Dropout Regularization In Deep Neural Network

This is a dataset that describes sonar chirp returns bouncing off different services. The 60 input variables are the strength of the returns at different angles. It is a binary classification problem that requires a model to differentiate rocks from metal cylinders.

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
import warnings
warnings.filterwarnings('ignore')
```

In [3]:
```
df = pd.read_csv("https://raw.githubusercontent.com/codebasics/deep-learning-keras-t
df.sample(5)
```

Out[3]:

	0	1	2	3	4	5	6	7	8	9	...	51	52
185	0.0340	0.0625	0.0381	0.0257	0.0441	0.1027	0.1287	0.1850	0.2647	0.4117	...	0.0141	0.0019
86	0.0188	0.0370	0.0953	0.0824	0.0249	0.0488	0.1424	0.1972	0.1873	0.1806	...	0.0093	0.0033
50	0.0353	0.0713	0.0326	0.0272	0.0370	0.0792	0.1083	0.0687	0.0298	0.0880	...	0.0163	0.0242
32	0.0195	0.0213	0.0058	0.0190	0.0319	0.0571	0.1004	0.0668	0.0691	0.0242	...	0.0157	0.0074
102	0.0587	0.1210	0.1268	0.1498	0.1436	0.0561	0.0832	0.0672	0.1372	0.2352	...	0.0331	0.0111

5 rows × 61 columns

In [4]:
```
df.shape
```

Out[4]:
```
(208, 61)
```

In [5]:
```
# check for nan values
df.isna().sum()
```

Out[5]:
```
0     0
1     0
2     0
3     0
4     0
     ..
56    0
57    0
58    0
59    0
60    0
Length: 61, dtype: int64
```

In [6]:

