In [14]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
df = pd.read_csv("sonar.all-data.csv")
df.head()
```

Out[14]:

	0.0200	0.0371	0.0428	0.0207	0.0954	0.0986	0.1539	0.1601	0.3109	0.2111	...	0.0027	0.0065	0.0159	0.0072	0.0167	0.0180	0.0084	0.0090
0	0.0453	0.0523	0.0843	0.0689	0.1183	0.2583	0.2156	0.3481	0.3337	0.2872	...	0.0084	0.0089	0.0048	0.0094	0.0191	0.0140	0.0049	0.0052
1	0.0262	0.0582	0.1099	0.1083	0.0974	0.2280	0.2431	0.3771	0.5598	0.6194	...	0.0232	0.0166	0.0095	0.0180	0.0244	0.0316	0.0164	0.0095
2	0.0100	0.0171	0.0623	0.0205	0.0205	0.0368	0.1098	0.1276	0.0598	0.1264	...	0.0121	0.0036	0.0150	0.0085	0.0073	0.0050	0.0044	0.0040
3	0.0762	0.0666	0.0481	0.0394	0.0590	0.0649	0.1209	0.2467	0.3564	0.4459	...	0.0031	0.0054	0.0105	0.0110	0.0015	0.0072	0.0048	0.0107
4	0.0286	0.0453	0.0277	0.0174	0.0384	0.0990	0.1201	0.1833	0.2105	0.3039	...	0.0045	0.0014	0.0038	0.0013	0.0089	0.0057	0.0027	0.0051

5 rows × 61 columns

In [15]:
```
df.columns = [i for i in range(61)]
```

In [18]:
```
df.sample(3)
```

Out[18]:

	0	1	2	3	4	5	6	7	8	9	...	51	52	53	54	55	56	57	5
104	0.0116	0.0179	0.0449	0.1096	0.1913	0.0924	0.0761	0.1092	0.0757	0.1006	...	0.0163	0.0099	0.0084	0.0270	0.0277	0.0097	0.0054	0.014
172	0.0329	0.0216	0.0386	0.0627	0.1158	0.1482	0.2054	0.1605	0.2532	0.2672	...	0.0095	0.0151	0.0059	0.0015	0.0053	0.0016	0.0042	0.005
149	0.0209	0.0278	0.0115	0.0445	0.0427	0.0766	0.1458	0.1430	0.1894	0.1853	...	0.0096	0.0014	0.0049	0.0039	0.0029	0.0078	0.0047	0.002

3 rows × 61 columns

In [19]:
```
df[60].value_counts()
```

Out[19]:
```
M    111
R     96
```

```
Name: 60, dtype: int64
```

In [21]:
```
x = df.iloc[:,:-1]
y = df.iloc[:,-1]
x.sample(3)
```

Out[21]:

	0	1	2	3	4	5	6	7	8	9	...	50	51	52	53	54	55	56	5
121	0.0249	0.0119	0.0277	0.0760	0.1218	0.1538	0.1192	0.1229	0.2119	0.2531	...	0.0140	0.0027	0.0068	0.0150	0.0012	0.0133	0.0048	0.024
19	0.0473	0.0509	0.0819	0.1252	0.1783	0.3070	0.3008	0.2362	0.3830	0.3759	...	0.0107	0.0193	0.0118	0.0064	0.0042	0.0054	0.0049	0.008
154	0.0211	0.0128	0.0015	0.0450	0.0711	0.1563	0.1518	0.1206	0.1666	0.1345	...	0.0174	0.0117	0.0023	0.0047	0.0049	0.0031	0.0024	0.003

3 rows × 60 columns

In [22]:
```
y = pd.get_dummies(y,drop_first=True)
y.sample(3)
```

Out[22]:

	R
173	0
3	1
146	0

In [24]:
```
y.value_counts()
```

Out[24]:
```
R
0    111
1     96
dtype: int64
```

In [26]:
```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test = train_test_split(x,y,random_state=5)
x_train.shape,x_test.shape
```

Out[26]:
```
((155, 60), (52, 60))
```

In [27]:
```
import tensorflow as tf
from tensorflow import keras
```

In [29]:
```
model = keras.Sequential([
    keras.layers.Dense(60,input_shape=(60,),activation="relu"),
    keras.layers.Dense(30,activation="relu"),
    keras.layers.Dense(15,activation="relu"),
    keras.layers.Dense(1,activation="sigmoid")
])
```

In [50]:
```
model.compile(optimizer="adam", loss="BinaryCrossentropy", metrics=['accuracy'])
```

In [52]:
```
model.fit(x_train,y_train,epochs=100,batch_size=8)
```

