Dependents	Education	Self_Employed	ApplicantIncome	Coapplica
0	Male	No	0	Graduate	No	5849.0	162
1	Male	Yes	1	Graduate	No	4583.0	150
2	Male	Yes	0	Graduate	Yes	3000.0	162
3	Male	Yes	0	Not Graduate	No	2583.0	235
4	Male	No	0	Graduate	No	6000.0	162
...	...	...	...	...	...	...	
609	Female	No	0	Graduate	No	2900.0	162
610	Male	Yes	3	Graduate	No	4106.0	162
611	Male	Yes	1	Graduate	No	8072.0	234
612	Male	Yes	2	Graduate	No	7583.0	162
613	Female	No	0	Graduate	Yes	4583.0	162

614 rows × 12 columns

In [694...
```
from sklearn.preprocessing import OneHotEncoder
```

In [695...
```
ohe = OneHotEncoder(drop='first')
```

In [696...
```
df = pd.concat([df,pd.DataFrame(ohe.fit_transform(df[["Gender"]]).toarray()
                                columns=["Male"])],axis=1).drop("Gender",ax
```

In [697...
```
ohe.categories_
```

Out[697...
```
[array(['Female', 'Male'], dtype=object)]
```

In [698...
```
df
```

Out[698…

	Married	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome
0	No	0	Graduate	No	5849.0	1621.250000
1	Yes	1	Graduate	No	4583.0	1508.000000
2	Yes	0	Graduate	Yes	3000.0	1621.250000
3	Yes	0	Not Graduate	No	2583.0	2358.000000
4	No	0	Graduate	No	6000.0	1621.250000
...	...	...	...	...	...	...
609	No	0	Graduate	No	2900.0	1621.250000
610	Yes	3	Graduate	No	4106.0	1621.250000
611	Yes	1	Graduate	No	8072.0	2342.094739
612	Yes	2	Graduate	No	7583.0	1621.250000
613	No	0	Graduate	Yes	4583.0	1621.250000

614 rows × 12 columns

In [699…
```
ohe1 = OneHotEncoder(drop='first')
```

In [700…
```
df = pd.concat([df,pd.DataFrame(ohe1.fit_transform(df[["Married"]]).toarray
                axis=1).drop("Married",axis=1)
```

In [701…
```
ohe1.categories_
```

Out[701…
```
[array(['No', 'Yes'], dtype=object)]
```

In [702…
```
df
```

Out[702…

	Dependents	Education	Self_Employed	ApplicantIncome	CoapplicantIncome	LoanAm
0	0	Graduate	No	5849.0	1621.250000	14
1	1	Graduate	No	4583.0	1508.000000	12
2	0	Graduate	Yes	3000.0	1621.250000	6
3	0	Not Graduate	No	2583.0	2358.000000	12
4	0	Graduate	No	6000.0	1621.250000	14
...	...	...	...	...	...	
609	0	Graduate	No	2900.0	1621.250000	
610	3	Graduate	No	4106.0	1621.250000	4
611	1	Graduate	No	8072.0	2342.094739	25
612	2	Graduate	No	7583.0	1621.250000	18
613	0	Graduate	Yes	4583.0	1621.250000	13

614 rows × 12 columns

In [703…
```
ohe2 = OneHotEncoder(drop='first')
```

In [704…
```
ohe2.fit(df[["Education"]])
```

Out[704… `OneHotEncoder(drop='first')`

In [705…
```
ohe2.categories_
```

Out[705… `[array(['Graduate', 'Not Graduate'], dtype=object)]`

In [706…
```
df = pd.concat([df,pd.DataFrame(ohe2.fit_transform(df[["Education"]]).toarı
                                dtype=int,columns=["Not Graduate"])],axis=1
```

In [707…
```
df
```

Out[707…

	Dependents	Self_Employed	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_
0	0	No	5849.0	1621.250000	146.41	
1	1	No	4583.0	1508.000000	128.00	
2	0	Yes	3000.0	1621.250000	66.00	
3	0	No	2583.0	2358.000000	120.00	
4	0	No	6000.0	1621.250000	141.00	
...	...	...	...	...	...	
609	0	No	2900.0	1621.250000	71.00	
610	3	No	4106.0	1621.250000	40.00	
611	1	No	8072.0	2342.094739	253.00	
612	2	No	7583.0	1621.250000	187.00	
613	0	Yes	4583.0	1621.250000	133.00	

614 rows × 12 columns

In [708…
```
ohe3 = OneHotEncoder(drop='first')
```

In [709…
```
ohe3.fit(df[["Self_Employed"]])
```

Out[709… `OneHotEncoder(drop='first')`

In [710…
```
ohe3.categories_
```

Out[710… `[array(['No', 'Yes'], dtype=object)]`

In [711…
```
df = pd.concat([df,pd.DataFrame(ohe3.fit_transform(df[["Self_Employed"]]).t
                                dtype=int,columns=["Self_Employed_Yes"])],a
```

In [712…
```
df
```

Out[712...