```
df.columns
```

Out[6]:
```
Int64Index([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16,
            17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33,
            34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50,
            51, 52, 53, 54, 55, 56, 57, 58, 59, 60],
           dtype='int64')
```

In [7]:
```
df[60].value_counts() # label is not skewed
```

Out[7]:
```
M    111
R     97
Name: 60, dtype: int64
```

In [8]:
```
X = df.drop(60, axis=1)
y = df[60]
y.head()
```

Out[8]:
```
0    R
1    R
2    R
3    R
4    R
Name: 60, dtype: object
```

In [9]:
```
y = pd.get_dummies(y, drop_first=True)
y.sample(5) # R --> 1 and M --> 0
```

Out[9]:

	R
198	0
183	0
102	0
176	0
38	1

In [10]:
```
y.value_counts()
```

Out[10]:
```
R
0    111
1     97
dtype: int64
```

In [11]:
```
X.head()
```

Out[11]:

	0	1	2	3	4	5	6	7	8	9	...	50	51
0	0.0200	0.0371	0.0428	0.0207	0.0954	0.0986	0.1539	0.1601	0.3109	0.2111	...	0.0232	0.0027
1	0.0453	0.0523	0.0843	0.0689	0.1183	0.2583	0.2156	0.3481	0.3337	0.2872	...	0.0125	0.0084
2	0.0262	0.0582	0.1099	0.1083	0.0974	0.2280	0.2431	0.3771	0.5598	0.6194	...	0.0033	0.0232
3	0.0100	0.0171	0.0623	0.0205	0.0205	0.0368	0.1098	0.1276	0.0598	0.1264	...	0.0241	0.0121
4	0.0762	0.0666	0.0481	0.0394	0.0590	0.0649	0.1209	0.2467	0.3564	0.4459	...	0.0156	0.0031

5 rows × 60 columns

In [12]:
```
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_sta
```

In [13]:
```
X_train.head()
```

Out[13]:

	0	1	2	3	4	5	6	7	8	9	...	50	51
67	0.0368	0.0403	0.0317	0.0293	0.0820	0.1342	0.1161	0.0663	0.0155	0.0506	...	0.0058	0.0091
14	0.0124	0.0433	0.0604	0.0449	0.0597	0.0355	0.0531	0.0343	0.1052	0.2120	...	0.0078	0.0083
164	0.0163	0.0198	0.0202	0.0386	0.0752	0.1444	0.1487	0.1484	0.2442	0.2822	...	0.0027	0.0077
179	0.0394	0.0420	0.0446	0.0551	0.0597	0.1416	0.0956	0.0802	0.1618	0.2558	...	0.0118	0.0146
19	0.0126	0.0149	0.0641	0.1732	0.2565	0.2559	0.2947	0.4110	0.4983	0.5920	...	0.0153	0.0092

5 rows × 60 columns

Using Deep Learning Model

Model without Dropout Layer

In [14]:
```
import tensorflow as tf
from tensorflow import keras
```

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

model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

model.fit(X_train, y_train, epochs=100, batch_size=8)
```

```
Epoch 1/100
20/20 [==============================] - 4s 7ms/step - loss: 0.6953 - accuracy: 0.54
49
Epoch 2/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6739 - accuracy: 0.62
82
Epoch 3/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6639 - accuracy: 0.68
59
Epoch 4/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6451 - accuracy: 0.62
18
Epoch 5/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6096 - accuracy: 0.81
41
```

```
Epoch 6/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5690 - accuracy: 0.75
00
Epoch 7/100
20/20 [==============================] - 0s 2ms/step - loss: 0.5262 - accuracy: 0.82
69
Epoch 8/100
20/20 [==============================] - 0s 2ms/step - loss: 0.4810 - accuracy: 0.82
05
Epoch 9/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4430 - accuracy: 0.84
62
Epoch 10/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4250 - accuracy: 0.82
05
Epoch 11/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3890 - accuracy: 0.86
54
Epoch 12/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3684 - accuracy: 0.86
54
Epoch 13/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3748 - accuracy: 0.82
69
Epoch 14/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3618 - accuracy: 0.83
97
Epoch 15/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3171 - accuracy: 0.89
10
Epoch 16/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3111 - accuracy: 0.89
74
Epoch 17/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3062 - accuracy: 0.85
26
Epoch 18/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3281 - accuracy: 0.86
54
Epoch 19/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3114 - accuracy: 0.87
18
Epoch 20/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2854 - accuracy: 0.86
54
Epoch 21/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2731 - accuracy: 0.88
46
Epoch 22/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2477 - accuracy: 0.92
95
Epoch 23/100
20/20 [==============================] - 0s 4ms/step - loss: 0.2466 - accuracy: 0.90
38
Epoch 24/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2455 - accuracy: 0.92
31
Epoch 25/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2313 - accuracy: 0.92
95
Epoch 26/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2379 - accuracy: 0.89
74
Epoch 27/100
```

```
20/20 [==============================] - 0s 3ms/step - loss: 0.2257 - accuracy: 0.89
74
Epoch 28/100
20/20 [==============================] - 0s 6ms/step - loss: 0.2058 - accuracy: 0.93
59
Epoch 29/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1959 - accuracy: 0.93
59
Epoch 30/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1787 - accuracy: 0.95
51
Epoch 31/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1951 - accuracy: 0.92
31
Epoch 32/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1651 - accuracy: 0.96
15
Epoch 33/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1582 - accuracy: 0.94
87
Epoch 34/100
20/20 [==============================] - 0s 4ms/step - loss: 0.1503 - accuracy: 0.96
15
Epoch 35/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1319 - accuracy: 0.96
15
Epoch 36/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1531 - accuracy: 0.94
87
Epoch 37/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1422 - accuracy: 0.95
51