```
Epoch 1/100
20/20 [==============================] - 10s 46ms/step - loss: 0.6936 - accuracy: 0.5224
Epoch 2/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6747 - accuracy: 0.6534
Epoch 3/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6635 - accuracy: 0.7787
Epoch 4/100
20/20 [==============================] - 0s 8ms/step - loss: 0.6610 - accuracy: 0.6764
Epoch 5/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6437 - accuracy: 0.6660
Epoch 6/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6161 - accuracy: 0.7630
Epoch 7/100
20/20 [==============================] - 0s 7ms/step - loss: 0.5786 - accuracy: 0.7765
Epoch 8/100
20/20 [==============================] - 0s 5ms/step - loss: 0.5182 - accuracy: 0.8068
Epoch 9/100
20/20 [==============================] - 0s 5ms/step - loss: 0.5712 - accuracy: 0.7090
Epoch 10/100
20/20 [==============================] - 0s 6ms/step - loss: 0.4664 - accuracy: 0.8104
Epoch 11/100
20/20 [==============================] - 0s 8ms/step - loss: 0.4540 - accuracy: 0.7929
Epoch 12/100
20/20 [==============================] - 0s 5ms/step - loss: 0.4214 - accuracy: 0.8485
Epoch 13/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3880 - accuracy: 0.8419
Epoch 14/100
20/20 [==============================] - 0s 7ms/step - loss: 0.4147 - accuracy: 0.8187
Epoch 15/100
```

```
20/20 [==============================] - 0s 3ms/step - loss: 0.4082 - accuracy: 0.8550
Epoch 16/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3430 - accuracy: 0.8805
Epoch 17/100
20/20 [==============================] - 0s 13ms/step - loss: 0.3769 - accuracy: 0.8588
Epoch 18/100
20/20 [==============================] - 0s 7ms/step - loss: 0.3562 - accuracy: 0.8659
Epoch 19/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3007 - accuracy: 0.8750
Epoch 20/100
20/20 [==============================] - 0s 6ms/step - loss: 0.2577 - accuracy: 0.9116
Epoch 21/100
20/20 [==============================] - 0s 6ms/step - loss: 0.2711 - accuracy: 0.8932
Epoch 22/100
20/20 [==============================] - 0s 5ms/step - loss: 0.2776 - accuracy: 0.8834
Epoch 23/100
20/20 [==============================] - 0s 9ms/step - loss: 0.2370 - accuracy: 0.9322
Epoch 24/100
20/20 [==============================] - 0s 7ms/step - loss: 0.2317 - accuracy: 0.9101
Epoch 25/100
20/20 [==============================] - 0s 7ms/step - loss: 0.1972 - accuracy: 0.9571
Epoch 26/100
20/20 [==============================] - 0s 6ms/step - loss: 0.2324 - accuracy: 0.9094
Epoch 27/100
20/20 [==============================] - 0s 4ms/step - loss: 0.2347 - accuracy: 0.9175
Epoch 28/100
20/20 [==============================] - 0s 8ms/step - loss: 0.1852 - accuracy: 0.9768
Epoch 29/100
20/20 [==============================] - 0s 10ms/step - loss: 0.1801 - accuracy: 0.9654
Epoch 30/100
20/20 [==============================] - 0s 9ms/step - loss: 0.1513 - accuracy: 0.9584
Epoch 31/100
20/20 [==============================] - 0s 14ms/step - loss: 0.1877 - accuracy: 0.9275
Epoch 32/100
20/20 [==============================] - 0s 13ms/step - loss: 0.2330 - accuracy: 0.8837
Epoch 33/100
20/20 [==============================] - 0s 12ms/step - loss: 0.2244 - accuracy: 0.9045
Epoch 34/100
20/20 [==============================] - 0s 8ms/step - loss: 0.1419 - accuracy: 0.9717
Epoch 35/100
20/20 [==============================] - 0s 8ms/step - loss: 0.1290 - accuracy: 0.9703
Epoch 36/100
20/20 [==============================] - 0s 7ms/step - loss: 0.1356 - accuracy: 0.9719
Epoch 37/100
20/20 [==============================] - 0s 4ms/step - loss: 0.1440 - accuracy: 0.9572
```

