In [1]:
```
#Imporing libraries
import numpy as np
import pandas as pd
```

In [2]:
```
#Reading csv file
data = pd.read_csv('Heart.csv')
```

In [3]:
```
data
```

Out[3]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak
0	1	63	1	typical	145	233	1	2	150	0	2.3
1	2	67	1	asymptomatic	160	286	0	2	108	1	1.5
2	3	67	1	asymptomatic	120	229	0	2	129	1	2.6
3	4	37	1	nonanginal	130	250	0	0	187	0	3.5
4	5	41	0	nontypical	130	204	0	2	172	0	1.4
...	...	...	...	...	...	...	...	...	...	...	...
298	299	45	1	typical	110	264	0	0	132	0	1.2
299	300	68	1	asymptomatic	144	193	1	0	141	0	3.4
300	301	57	1	asymptomatic	130	131	0	0	115	1	1.2
301	302	57	0	nontypical	130	236	0	2	174	0	0.0
302	303	38	1	nonanginal	138	175	0	0	173	0	0.0

303 rows × 15 columns

In [4]:
```
#display structure of dataset
data.shape
```

Out[4]:
```
(303, 15)
```

In [5]:
```
data.columns
```

Out[5]:
```
Index(['Unnamed: 0', 'Age', 'Sex', 'ChestPain', 'RestBP', 'Chol', 'Fbs',
       'RestECG', 'MaxHR', 'ExAng', 'Oldpeak', 'Slope', 'Ca', 'Thal', 'AHD'],
      dtype='object')
```

In [6]:
```
#check for null values
data.isna()
```

Out[6]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak
0	False	False	False	False	False	False	False	False	False	False	False
1	False	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False	False	False
...	...	...	...	...	...	...	...	...	...	...	...
298	False	False	False	False	False	False	False	False	False	False	False
299	False	False	False	False	False	False	False	False	False	False	False
300	False	False	False	False	False	False	False	False	False	False	False
301	False	False	False	False	False	False	False	False	False	False	False
302	False	False	False	False	False	False	False	False	False	False	False

303 rows × 15 columns

In [7]:
```
#Display count of null is particular column
data.isna().sum()
```

Out[7]:
```
Unnamed: 0    0
Age           0
Sex           0
ChestPain     0
RestBP        0
Chol          0
Fbs           0
RestECG       0
MaxHR         0
ExAng         0
Oldpeak       0
Slope         0
Ca            4
Thal          2
AHD           0
dtype: int64
```

In [8]:
```
#Display's total no of null values
data.isna().sum().sum()
```

Out[8]:
```
6
```

Data Cleaning Removing null values

In [9]:
```
data['Ca'].value_counts()
```

Out[9]:
```
0.0    176
1.0     65
2.0     38
3.0     20
Name: Ca, dtype: int64
```

In [10]:
```
data['Ca'].fillna(0, inplace = True)
```

In [11]:
```
data['Thal'].value_counts()
```

Out[11]:
```
normal        166
reversable    117
fixed          18
Name: Thal, dtype: int64
```

In [12]:
```
data['Thal'].fillna('normal', inplace = True)
```

In [13]:
```
data.isna().sum().sum()
```

Out[13]:
```
0
```

Label Encoding

In [14]:
```
data['ChestPain'].unique()
```

Out[14]:
```
array(['typical', 'asymptomatic', 'nonanginal', 'nontypical'],
      dtype=object)
```

In [15]:
```
data['Thal'].unique()
```

Out[15]:
```
array(['fixed', 'normal', 'reversable'], dtype=object)
```

In [16]:
```
data['AHD'].unique()
```

Out[16]:
```
array(['No', 'Yes'], dtype=object)
```

In [17]:
```
#Import label encoder
from sklearn import preprocessing
label_encoder = preprocessing.LabelEncoder()

data['ChestPain'] = label_encoder.fit_transform(data['ChestPain'])
data['Thal'] = label_encoder.fit_transform(data['Thal'])
data['AHD'] = label_encoder.fit_transform(data['AHD'])
```

