Importing Dependencies

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import sklearn.datasets
from sklearn.model_selection import train_test_split
```

Data collection and processing

```
breast_cancer_dataset = sklearn.datasets.load_breast_cancer()
```

```
print(breast_cancer_dataset)
```


```
{'data': 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]]), 'target': array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0,
       1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0,
       1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1,
       1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0,
       0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1,
       1, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0,
       0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0,
       1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1,
       1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0,
       0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0,
       0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0,
       1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
       1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 1,
       1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
       1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1,
       1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1,
       1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 0, 1, 0, 0, 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, 1]), 'frame': None, 'target_names': array(['malignant', 'benign'], dtyp
       'mean smoothness', 'mean compactness', 'mean concavity',
       'mean concave points', 'mean symmetry', 'mean fractal dimension',
       'radius error', 'texture error', 'perimeter error', 'area error',
       'smoothness error', 'compactness error', 'concavity error',
       'concave points error', 'symmetry error',
       'fractal dimension error', 'worst radius', 'worst texture',
       'worst perimeter', 'worst area', 'worst smoothness',
       'worst compactness', 'worst concavity', 'worst concave points',
       'worst symmetry', 'worst fractal dimension'], dtype='<U23'), 'filename': 'breast_cancer.csv', 'data_module': 'sklearn.dataset
```


```
# creating a dataframe
dataframe = pd.DataFrame(breast_cancer_dataset.data,columns = breast_cancer_dataset.feature_names)
```

```
dataframe.head()
```

	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity	mean concave points	sy
0	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.3001	0.14710	
1	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.0869	0.07017	
2	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.1974	0.12790	
3	11.42	20.38	77.58	386.1	0.14250	0.28390	0.2414	0.10520	
4	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.1980	0.10430	

5 rows × 30 columns

```
# addding target to the dataframe
# 0 ---->   1---->
dataframe['label'] = breast_cancer_dataset.target
```

```
dataframe.tail()
```

	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity	mean concave points
564	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890
565	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791
566	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302
567	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200
568	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000

5 rows × 31 columns

```
dataframe.shape   #tells us the no. of columns and rows
```

```
(569, 31)
```

```
dataframe.info()  # tells us about each column info. which type of column is that
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 569 entries, 0 to 568
Data columns (total 31 columns):
 #   Column                   Non-Null Count  Dtype  
---  ------                   --------------  -----  
 0   mean radius              569 non-null    float64
 1   mean texture             569 non-null    float64
 2   mean perimeter           569 non-null    float64
 3   mean area                569 non-null    float64
 4   mean smoothness          569 non-null    float64
 5   mean compactness         569 non-null    float64
 6   mean concavity           569 non-null    float64
 7   mean concave points      569 non-null    float64
 8   mean symmetry            569 non-null    float64
 9   mean fractal dimension   569 non-null    float64
 10  radius error             569 non-null    float64
 11  texture error            569 non-null    float64
 12  perimeter error          569 non-null    float64
 13  area error               569 non-null    float64
 14  smoothness error         569 non-null    float64
 15  compactness error        569 non-null    float64
 16  concavity error          569 non-null    float64
 17  concave points error     569 non-null    float64
 18  symmetry error           569 non-null    float64
 19  fractal dimension error  569 non-null    float64
 20  worst radius             569 non-null    float64
 21  worst texture            569 non-null    float64
 22  worst perimeter          569 non-null    float64
 23  worst area               569 non-null    float64
 24  worst smoothness         569 non-null    float64
 25  worst compactness        569 non-null    float64
 26  worst concavity          569 non-null    float64
 27  worst concave points     569 non-null    float64
 28  worst symmetry           569 non-null    float64
 29  worst fractal dimension  569 non-null    float64
 30  label                    569 non-null    int64  
dtypes: float64(30), int64(1)
memory usage: 137.9 KB
```

```
dataframe.isnull().sum() #tells us about the null values
```

```
mean radius               0
mean texture              0
mean perimeter            0
mean area                 0
mean smoothness           0
mean compactness          0
mean concavity            0
mean concave points       0
mean symmetry             0
mean fractal dimension    0
radius error              0
texture error             0
perimeter error           0
area error                0
smoothness error          0
compactness error         0
concavity error           0
concave points error      0
symmetry error            0
fractal dimension error   0
worst radius              0
worst texture             0
worst perimeter           0
worst area                0
worst smoothness          0
worst compactness         0
worst concavity           0
worst concave points      0
worst symmetry            0
worst fractal dimension   0
label                     0
dtype: int64
```

