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

In [2]:
```
data = pd.read_csv('data.csv')
del data['Unnamed: 32']
```

In [3]:
```
data.head()
```

Out[3]:

	id	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mea
0	842302	M	17.99	10.38	122.80	1001.0	0.1184
1	842517	M	20.57	17.77	132.90	1326.0	0.0847
2	84300903	M	19.69	21.25	130.00	1203.0	0.1096
3	84348301	M	11.42	20.38	77.58	386.1	0.1425
4	84358402	M	20.29	14.34	135.10	1297.0	0.1003

5 rows × 32 columns

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

Out[4]:
```
(569, 32)
```

In [5]:
```
X = data.iloc[:, 2:].values
y = data.iloc[:, 1].values
```

In [6]:
```
X
```

Out[6]:
```
array([[1.799e+01, 1.038e+01, 1.228e+02, ..., 2.654e-01, 4.601e-01,
        1.189e-01],
       [2.057e+01, 1.777e+01, 1.329e+02, ..., 1.860e-01, 2.750e-01,
        8.902e-02],
       [1.969e+01, 2.125e+01, 1.300e+02, ..., 2.430e-01, 3.613e-01,
        8.758e-02],
       ...,
       [1.660e+01, 2.808e+01, 1.083e+02, ..., 1.418e-01, 2.218e-01,
        7.820e-02],
       [2.060e+01, 2.933e+01, 1.401e+02, ..., 2.650e-01, 4.087e-01,
        1.240e-01],
       [7.760e+00, 2.454e+01, 4.792e+01, ..., 0.000e+00, 2.871e-01,
        7.039e-02]])
```

In [7]:
```
y
```

Out[7]:
```
array(['M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'B', 'B', 'B', 'M', 'M', 'M', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'B', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B',
       'B', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M',
       'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M', 'M', 'B', 'M', 'B', 'M',
       'M', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'M', 'M', 'B', 'B', 'B',
       'M', 'B', 'B', 'M', 'M', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'B',
       'B', 'M', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'B', 'M', 'M', 'B', 'M',
       'B', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'M', 'B', 'B', 'M', 'B',
       'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'M', 'M',
       'B', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'M', 'M',
       'M', 'B', 'M', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'B', 'M', 'M',
       'B', 'M', 'M', 'M', 'M', 'B', 'M', 'M', 'M', 'B', 'M', 'B', 'M',
       'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'B', 'B', 'M', 'M', 'B',
       'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'M',
       'B', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'B',
       'B', 'B', 'B', 'M', 'B', 'M', 'M', 'M', 'M', 'M', 'M', 'M', 'M',
       'M', 'M', 'M', 'M', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'M',
       'B', 'M', 'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'M', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
       'B', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'M', 'B', 'M', 'B',
       'B', 'B', 'B', 'M', 'M', 'M', 'B', 'B', 'B', 'B', 'M', 'B', 'M',
       'B', 'M', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'M', 'M', 'B', 'M', 'M', 'M', 'B', 'M', 'M', 'B', 'B', 'B',
       'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'M',
       'B', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
       'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'M', 'B', 'M', 'M', 'B', 'M', 'B', 'B', 'B', 'B', 'B', 'M',
       'B', 'B', 'M', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B',
       'B', 'B', 'B', 'B', 'B', 'B', 'M', 'B', 'M', 'B', 'B', 'M', 'B',
       'B', 'B', 'B', 'B', 'M', 'M', 'B', 'M', 'B', 'M', 'B', 'B', 'B',
       'B', 'B', 'M', 'B', 'B', 'M', 'B', 'M', 'B', 'M', 'M', 'B', 'B',
       'B', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'M', 'B', 'M', 'M', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B', 'B',
       'B', 'B', 'B', 'M', 'M', 'M', 'M', 'M', 'M', 'B'], dtype=object)
```

In [8]:
```
from sklearn.preprocessing import LabelEncoder
labelencoder_X_1 = LabelEncoder()
y = labelencoder_X_1.fit_transform(y)
```

In [9]:
```
y
```

Out[9]:
```
array([1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1,
       1, 1, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 0, 0, 0, 0, 1, 0, 1, 1,
       0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 1, 1,
       0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0,
       0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 1,
       1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0,
       0, 1, 0, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 1, 1,
       1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 1, 0, 0, 1, 1,
       0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0,
       0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 1, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1,
       1, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1,
       1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1, 1, 0, 1, 1,
       0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0,
       0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 1, 0, 0, 1,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0,
       0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1,
       0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
       0, 0, 0, 1, 0, 1, 0, 0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 1, 0, 0,
       0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 0, 0, 0, 1, 0, 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, 1, 1, 1, 1, 1, 1, 0])
```