In [18]:
```
#Label's encoded
data
```

Out[18]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slo
0	1	63	1	3	145	233	1	2	150	0	2.3	
1	2	67	1	0	160	286	0	2	108	1	1.5	
2	3	67	1	0	120	229	0	2	129	1	2.6	
3	4	37	1	1	130	250	0	0	187	0	3.5	
4	5	41	0	2	130	204	0	2	172	0	1.4	
...	...	...	...	...	...	...	...	...	...	...	...	
298	299	45	1	3	110	264	0	0	132	0	1.2	
299	300	68	1	0	144	193	1	0	141	0	3.4	
300	301	57	1	0	130	131	0	0	115	1	1.2	
301	302	57	0	2	130	236	0	2	174	0	0.0	
302	303	38	1	1	138	175	0	0	173	0	0.0	

303 rows × 15 columns

In [19]:
```
#Gives first 15 rows
data.head(15)
```

Out[19]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slop
0	1	63	1	3	145	233	1	2	150	0	2.3	
1	2	67	1	0	160	286	0	2	108	1	1.5	
2	3	67	1	0	120	229	0	2	129	1	2.6	
3	4	37	1	1	130	250	0	0	187	0	3.5	
4	5	41	0	2	130	204	0	2	172	0	1.4	
5	6	56	1	2	120	236	0	0	178	0	0.8	
6	7	62	0	0	140	268	0	2	160	0	3.6	
7	8	57	0	0	120	354	0	0	163	1	0.6	
8	9	63	1	0	130	254	0	2	147	0	1.4	
9	10	53	1	0	140	203	1	2	155	1	3.1	
10	11	57	1	0	140	192	0	0	148	0	0.4	
11	12	56	0	2	140	294	0	2	153	0	1.3	
12	13	56	1	1	130	256	1	2	142	1	0.6	
13	14	44	1	2	120	263	0	0	173	0	0.0	
14	15	52	1	1	172	199	1	0	162	0	0.5	

In [20]:
```
#Displays random rows
data.sample(25)
```

Out[20]:

	Unnamed: 0	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slo
229	230	66	1	0	112	212	0	2	132	1	0.1	
74	75	44	1	0	110	197	0	2	177	0	0.0	
157	158	58	1	0	125	300	0	2	171	0	0.0	
50	51	41	0	2	105	198	0	0	168	0	0.0	
257	258	76	0	1	140	197	0	1	116	0	1.1	
44	45	61	0	0	130	330	0	2	169	0	0.0	
42	43	71	0	2	160	302	0	0	162	0	0.4	
138	139	35	1	0	120	198	0	0	130	1	1.6	
299	300	68	1	0	144	193	1	0	141	0	3.4	
165	166	57	1	0	132	207	0	0	168	1	0.0	
64	65	54	1	0	120	188	0	0	113	0	1.4	
241	242	41	0	2	126	306	0	0	163	0	0.0	
261	262	58	0	2	136	319	1	2	152	0	0.0	
288	289	56	1	2	130	221	0	2	163	0	0.0	
233	234	74	0	2	120	269	0	2	121	1	0.2	
188	189	54	1	2	192	283	0	2	195	0	0.0	
112	113	52	1	3	118	186	0	2	190	0	0.0	
162	163	54	0	1	110	214	0	0	158	0	1.6	
131	132	51	1	1	94	227	0	0	154	1	0.0	
279	280	58	0	0	130	197	0	0	131	0	0.6	
273	274	71	0	0	112	149	0	0	125	0	1.6	
300	301	57	1	0	130	131	0	0	115	1	1.2	
155	156	70	1	0	130	322	0	2	109	0	2.4	
263	264	44	1	1	120	226	0	0	169	0	0.0	
25	26	50	0	1	120	219	0	0	158	0	1.6	

In [21]:
```
#display info of dataset
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 303 entries, 0 to 302
Data columns (total 15 columns):
 #   Column      Non-Null Count  Dtype  
---  ------      --------------  -----  
 0   Unnamed: 0  303 non-null    int64  
 1   Age         303 non-null    int64  
 2   Sex         303 non-null    int64  
 3   ChestPain   303 non-null    int32  
 4   RestBP      303 non-null    int64  
 5   Chol        303 non-null    int64  
 6   Fbs         303 non-null    int64  
 7   RestECG     303 non-null    int64  
 8   MaxHR       303 non-null    int64  
 9   ExAng       303 non-null    int64  
 10  Oldpeak     303 non-null    float64
 11  Slope       303 non-null    int64  
 12  Ca          303 non-null    float64
 13  Thal        303 non-null    int32  
 14  AHD         303 non-null    int32  
dtypes: float64(2), int32(3), int64(10)
memory usage: 32.1 KB
```