```
Epoch 38/100
20/20 [==============================] - 0s 7ms/step - loss: 0.1539 - accuracy: 0.9494
Epoch 39/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0883 - accuracy: 0.9839
Epoch 40/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0810 - accuracy: 0.9957
Epoch 41/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0648 - accuracy: 0.9944
Epoch 42/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0869 - accuracy: 0.9724
Epoch 43/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0707 - accuracy: 0.9825
Epoch 44/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0599 - accuracy: 0.9962
Epoch 45/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0459 - accuracy: 0.9980
Epoch 46/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0423 - accuracy: 0.9943
Epoch 47/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0846 - accuracy: 0.9787
Epoch 48/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0655 - accuracy: 0.9749
Epoch 49/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0578 - accuracy: 0.9745
Epoch 50/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0337 - accuracy: 0.9991
Epoch 51/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0262 - accuracy: 1.0000
Epoch 52/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0292 - accuracy: 1.0000
Epoch 53/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0452 - accuracy: 0.9872
Epoch 54/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0366 - accuracy: 0.9842
Epoch 55/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0244 - accuracy: 1.0000
Epoch 56/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0251 - accuracy: 1.0000
Epoch 57/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0314 - accuracy: 1.0000
Epoch 58/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0240 - accuracy: 1.0000
Epoch 59/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0247 - accuracy: 1.0000
Epoch 60/100
```

```
20/20 [==============================] - 0s 4ms/step - loss: 0.0146 - accuracy: 1.0000
Epoch 61/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0149 - accuracy: 1.0000
Epoch 62/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0138 - accuracy: 1.0000
Epoch 63/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0093 - accuracy: 1.0000
Epoch 64/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0111 - accuracy: 1.0000
Epoch 65/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0106 - accuracy: 1.0000
Epoch 66/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0196 - accuracy: 1.0000
Epoch 67/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0134 - accuracy: 1.0000
Epoch 68/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0103 - accuracy: 1.0000
Epoch 69/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0095 - accuracy: 1.0000
Epoch 70/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0077 - accuracy: 1.0000
Epoch 71/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0099 - accuracy: 1.0000
Epoch 72/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0059 - accuracy: 1.0000
Epoch 73/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0050 - accuracy: 1.0000
Epoch 74/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0063 - accuracy: 1.0000
Epoch 75/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0087 - accuracy: 1.0000
Epoch 76/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0056 - accuracy: 1.0000
Epoch 77/100
20/20 [==============================] - 0s 9ms/step - loss: 0.0054 - accuracy: 1.0000
Epoch 78/100
20/20 [==============================] - 0s 9ms/step - loss: 0.0045 - accuracy: 1.0000
Epoch 79/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0043 - accuracy: 1.0000
Epoch 80/100
20/20 [==============================] - 0s 16ms/step - loss: 0.0046 - accuracy: 1.0000
Epoch 81/100
20/20 [==============================] - 0s 22ms/step - loss: 0.0049 - accuracy: 1.0000
Epoch 82/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0046 - accuracy: 1.0000
```

```
Epoch 83/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 84/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0046 - accuracy: 1.0000
Epoch 85/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0032 - accuracy: 1.0000
Epoch 86/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 87/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0038 - accuracy: 1.0000
Epoch 88/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0040 - accuracy: 1.0000
Epoch 89/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0033 - accuracy: 1.0000
Epoch 90/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0027 - accuracy: 1.0000
Epoch 91/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0035 - accuracy: 1.0000
Epoch 92/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0036 - accuracy: 1.0000
Epoch 93/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 94/100
20/20 [==============================] - 0s 13ms/step - loss: 0.0022 - accuracy: 1.0000
Epoch 95/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0030 - accuracy: 1.0000
Epoch 96/100
20/20 [==============================] - 0s 8ms/step - loss: 0.0025 - accuracy: 1.0000
Epoch 97/100
20/20 [==============================] - 0s 6ms/step - loss: 0.0023 - accuracy: 1.0000
Epoch 98/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0021 - accuracy: 1.0000
Epoch 99/100
20/20 [==============================] - 0s 7ms/step - loss: 0.0021 - accuracy: 1.0000
Epoch 100/100
20/20 [==============================] - 0s 5ms/step - loss: 0.0020 - accuracy: 1.0000
```

Out[52]:
```
<tensorflow.python.keras.callbacks.History at 0x24b2dfd42b0>
```

In [53]:
```
model.evaluate(x_test,y_test)
```