In [10]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, randon
```

In [11]:
```
X_train.shape
```

Out[11]:
```
(455, 30)
```

In [12]:
```
X_test.shape
```

Out[12]:
```
(114, 30)
```

In [13]:
```
X_train
```

Out[13]:
```
array([[1.005e+01, 1.753e+01, 6.441e+01, ..., 6.499e-02, 2.894e-01,
        7.664e-02],
       [1.080e+01, 2.198e+01, 6.879e+01, ..., 7.485e-02, 2.965e-01,
        7.662e-02],
       [1.614e+01, 1.486e+01, 1.043e+02, ..., 1.129e-01, 2.778e-01,
        7.012e-02],
       ...,
       [9.436e+00, 1.832e+01, 5.982e+01, ..., 5.052e-02, 2.454e-01,
        8.136e-02],
       [9.720e+00, 1.822e+01, 6.073e+01, ..., 0.000e+00, 1.909e-01,
        6.559e-02],
       [1.151e+01, 2.393e+01, 7.452e+01, ..., 9.653e-02, 2.112e-01,
        8.732e-02]])
```

In [14]:
```
X_test
```

Out[14]:
```
array([[1.340e+01, 2.052e+01, 8.864e+01, ..., 2.051e-01, 3.585e-01,
        1.109e-01],
       [1.321e+01, 2.525e+01, 8.410e+01, ..., 6.005e-02, 2.444e-01,
        6.788e-02],
       [1.402e+01, 1.566e+01, 8.959e+01, ..., 8.216e-02, 2.136e-01,
        6.710e-02],
       ...,
       [2.018e+01, 1.954e+01, 1.338e+02, ..., 2.173e-01, 3.032e-01,
        8.075e-02],
       [1.831e+01, 2.058e+01, 1.208e+02, ..., 1.510e-01, 3.074e-01,
        7.863e-02],
       [1.504e+01, 1.674e+01, 9.873e+01, ..., 1.018e-01, 2.177e-01,
        8.549e-02]])
```

In [15]:
```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

In [16]:
```
X_train
```

Out[16]:
```
array([[-1.15036482, -0.39064196, -1.12855021, ..., -0.75798367,
        -0.01614761, -0.38503402],
       [-0.93798972,  0.68051405, -0.94820146, ..., -0.60687023,
         0.09669004, -0.38615797],
       [ 0.574121  , -1.03333557,  0.51394098, ..., -0.02371948,
        -0.20050207, -0.75144254],
       ...,
       [-1.32422924, -0.20048168, -1.31754581, ..., -0.97974953,
        -0.71542314, -0.11978123],
       [-1.24380987, -0.2245526 , -1.28007609, ..., -1.75401433,
        -1.58157125, -1.00601779],
       [-0.73694129,  1.14989702, -0.71226578, ..., -0.27460457,
        -1.25895095,  0.21515662]])
```

In [17]:
```
X_test
```

Out[17]:
```
array([[-0.20175604,  0.3290786 , -0.13086754, ...,  1.3893291 ,
         1.08203284,  1.54029664],
       [-0.25555773,  1.46763319, -0.31780437, ..., -0.83369364,
        -0.73131577, -0.87732522],
       [-0.02619262, -0.8407682 , -0.09175081, ..., -0.49483785,
        -1.22080864, -0.92115937],
       ...,
       [ 1.71811488,  0.09318356,  1.7286186 , ...,  1.57630515,
         0.20317063, -0.15406178],
       [ 1.18859296,  0.34352115,  1.19333694, ...,  0.56019755,
         0.26991966, -0.27320074],
       [ 0.26263752, -0.58080224,  0.28459338, ..., -0.19383705,
        -1.15564888,  0.11231497]])
```

In [18]:
```
import keras
from keras.models import Sequential
from keras.layers import Dense, Dropout
from keras import models
from keras import layers
```

In [19]:
```
classifier = models.Sequential()
```

In [20]:
```
classifier.add(layers.Dense(16, activation='relu' ,input_dim=30,use_bias=True,nam
classifier.add(layers.Dropout(rate=0.1))
```

In [21]:
```
classifier.add(layers.Dense(16, activation='relu',use_bias=True,name = 'hidden1')
classifier.add(layers.Dropout(rate=0.1))
```

In [22]:
```
classifier.add(layers.Dense(1,  activation='sigmoid',use_bias=True,name = 'output
```

In [23]:
```
classifier.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input (Dense)                (None, 16)                496
_________________________________________________________________
dropout (Dropout)            (None, 16)                0
_________________________________________________________________
hidden1 (Dense)              (None, 16)                272
_________________________________________________________________
dropout_1 (Dropout)          (None, 16)                0
_________________________________________________________________
output (Dense)               (None, 1)                 17
=================================================================
Total params: 785
Trainable params: 785
Non-trainable params: 0
_________________________________________________________________
```