In [22]:
```
#Displays data type of columns
data.dtypes
```

Out[22]:
```
Unnamed: 0      int64
Age             int64
Sex             int64
ChestPain       int32
RestBP          int64
Chol            int64
Fbs             int64
RestECG         int64
MaxHR           int64
ExAng           int64
Oldpeak       float64
Slope           int64
Ca            float64
Thal            int32
AHD             int32
dtype: object
```

In [23]:
```
#no of zeros in column
(data == 0).sum(axis = 0)
```

Out[23]:
```
Unnamed: 0      0
Age             0
Sex            97
ChestPain     144
RestBP          0
Chol            0
Fbs           258
RestECG       151
MaxHR           0
ExAng         204
Oldpeak        99
Slope           0
Ca            180
Thal           18
AHD           164
dtype: int64
```

In [24]:
```
#no of zeros in row
(data == 0).sum(axis = 1)
```

Out[24]:
```
0      4
1      2
2      2
3      5
4      5
      ..
298    4
299    3
300    3
301    4
302    6
Length: 303, dtype: int64
```

In [25]:
```
#Calculating mean age of patients
meanAge = data['Age'].mean()
print("\nMean age of Patients: ",meanAge)
```

```
Mean age of Patients:  54.43894389438944
```

In [26]:
```
#Extract nspecific columns
SpecificColumns = data[['Age','Sex', 'ChestPain', 'RestBP', 'Chol']]
```

In [27]:
```
SpecificColumns
```

Out[27]:

	Age	Sex	ChestPain	RestBP	Chol
0	63	1	3	145	233
1	67	1	0	160	286
2	67	1	0	120	229
3	37	1	1	130	250
4	41	0	2	130	204
...	...	...	...	...	...
298	45	1	3	110	264
299	68	1	0	144	193
300	57	1	0	130	131
301	57	0	2	130	236
302	38	1	1	138	175

303 rows × 5 columns

In [28]:
```
#Training and testing of dataset
X = data.drop('AHD',axis = 1)
Y = data['AHD']

X,Y
```

Out[28]:
```
(     Unnamed: 0  Age  Sex  ChestPain  RestBP  Chol  Fbs  RestECG  MaxHR  \
0             1   63    1          3     145   233    1        2    150
1             2   67    1          0     160   286    0        2    108
2             3   67    1          0     120   229    0        2    129
3             4   37    1          1     130   250    0        0    187
4             5   41    0          2     130   204    0        2    172
..          ...  ...  ...        ...     ...   ...  ...      ...    ...
298         299   45    1          3     110   264    0        0    132
299         300   68    1          0     144   193    1        0    141
300         301   57    1          0     130   131    0        0    115
301         302   57    0          2     130   236    0        2    174
302         303   38    1          1     138   175    0        0    173

     ExAng  Oldpeak  Slope   Ca  Thal
0        0      2.3      3  0.0     0
1        1      1.5      2  3.0     1
2        1      2.6      2  2.0     2
3        0      3.5      3  0.0     1
4        0      1.4      1  0.0     1
..     ...      ...    ...  ...   ...
298      0      1.2      2  0.0     2
299      0      3.4      2  2.0     2
300      1      1.2      2  1.0     2
301      0      0.0      2  1.0     1
302      0      0.0      1  0.0     1

[303 rows x 14 columns],
0      0
1      1
2      1
3      0
4      0
      ..
298    1
299    1
300    1
301    1
302    0
Name: AHD, Length: 303, dtype: int32)
```