```
2/2 [==============================] - 1s 5ms/step - loss: 0.7818 - accuracy: 0.8077
```

Out[53]:
```
[0.7817773222923279, 0.807692289352417]
```

In [63]:
```
y_pred = model.predict(x_test)
print((y_pred[:15]).reshape(-1,))
print(np.round(y_pred[:15]).reshape(-1,))
```

```
[3.8150156e-05 5.5833697e-02 1.3412833e-03 8.7437576e-05 1.4203519e-02
 1.7541647e-04 1.5029311e-04 1.5363395e-03 1.8193126e-03 9.6382958e-01
 5.7824969e-02 2.5085476e-01 1.0000000e+00 1.0937174e-04 4.2941958e-02]
[0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 1. 0. 0.]
```

In [69]:
```
from sklearn.metrics import confusion_matrix, classification_report
y_pred = np.round(y_pred)
print(classification_report(y_test,y_pred))
```

```
              precision    recall  f1-score   support

           0       0.82      0.88      0.85        32
           1       0.78      0.70      0.74        20

    accuracy                           0.81        52
   macro avg       0.80      0.79      0.79        52
weighted avg       0.81      0.81      0.81        52
```

In [70]:
```
print(confusion_matrix(y_test,y_pred))
```

```
[[28  4]
 [ 6 14]]
```

In [71]:
```
model_2 = keras.Sequential([
    keras.layers.Dense(60,input_shape=(60,),activation="relu"),
    keras.layers.Dropout(0.5),
    keras.layers.Dense(30,activation="relu"),
    keras.layers.Dropout(0.5),
    keras.layers.Dense(15,activation="relu"),
    keras.layers.Dropout(0.5),
    keras.layers.Dense(1,activation="sigmoid")
])
```

In [72]:
```
model_2.compile(optimizer="adam", loss="BinaryCrossentropy", metrics=['accuracy'])
```

In [73]:
```
model_2.fit(x_train,y_train,epochs=100,batch_size=8)
```

```
Epoch 1/100
```

```
20/20 [==============================] - 2s 7ms/step - loss: 0.7639 - accuracy: 0.4532
Epoch 2/100
20/20 [==============================] - 0s 17ms/step - loss: 0.7352 - accuracy: 0.4712 0s - loss: 0.7349 - accuracy:
0.47
Epoch 3/100
20/20 [==============================] - 0s 8ms/step - loss: 0.6931 - accuracy: 0.5524
Epoch 4/100
20/20 [==============================] - 0s 5ms/step - loss: 0.7197 - accuracy: 0.5171
Epoch 5/100
20/20 [==============================] - 0s 4ms/step - loss: 0.7335 - accuracy: 0.3734
Epoch 6/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6808 - accuracy: 0.6291
Epoch 7/100
20/20 [==============================] - 0s 6ms/step - loss: 0.7084 - accuracy: 0.5690
Epoch 8/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6969 - accuracy: 0.5186
Epoch 9/100
20/20 [==============================] - 0s 7ms/step - loss: 0.6663 - accuracy: 0.6042
Epoch 10/100
20/20 [==============================] - 0s 8ms/step - loss: 0.7346 - accuracy: 0.4239
Epoch 11/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6830 - accuracy: 0.5776
Epoch 12/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6917 - accuracy: 0.5220
Epoch 13/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6898 - accuracy: 0.5472
Epoch 14/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6716 - accuracy: 0.5375
Epoch 15/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6951 - accuracy: 0.4657
Epoch 16/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6882 - accuracy: 0.5474
Epoch 17/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6749 - accuracy: 0.5659
Epoch 18/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6753 - accuracy: 0.6041
Epoch 19/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6650 - accuracy: 0.6698
Epoch 20/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6915 - accuracy: 0.5971
Epoch 21/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6860 - accuracy: 0.5362
Epoch 22/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6476 - accuracy: 0.6337
Epoch 23/100
```