In [24]:
```
classifier.weights
```

```
          0.14548662, -0.01685229, -0.045203  ,  0.09039056,  0.00431851,
          0.22250053],
        [-0.3370662 , -0.0680767 ,  0.03867662, -0.02139777, -0.23592842,

          0.06566933,  0.09550411,  0.18874952,  0.32458898,  0.2650937 ,
          0.25384465,  0.19958553, -0.07092944,  0.18347833, -0.00761372,
          0.2602667 ],
        [ 0.17438576,  0.04811737, -0.0981642 , -0.2887862 , -0.03320611,
         -0.21978281, -0.31064084,  0.0474453 ,  0.3571976 ,  0.2112219 ,
         -0.14187685,  0.23495635,  0.12937236, -0.07080775,  0.1900616 ,
          0.34059212],
        [ 0.26228324, -0.25678337,  0.16024807,  0.11726385, -0.25625423,
          0.0470573 ,  0.3063461 , -0.01136282, -0.13627036, -0.2579608 ,
         -0.28634602,  0.04893029, -0.04770714, -0.35470438, -0.22224908,
          0.02320153],
        [ 0.24757442, -0.03534093, -0.02039048,  0.20620683, -0.19533987,
          0.20112523, -0.13179651, -0.18376705, -0.2341268 ,  0.2369735 ,
         -0.24957442, -0.16068298, -0.3020139 ,  0.06480405,  0.26707217,
          0.2712963 ],
        [-0.07620648,  0.20558742,  0.06599   , -0.141245  ,  0.08025038,
```

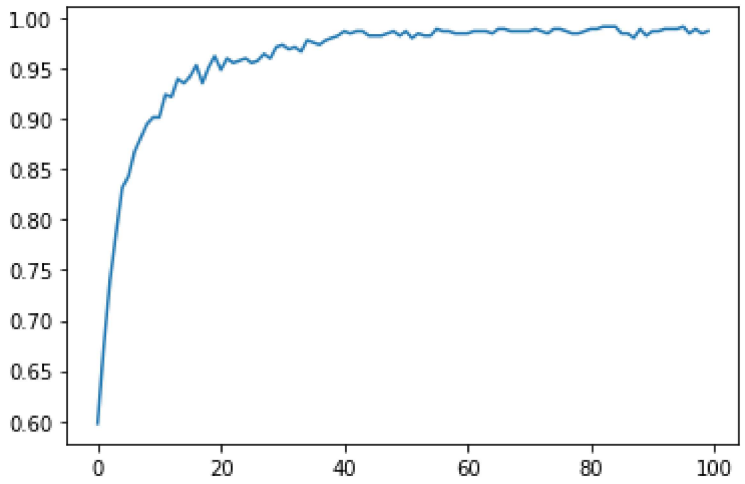
In [25]:
```
classifier.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accura
```

In [26]:
```
history = classifier.fit(X_train, y_train, batch_size=100, epochs=100,validation_
```

```
0.9888 - val_loss: 0.0295 - val_accuracy: 1.0000
Epoch 95/100
5/5 [==============================] - 0s 5ms/step - loss: 0.0462 - accuracy:
0.9888 - val_loss: 0.0293 - val_accuracy: 1.0000
Epoch 96/100
5/5 [==============================] - 0s 6ms/step - loss: 0.0450 - accuracy:
0.9910 - val_loss: 0.0290 - val_accuracy: 1.0000
Epoch 97/100

5/5 [==============================] - 0s 6ms/step - loss: 0.0507 - accuracy:
0.9843 - val_loss: 0.0289 - val_accuracy: 1.0000
Epoch 98/100
5/5 [==============================] - 0s 6ms/step - loss: 0.0509 - accuracy:
0.9888 - val_loss: 0.0291 - val_accuracy: 1.0000
Epoch 99/100
5/5 [==============================] - 0s 6ms/step - loss: 0.0518 - accuracy:
0.9843 - val_loss: 0.0292 - val_accuracy: 1.0000
Epoch 100/100
5/5 [==============================] - 0s 5ms/step - loss: 0.0478 - accuracy:
0.9865 - val_loss: 0.0299 - val_accuracy: 1.0000
```

In [27]:
```
plt.plot(history.history['accuracy'])
plt.show()
```



In [28]:
```
y_pred = classifier.predict(X_test)
y_pred = (y_pred > 0.5)
```

In [29]:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
cm
```

Out[29]:
```
array([[65,  2],
       [ 2, 45]], dtype=int64)
```

In [30]:
```
print("Our accuracy is {}%".format(((cm[0][0] + cm[1][1])/114)*100))
```

```
Our accuracy is 96.49122807017544%
```