In [30]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(X,Y,test_size=0.25,random_state

x_train.shape, x_test.shape, y_train.shape, y_test.shape
```

Out[30]:
```
((227, 14), (76, 14), (227,), (76,))
```

In [31]:
```
#Confusion matrix
actual = list(np.ones(45))+list(np.zeros(55))
```

In [32]:
```
np.array(actual)
```

Out[32]:
```
array([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., 1., 1., 1., 1.,
       1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 0., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.])
```

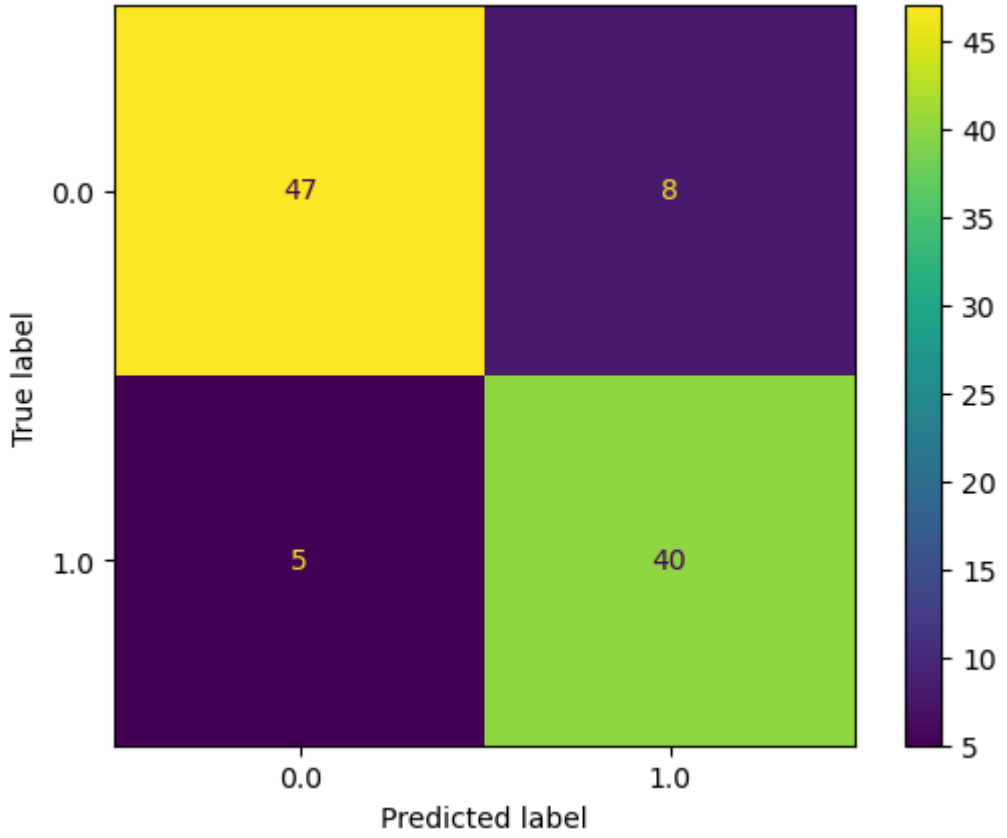
In [33]:
```
predicted = list(np.ones(40))+ list(np.zeros(52))+ list(np.ones(8))
np.array(predicted)
```

Out[33]:
```
array([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., 1., 1., 1., 1.,
       1., 1., 1., 1., 1., 1., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
       0., 0., 0., 0., 0., 0., 0., 1., 1., 1., 1., 1., 1., 1., 1.])
```

In [34]:
```
#Display the confusion matrics
from sklearn.metrics import ConfusionMatrixDisplay
```

In [36]:
```
ConfusionMatrixDisplay.from_predictions(actual, predicted)
```

Out[36]:
```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x2459f146c10>
```



In [37]:
```
from sklearn.metrics import classification_report
print(classification_report(actual, predicted))
```

```
              precision    recall  f1-score   support

         0.0       0.90      0.85      0.88        55
         1.0       0.83      0.89      0.86        45

    accuracy                           0.87       100
   macro avg       0.87      0.87      0.87       100
weighted avg       0.87      0.87      0.87       100
```

In [38]:
```
from sklearn.metrics import accuracy_score
accuracy_score(actual, predicted)
```

Out[38]:
```
0.87
```