```
20/20 [==============================] - 0s 4ms/step - loss: 0.6166 - accuracy: 0.6450
Epoch 24/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6502 - accuracy: 0.6283
Epoch 25/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6504 - accuracy: 0.6694
Epoch 26/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6496 - accuracy: 0.5746
Epoch 27/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6376 - accuracy: 0.6871
Epoch 28/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6051 - accuracy: 0.7185
Epoch 29/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6061 - accuracy: 0.6566
Epoch 30/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6681 - accuracy: 0.5904
Epoch 31/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6243 - accuracy: 0.6506
Epoch 32/100
20/20 [==============================] - ETA: 0s - loss: 0.6132 - accuracy: 0.65 - 0s 3ms/step - loss: 0.6112 - accur
acy: 0.6590
Epoch 33/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5878 - accuracy: 0.7259
Epoch 34/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6166 - accuracy: 0.6830
Epoch 35/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5941 - accuracy: 0.6987
Epoch 36/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5898 - accuracy: 0.6962
Epoch 37/100
20/20 [==============================] - 0s 5ms/step - loss: 0.5400 - accuracy: 0.7715
Epoch 38/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5058 - accuracy: 0.7212
Epoch 39/100
20/20 [==============================] - 0s 6ms/step - loss: 0.5703 - accuracy: 0.7052
Epoch 40/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5438 - accuracy: 0.7479
Epoch 41/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5350 - accuracy: 0.7501
Epoch 42/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5673 - accuracy: 0.7104
Epoch 43/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6142 - accuracy: 0.7552
Epoch 44/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4894 - accuracy: 0.8100
Epoch 45/100
```

```
20/20 [==============================] - 0s 4ms/step - loss: 0.5237 - accuracy: 0.7238
Epoch 46/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4922 - accuracy: 0.7493
Epoch 47/100
20/20 [==============================] - 0s 5ms/step - loss: 0.5111 - accuracy: 0.7952
Epoch 48/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4715 - accuracy: 0.7739
Epoch 49/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4911 - accuracy: 0.8045
Epoch 50/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5457 - accuracy: 0.6622
Epoch 51/100
20/20 [==============================] - 0s 6ms/step - loss: 0.4639 - accuracy: 0.7647
Epoch 52/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5239 - accuracy: 0.7388
Epoch 53/100
20/20 [==============================] - ETA: 0s - loss: 0.4997 - accuracy: 0.74 - 0s 5ms/step - loss: 0.4903 - accur
acy: 0.7501
Epoch 54/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5570 - accuracy: 0.7477
Epoch 55/100
20/20 [==============================] - 0s 7ms/step - loss: 0.4103 - accuracy: 0.7560
Epoch 56/100
20/20 [==============================] - 0s 11ms/step - loss: 0.4425 - accuracy: 0.8363
Epoch 57/100
20/20 [==============================] - 0s 7ms/step - loss: 0.4251 - accuracy: 0.8250
Epoch 58/100
20/20 [==============================] - 0s 5ms/step - loss: 0.4704 - accuracy: 0.7333
Epoch 59/100
20/20 [==============================] - 0s 5ms/step - loss: 0.4590 - accuracy: 0.8235
Epoch 60/100
20/20 [==============================] - 0s 6ms/step - loss: 0.4659 - accuracy: 0.7898
Epoch 61/100
20/20 [==============================] - 0s 5ms/step - loss: 0.4417 - accuracy: 0.7798
Epoch 62/100
20/20 [==============================] - 0s 9ms/step - loss: 0.4338 - accuracy: 0.7727
Epoch 63/100
20/20 [==============================] - 0s 7ms/step - loss: 0.4528 - accuracy: 0.7551
Epoch 64/100
20/20 [==============================] - ETA: 1s - loss: 0.4992 - accuracy: 0.68 - ETA: 0s - loss: 0.4057 - accuracy:
0.80 - 0s 8ms/step - loss: 0.3889 - accuracy: 0.8336
Epoch 65/100
20/20 [==============================] - 0s 11ms/step - loss: 0.4264 - accuracy: 0.8486
Epoch 66/100
20/20 [==============================] - 0s 10ms/step - loss: 0.4516 - accuracy: 0.7977
```