	Dependents	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term
0	0	5849.0	1621.250000	146.41	360.0
1	1	4583.0	1508.000000	128.00	360.0
2	0	3000.0	1621.250000	66.00	360.0
3	0	2583.0	2358.000000	120.00	360.0
4	0	6000.0	1621.250000	141.00	360.0
...	...	...	...	...	...
609	0	2900.0	1621.250000	71.00	360.0
610	3	4106.0	1621.250000	40.00	180.0
611	1	8072.0	2342.094739	253.00	360.0
612	2	7583.0	1621.250000	187.00	360.0
613	0	4583.0	1621.250000	133.00	360.0

614 rows × 12 columns

In [713...
```
ohe4 = OneHotEncoder()
```

In [714...
```
ohe4.fit(df[["Property_Area"]])
```

Out[714... OneHotEncoder()

In [715...
```
ohe4.categories_
```

Out[715... [array(['Rural', 'Semiurban', 'Urban'], dtype=object)]

In [716...
```
df = pd.concat([df,pd.DataFrame(ohe4.fit_transform(df[["Property_Area"]]).t
                                columns=['Rural','Semiurban','Urban'])],axi
```

In [717...
```
df
```

Out[717…

	Dependents	ApplicantIncome	CoapplicantIncome	LoanAmount	Loan_Amount_Term
0	0	5849.0	1621.250000	146.41	360.0
1	1	4583.0	1508.000000	128.00	360.0
2	0	3000.0	1621.250000	66.00	360.0
3	0	2583.0	2358.000000	120.00	360.0
4	0	6000.0	1621.250000	141.00	360.0
...	...	...	...	...	...
609	0	2900.0	1621.250000	71.00	360.0
610	3	4106.0	1621.250000	40.00	180.0
611	1	8072.0	2342.094739	253.00	360.0
612	2	7583.0	1621.250000	187.00	360.0
613	0	4583.0	1621.250000	133.00	360.0

614 rows × 14 columns

Encoding of df["Loan_Status"] with Label Encoder

In [718…
```
from sklearn.preprocessing import LabelEncoder
```

In [719…
```
le = LabelEncoder()
```

In [720…
```
le.fit(df["Loan_Status"])
```

Out[720… `LabelEncoder()`

In [721…
```
df = pd.concat([ df, pd.DataFrame(le.fit_transform(df["Loan_Status"]),colu
                ,axis=1).drop("Loan_Status",axis=1)
```

In [722…
```
le.classes_
```

Out[722… `array(['N', 'Y'], dtype=object)`

In [723…
```
df = df[['Male','Married_Yes','Dependents','Not Graduate',
         'Self_Employed_Yes','ApplicantIncome','CoapplicantIncome',
        'LoanAmount','Loan_Amount_Term','Credit_History','Rural','Semiurba
```

In [724...
```
df
```

Out[724...

	Male	Married_Yes	Dependents	Not Graduate	Self_Employed_Yes	ApplicantIncome	Coap
0	1	0	0	0	0	5849.0	
1	1	1	1	0	0	4583.0	
2	1	1	0	0	1	3000.0	
3	1	1	0	1	0	2583.0	
4	1	0	0	0	0	6000.0	
...	...	...	...	...	...	...	
609	0	0	0	0	0	2900.0	
610	1	1	3	0	0	4106.0	
611	1	1	1	0	0	8072.0	
612	1	1	2	0	0	7583.0	
613	0	0	0	0	1	4583.0	

614 rows × 14 columns

Splitting

In [725...
```
X = df.drop("LOAN_Status",axis=1)
```

In [726...
```
X.sample()
```

Out[726...

	Male	Married_Yes	Dependents	Not Graduate	Self_Employed_Yes	ApplicantIncome	Coap
281	1	1	0	0	0	3927.0	

In [727...
```
y = df["LOAN_Status"]
```

In [728...
```
y.sample()
```

Out[728...
```
363    1
Name: LOAN_Status, dtype: int64
```

In [729…
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import KFold , cross_val_score
from sklearn.svm import SVC
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier , AdaBoostClassifier
```

In [730…
```
Xtrain,Xtest,ytrain,ytest = train_test_split(X,y,test_size=.20)
```

In [731…
```
X.shape , Xtrain.shape , Xtest.shape
```

Out[731…
```
((614, 13), (491, 13), (123, 13))
```

In [732…
```
y.shape , ytrain.shape , ytest.shape
```

Out[732…
```
((614,), (491,), (123,))
```

In [733…
```
kf = KFold(n_splits=11)
```

In [734…
```
dct = DecisionTreeClassifier()
```

In [735…
```
rfc = RandomForestClassifier()
```

In [736…
```
algo = [ dct , rfc ]
```

Without Feature Scaling

In [737…
```
for i in algo:
    i.fit(Xtrain,ytrain)
    s = i.score(Xtest,ytest)
    print(f'{i} = {s}')
```