Epoch 38/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1655 - accuracy: 0.92
95
Epoch 39/100
20/20 [==============================] - 0s 3ms/step - loss: 0.1447 - accuracy: 0.93
59
Epoch 40/100
20/20 [==============================] - 0s 4ms/step - loss: 0.1619 - accuracy: 0.91
67
Epoch 41/100
20/20 [==============================] - 0s 4ms/step - loss: 0.1082 - accuracy: 0.95
51
Epoch 42/100
20/20 [==============================] - 0s 4ms/step - loss: 0.1116 - accuracy: 0.95
51
Epoch 43/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0920 - accuracy: 0.98
08
Epoch 44/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0881 - accuracy: 0.98
08
Epoch 45/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0775 - accuracy: 0.98
72
Epoch 46/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0842 - accuracy: 0.99
36
Epoch 47/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0591 - accuracy: 0.99
36
Epoch 48/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0519 - accuracy: 1.00
```

```
00
Epoch 49/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0494 - accuracy: 1.00
00
Epoch 50/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0483 - accuracy: 1.00
00
Epoch 51/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0444 - accuracy: 0.99
36
Epoch 52/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0394 - accuracy: 1.00
00
Epoch 53/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0440 - accuracy: 0.99
36
Epoch 54/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0404 - accuracy: 1.00
00
Epoch 55/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0401 - accuracy: 1.00
00
Epoch 56/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0336 - accuracy: 1.00
00
Epoch 57/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0252 - accuracy: 1.00
00
Epoch 58/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0259 - accuracy: 1.00
00
Epoch 59/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0210 - accuracy: 1.00
00
Epoch 60/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0219 - accuracy: 1.00
00
Epoch 61/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0207 - accuracy: 1.00
00
Epoch 62/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0180 - accuracy: 1.00
00
Epoch 63/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0178 - accuracy: 1.00
00
Epoch 64/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0159 - accuracy: 1.00
00
Epoch 65/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0156 - accuracy: 1.00
00
Epoch 66/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0152 - accuracy: 1.00
00
Epoch 67/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0171 - accuracy: 1.00
00
Epoch 68/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0146 - accuracy: 1.00
00
Epoch 69/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0110 - accuracy: 1.00
00
```

```
Epoch 70/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0119 - accuracy: 1.00
00
Epoch 71/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0099 - accuracy: 1.00
00
Epoch 72/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0092 - accuracy: 1.00
00
Epoch 73/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0093 - accuracy: 1.00
00
Epoch 74/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0079 - accuracy: 1.00
00
Epoch 75/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0081 - accuracy: 1.00
00
Epoch 76/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0087 - accuracy: 1.00
00
Epoch 77/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0090 - accuracy: 1.00
00
Epoch 78/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0060 - accuracy: 1.00
00
Epoch 79/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0059 - accuracy: 1.00
00
Epoch 80/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0056 - accuracy: 1.00
00
Epoch 81/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0056 - accuracy: 1.00
00
Epoch 82/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0050 - accuracy: 1.00
00
Epoch 83/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0051 - accuracy: 1.00
00
Epoch 84/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0059 - accuracy: 1.00
00
Epoch 85/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0043 - accuracy: 1.00
00
Epoch 86/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0039 - accuracy: 1.00
00
Epoch 87/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0039 - accuracy: 1.00
00
Epoch 88/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0038 - accuracy: 1.00
00
Epoch 89/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0037 - accuracy: 1.00
00
Epoch 90/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0036 - accuracy: 1.00
00
Epoch 91/100
```

```
20/20 [==============================] - 0s 2ms/step - loss: 0.0036 - accuracy: 1.00
00
Epoch 92/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0032 - accuracy: 1.00
00
Epoch 93/100
20/20 [==============================] - 0s 4ms/step - loss: 0.0032 - accuracy: 1.00
00
Epoch 94/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0029 - accuracy: 1.00
00
Epoch 95/100
20/20 [==============================] - 0s 2ms/step - loss: 0.0028 - accuracy: 1.00
00
Epoch 96/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0028 - accuracy: 1.00
00
Epoch 97/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0026 - accuracy: 1.00
00
Epoch 98/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0024 - accuracy: 1.00
00
Epoch 99/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0023 - accuracy: 1.00
00
Epoch 100/100
20/20 [==============================] - 0s 3ms/step - loss: 0.0023 - accuracy: 1.00
00
```