```
Epoch 67/100
20/20 [==============================] - 0s 10ms/step - loss: 0.4352 - accuracy: 0.7649
Epoch 68/100
20/20 [==============================] - 0s 9ms/step - loss: 0.4101 - accuracy: 0.8199
Epoch 69/100
20/20 [==============================] - 0s 8ms/step - loss: 0.4591 - accuracy: 0.7332
Epoch 70/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3888 - accuracy: 0.7857
Epoch 71/100
20/20 [==============================] - 0s 7ms/step - loss: 0.3491 - accuracy: 0.8683
Epoch 72/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3948 - accuracy: 0.8319
Epoch 73/100
20/20 [==============================] - 0s 6ms/step - loss: 0.4381 - accuracy: 0.7766
Epoch 74/100
20/20 [==============================] - 0s 6ms/step - loss: 0.4067 - accuracy: 0.7993
Epoch 75/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4832 - accuracy: 0.7937
Epoch 76/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3782 - accuracy: 0.8355
Epoch 77/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4176 - accuracy: 0.8563
Epoch 78/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3827 - accuracy: 0.8862
Epoch 79/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3961 - accuracy: 0.8168
Epoch 80/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3791 - accuracy: 0.8495
Epoch 81/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3957 - accuracy: 0.8259
Epoch 82/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3306 - accuracy: 0.8912
Epoch 83/100
20/20 [==============================] - 0s 6ms/step - loss: 0.4297 - accuracy: 0.8464
Epoch 84/100
20/20 [==============================] - 0s 13ms/step - loss: 0.3679 - accuracy: 0.8769
Epoch 85/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3094 - accuracy: 0.8859
Epoch 86/100
20/20 [==============================] - 0s 7ms/step - loss: 0.3248 - accuracy: 0.8811
Epoch 87/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3657 - accuracy: 0.8878
Epoch 88/100
20/20 [==============================] - 0s 5ms/step - loss: 0.4171 - accuracy: 0.7876
Epoch 89/100
```

```
20/20 [==============================] - 0s 5ms/step - loss: 0.3389 - accuracy: 0.8715
Epoch 90/100
20/20 [==============================] - 0s 8ms/step - loss: 0.3089 - accuracy: 0.8749
Epoch 91/100
20/20 [==============================] - 0s 7ms/step - loss: 0.3691 - accuracy: 0.8742
Epoch 92/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3948 - accuracy: 0.8171
Epoch 93/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3414 - accuracy: 0.8064
Epoch 94/100
20/20 [==============================] - 0s 6ms/step - loss: 0.2516 - accuracy: 0.9040
Epoch 95/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3256 - accuracy: 0.8299
Epoch 96/100
20/20 [==============================] - 0s 8ms/step - loss: 0.3365 - accuracy: 0.8711
Epoch 97/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3057 - accuracy: 0.8738
Epoch 98/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3434 - accuracy: 0.8423
Epoch 99/100
20/20 [==============================] - 0s 7ms/step - loss: 0.3060 - accuracy: 0.8839
Epoch 100/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3128 - accuracy: 0.8635
```

Out[73]:
```
<tensorflow.python.keras.callbacks.History at 0x24b2c9def70>
```

In [81]:
```
model_2.evaluate(x_test,y_test)
```

```
2/2 [==============================] - 0s 4ms/step - loss: 0.3190 - accuracy: 0.8846
```

Out[81]:
```
[0.31899914145469666, 0.8846153616905212]
```

In [82]:
```
y_pred_2 = model_2.predict(x_test)
print((y_pred_2[:15]).reshape(-1,))
print(np.round(y_pred_2[:15]).reshape(-1,))
```

```
[0.05700263 0.71236736 0.06081334 0.06818348 0.23670712 0.0401794
 0.10132793 0.18604097 0.1699242  0.81695354 0.2787338  0.9837973
 0.9992234  0.01878974 0.2087085 ]
[0. 1. 0. 0. 0. 0. 0. 0. 0. 1. 0. 1. 1. 0. 0.]
```

In [83]:
```
y_pred_2 = np.round(y_pred_2)
print(classification_report(y_test,y_pred_2))
```

```
              precision    recall  f1-score   support
```

```
              0       0.86      0.97      0.91        32
              1       0.94      0.75      0.83        20

    accuracy                            0.88        52
   macro avg       0.90      0.86      0.87        52
weighted avg       0.89      0.88      0.88        52
```

In [84]:
```
print(confusion_matrix(y_test,y_pred_2))
```

```
[[31  1]
 [ 5 15]]
```

In [ ]:
```

```