```
DecisionTreeClassifier() = 0.7317073170731707
RandomForestClassifier() = 0.7560975609756098
```

With Feature Scaling

In [738…
```
ss = StandardScaler()
```

In [739…
```
ss.fit(Xtrain)
```

Out[739… StandardScaler()

In [740…
```
Xtrain_ss = ss.transform(Xtrain)
```

In [741…
```
Xtest_ss = ss.transform(Xtest)
```

In [742…
```
for i in algo:
    i.fit(Xtrain_ss,ytrain)
    s = i.score(Xtest_ss,ytest)
    print(f'{i} = {s}')
```

```
DecisionTreeClassifier() = 0.7317073170731707
RandomForestClassifier() = 0.7804878048780488
```

With Cross Validation

In [743…
```
for i in algo:
    s = cross_val_score(i,X,y,cv = kf)
    print(f'{i} = {s.mean()}')
```

```
DecisionTreeClassifier() = 0.6514757969303425
RandomForestClassifier() = 0.7507969303423849
```

Boosting

In [744…
```
rfc1 = RandomForestClassifier(n_estimators=150,max_depth=2,max_leaf_nodes=3
```

In [745…
```
abc = AdaBoostClassifier()
```

In [746…
```
algo1 = [rfc1   , abc ]
```

In [747…
```
for i in algo1:
    print(i)
```

```
RandomForestClassifier(max_depth=2, max_leaf_nodes=3, n_estimators=150)
AdaBoostClassifier()
```

Without Feature Scaling

In [748…
```
for i in algo1:
    i.fit(Xtrain,ytrain)
    s = i.score(Xtest,ytest)
    print(f'{i} = {s}')
```

```
RandomForestClassifier(max_depth=2, max_leaf_nodes=3, n_estimators=150) = 0
.6910569105691057
AdaBoostClassifier() = 0.7642276422764228
```

With Feature Scaling

In [749…

```
for i in algo1:
    i.fit(Xtrain_ss,ytrain)
    s = i.score(Xtest_ss,ytest)
    print(f'{i} = {s}')
```

```
RandomForestClassifier(max_depth=2, max_leaf_nodes=3, n_estimators=150) = 0
.6910569105691057
AdaBoostClassifier() = 0.7642276422764228
```

With Cross Validation (Boosting)

In [750…

```
%%time
for i in algo1:
    s = cross_val_score(i,X,y,cv = kf)
    print(f'{i} = {s.mean()}')
```

```
RandomForestClassifier(max_depth=2, max_leaf_nodes=3, n_estimators=150) = 0
.6806965761511217
AdaBoostClassifier() = 0.7425619834710744
CPU times: user 1.71 s, sys: 15.7 ms, total: 1.72 s
Wall time: 1.72 s
```

With GridSearch CV

In [751…

```
from sklearn.model_selection import GridSearchCV
```

In [752…

```
dic = { 'n_estimators' : [100,125,180],'criterion': ['gini', 'entropy'], 'r
       ,'min_samples_leaf' : [ 1,5]  }
```

In [753…

```
kf1 = KFold(n_splits=12)
```

In [754…

```
gvc = GridSearchCV(RandomForestClassifier(),param_grid=dic,cv = kf1)
```

In [755…

```
%%time
gvc.fit(X,y)
```

```
CPU times: user 46.1 s, sys: 399 ms, total: 46.5 s
Wall time: 46.7 s
```

Out[755…
```
GridSearchCV(cv=KFold(n_splits=12, random_state=None, shuffle=False),
             estimator=RandomForestClassifier(),
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [2, 3, 10], 'min_samples_leaf': [1, 5
],
                         'n_estimators': [100, 125, 180]})
```

In [756…
```
gvc.best_params_
```

Out[756…
```
{'criterion': 'entropy',
 'max_depth': 10,
 'min_samples_leaf': 5,
 'n_estimators': 180}
```

In [757…
```
gvc.best_estimator_
```

Out[757…
```
RandomForestClassifier(criterion='entropy', max_depth=10, min_samples_leaf=
5,
                       n_estimators=180)
```

In [758…
```
gvc.best_score_
```

Out[758…
```
0.763826043237808
```

In [ ]:
```

```