Out[15]:
```
<keras.callbacks.History at 0x18ef4d410d0>
```

In [16]:
```
model.evaluate(X_test, y_test)
```

Out[16]:
```
2/2 [==============================] - 0s 4ms/step - loss: 0.8462 - accuracy: 0.7692
[0.8462251424789429, 0.7692307829856873]
```

Training Accuracy >>> Test Accuracy

In [17]:
```
y_pred = model.predict(X_test).reshape(-1)
print(y_pred[:10])

# round the values to nearest integer ie 0 or 1
y_pred = np.round(y_pred)
print(y_pred[:10])
```

```
2/2 [==============================] - 0s 5ms/step
[2.2835712e-08 9.0542907e-01 9.9875546e-01 2.4035844e-06 9.9999911e-01
 9.9984586e-01 1.5155044e-01 9.9999982e-01 1.5265831e-06 9.9999958e-01]
[0. 1. 1. 0. 1. 1. 0. 1. 0. 1.]
```

In [18]:
```
y_test[:10]
```

Out[18]:

	R
186	0
155	0
165	0
200	0

	R
58	1
34	1
151	0
18	1
202	0
62	1

In [19]:
```
from sklearn.metrics import confusion_matrix , classification_report

print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.74      0.85      0.79        27
           1       0.81      0.68      0.74        25

    accuracy                           0.77        52
   macro avg       0.78      0.77      0.77        52
weighted avg       0.77      0.77      0.77        52
```

Model with Dropout Layer

In [20]:
```
modeld = keras.Sequential([
    keras.layers.Dense(60, input_dim=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')
])

modeld.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])

modeld.fit(X_train, y_train, epochs=100, batch_size=8)
```

```
Epoch 1/100
20/20 [==============================] - 1s 3ms/step - loss: 0.7185 - accuracy: 0.54
49
Epoch 2/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6975 - accuracy: 0.57
69
Epoch 3/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6737 - accuracy: 0.50
00
Epoch 4/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6850 - accuracy: 0.52
56
Epoch 5/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6968 - accuracy: 0.55
77
Epoch 6/100
20/20 [==============================] - 0s 3ms/step - loss: 0.7143 - accuracy: 0.48
72
```

```
Epoch 7/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6803 - accuracy: 0.63
46
Epoch 8/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6666 - accuracy: 0.58
33
Epoch 9/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6887 - accuracy: 0.51
92
Epoch 10/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6738 - accuracy: 0.54
49
Epoch 11/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6690 - accuracy: 0.57
05
Epoch 12/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6694 - accuracy: 0.54
49
Epoch 13/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6848 - accuracy: 0.57
05
Epoch 14/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6929 - accuracy: 0.53
85
Epoch 15/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6844 - accuracy: 0.53
85
Epoch 16/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6430 - accuracy: 0.62
18
Epoch 17/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6708 - accuracy: 0.58
33
Epoch 18/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6556 - accuracy: 0.64
10
Epoch 19/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6501 - accuracy: 0.62
18
Epoch 20/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6567 - accuracy: 0.62
82
Epoch 21/100
20/20 [==============================] - 0s 5ms/step - loss: 0.6440 - accuracy: 0.60
26
Epoch 22/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6484 - accuracy: 0.57
69
Epoch 23/100
20/20 [==============================] - 0s 3ms/step - loss: 0.6604 - accuracy: 0.62
18
Epoch 24/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6756 - accuracy: 0.57
05
Epoch 25/100
20/20 [==============================] - 0s 4ms/step - loss: 0.6302 - accuracy: 0.69
23
Epoch 26/100
20/20 [==============================] - 0s 14ms/step - loss: 0.5872 - accuracy: 0.6
795
Epoch 27/100
20/20 [==============================] - 0s 10ms/step - loss: 0.6573 - accuracy: 0.6
346
Epoch 28/100
```

```
20/20 [==============================] - 0s 5ms/step - loss: 0.5927 - accuracy: 0.71
79
Epoch 29/100
20/20 [==============================] - 0s 6ms/step - loss: 0.6373 - accuracy: 0.62
18
Epoch 30/100
20/20 [==============================] - 0s 12ms/step - loss: 0.6043 - accuracy: 0.6
346
Epoch 31/100
20/20 [==============================] - 0s 6ms/step - loss: 0.5734 - accuracy: 0.66
03
Epoch 32/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5991 - accuracy: 0.71
15
Epoch 33/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5751 - accuracy: 0.73
72
Epoch 34/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5863 - accuracy: 0.70
51
Epoch 35/100
20/20 [==============================] - 0s 5ms/step - loss: 0.5515 - accuracy: 0.76
28
Epoch 36/100
20/20 [==============================] - 0s 5ms/step - loss: 0.5398 - accuracy: 0.77
56
Epoch 37/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5239 - accuracy: 0.70
51
Epoch 38/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5754 - accuracy: 0.71
79
Epoch 39/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5137 - accuracy: 0.76
92
Epoch 40/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4875 - accuracy: 0.78
21
Epoch 41/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5353 - accuracy: 0.73
08
Epoch 42/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4931 - accuracy: 0.73
72
Epoch 43/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5207 - accuracy: 0.72
44
Epoch 44/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5101 - accuracy: 0.77
56
Epoch 45/100
20/20 [==============================] - 0s 3ms/step - loss: 0.5203 - accuracy: 0.76
28
Epoch 46/100
20/20 [==============================] - 0s 4ms/step - loss: 0.5115 - accuracy: 0.79
49
Epoch 47/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4797 - accuracy: 0.83
33
Epoch 48/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4835 - accuracy: 0.78
21
Epoch 49/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4729 - accuracy: 0.77
```

```
56
Epoch 50/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4406 - accuracy: 0.77
56
Epoch 51/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4684 - accuracy: 0.78
21
Epoch 52/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4610 - accuracy: 0.76
92
Epoch 53/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4567 - accuracy: 0.73
72
Epoch 54/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4514 - accuracy: 0.80
13
Epoch 55/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4635 - accuracy: 0.79
49
Epoch 56/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4062 - accuracy: 0.85
26
Epoch 57/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4605 - accuracy: 0.78
85
Epoch 58/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4114 - accuracy: 0.82
05
Epoch 59/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4531 - accuracy: 0.77
56
Epoch 60/100
20/20 [==============================] - 0s 5ms/step - loss: 0.3792 - accuracy: 0.80
77
Epoch 61/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4217 - accuracy: 0.80
13
Epoch 62/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4431 - accuracy: 0.81
41
Epoch 63/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4090 - accuracy: 0.83
97
Epoch 64/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4122 - accuracy: 0.83
33
Epoch 65/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3703 - accuracy: 0.83
97
Epoch 66/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4255 - accuracy: 0.78
85
Epoch 67/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4008 - accuracy: 0.80
77
Epoch 68/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3742 - accuracy: 0.82
05
Epoch 69/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3852 - accuracy: 0.82
05
Epoch 70/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3414 - accuracy: 0.84
62
```

```
Epoch 71/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3610 - accuracy: 0.83
97
Epoch 72/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4375 - accuracy: 0.80
77
Epoch 73/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3378 - accuracy: 0.86
54
Epoch 74/100
20/20 [==============================] - 0s 4ms/step - loss: 0.4144 - accuracy: 0.83
33
Epoch 75/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4037 - accuracy: 0.81
41
Epoch 76/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3659 - accuracy: 0.81
41
Epoch 77/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3711 - accuracy: 0.86
54
Epoch 78/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3883 - accuracy: 0.85
26
Epoch 79/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4163 - accuracy: 0.82
05
Epoch 80/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3437 - accuracy: 0.88
46
Epoch 81/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3258 - accuracy: 0.87
82
Epoch 82/100
20/20 [==============================] - 0s 4ms/step - loss: 0.3395 - accuracy: 0.89
10
Epoch 83/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3376 - accuracy: 0.83
33
Epoch 84/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3222 - accuracy: 0.89
10
Epoch 85/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3283 - accuracy: 0.85
90
Epoch 86/100
20/20 [==============================] - 0s 3ms/step - loss: 0.4214 - accuracy: 0.82
05
Epoch 87/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3381 - accuracy: 0.87
18
Epoch 88/100
20/20 [==============================] - 0s 2ms/step - loss: 0.3120 - accuracy: 0.85
90
Epoch 89/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3015 - accuracy: 0.87
82
Epoch 90/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3315 - accuracy: 0.87
82
Epoch 91/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3004 - accuracy: 0.87
18
Epoch 92/100
```

```
20/20 [==============================] - 0s 3ms/step - loss: 0.2727 - accuracy: 0.87
82
Epoch 93/100
20/20 [==============================] - 0s 4ms/step - loss: 0.2593 - accuracy: 0.89
10
Epoch 94/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3109 - accuracy: 0.91
03
Epoch 95/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3702 - accuracy: 0.86
54
Epoch 96/100
20/20 [==============================] - 0s 2ms/step - loss: 0.3374 - accuracy: 0.84
62
Epoch 97/100
20/20 [==============================] - 0s 3ms/step - loss: 0.2665 - accuracy: 0.90
38
Epoch 98/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3150 - accuracy: 0.84
62
Epoch 99/100
20/20 [==============================] - 0s 3ms/step - loss: 0.3316 - accuracy: 0.85
90
Epoch 100/100
20/20 [==============================] - 0s 6ms/step - loss: 0.3229 - accuracy: 0.85
26
```

Out[20]:
```
<keras.callbacks.History at 0x18ef50a2af0>
```

In [21]:
```
modeld.evaluate(X_test, y_test)
```

```
2/2 [==============================] - 0s 3ms/step - loss: 0.4382 - accuracy: 0.8269
```

Out[21]:
```
[0.43816396594047546, 0.8269230723381042]
```

In [22]:
```
y_pred = modeld.predict(X_test).reshape(-1)
print(y_pred[:10])

# round the values to nearest integer ie 0 or 1
y_pred = np.round(y_pred)
print(y_pred[:10])
```

```
2/2 [==============================] - 0s 3ms/step
[6.9921763e-05 8.8966221e-01 9.6630204e-01 2.4087893e-02 9.9961352e-01
 9.4009644e-01 6.6094136e-01 9.9968743e-01 1.9487558e-02 9.9977410e-01]
[0. 1. 1. 0. 1. 1. 1. 1. 0. 1.]
```

You can see that by using dropout layer test accuracy increased from 0.77 to 0.81

In [ ]:
```
```