```
dataframe.describe() #tells us about the statistical measures of the data
```

	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	conca
count	569.000000	569.000000	569.000000	569.000000	569.000000	569.000000	569.00
mean	14.127292	19.289649	91.969033	654.889104	0.096360	0.104341	0.08
std	3.524049	4.301036	24.298981	351.914129	0.014064	0.052813	0.07
min	6.981000	9.710000	43.790000	143.500000	0.052630	0.019380	0.00
25%	11.700000	16.170000	75.170000	420.300000	0.086370	0.064920	0.02
50%	13.370000	18.840000	86.240000	551.100000	0.095870	0.092630	0.06
75%	15.780000	21.800000	104.100000	782.700000	0.105300	0.130400	0.13
max	28.110000	39.280000	188.500000	2501.000000	0.163400	0.345400	0.42

8 rows × 31 columns

```
dataframe['label'].value_counts() # checking the distribution of target variable
```

```
label
1    357
0    212
Name: count, dtype: int64
```

1 ---> Benign 0 ---> Malignant

```
dataframe.groupby('label').mean()  # groupby helps to show the mean values of the label values separetly
```

label	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity
0	17.462830	21.604906	115.365377	978.376415	0.102898	0.145188	0.16077
1	12.146524	17.914762	78.075406	462.790196	0.092478	0.080085	0.04605

2 rows × 30 columns

Separating the features and target

```
X = dataframe.drop(columns='label',axis = 1)
Y = dataframe['label']
```

```
print(X)
print(Y)
```

```
564                0.05623  ...        25.450          26.40
565                0.05533  ...        23.690          38.25
566                0.05648  ...        18.980          34.12
567                0.07016  ...        25.740          39.42
568                0.05884  ...         9.456          30.37

     worst perimeter  worst area  worst smoothness  worst compactness  \
0             184.60      2019.0           0.16220            0.66560
1             158.80      1956.0           0.12380            0.18660
2             152.50      1709.0           0.14440            0.42450
3              98.87       567.7           0.20980            0.86630
4             152.20      1575.0           0.13740            0.20500
..               ...         ...               ...                ...
564           166.10      2027.0           0.14100            0.21130
565           155.00      1731.0           0.11660            0.19220
566           126.70      1124.0           0.11390            0.30940
567           184.60      1821.0           0.16500            0.86810
568            59.16       268.6           0.08996            0.06444

     worst concavity  worst concave points  worst symmetry  \
0             0.7119                0.2654          0.4601
1             0.2416                0.1860          0.2750
2             0.4504                0.2430          0.3613
3             0.6869                0.2575          0.6638
4             0.4000                0.1625          0.2364
..               ...                   ...             ...
564           0.4107                0.2216          0.2060
565           0.3215                0.1628          0.2572
566           0.3403                0.1418          0.2218
567           0.9387                0.2650          0.4087
568           0.0000                0.0000          0.2871

     worst fractal dimension
0                    0.11890
1                    0.08902
2                    0.08758
3                    0.17300
4                    0.07678
..                       ...
564                  0.07115
565                  0.06637
566                  0.07820
567                  0.12400
568                  0.07039

[569 rows x 30 columns]
0      0
1      0
2      0
3      0
4      0
      ..
564    0
565    0
566    0
567    0
568    1
Name: label, Length: 569, dtype: int64
```

Splitting the data into training data and Testing data

```
X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size = 0.2,random_state = 2)
```

```
print(X.shape,X_train.shape,X_test.shape)
```

```
(569, 30) (455, 30) (114, 30)
```

Standardize the data

```
from sklearn.preprocessing import StandardScaler
```

```
scaler = StandardScaler()

X_train_std = scaler.fit_transform(X_train)
X_test_std = scaler.transform(X_test)
```

```
print(X_train_std)
```

```
[[-0.01330339  1.7757658  -0.01491962 ... -0.13236958 -1.08014517
  -0.03527943]
 [-0.8448276  -0.6284278  -0.87702746 ... -1.11552632 -0.85773964
  -0.72098905]
 [ 1.44755936  0.71180168  1.47428816 ...  0.87583964  0.4967602
   0.46321706]
 ...
 [-0.46608541 -1.49375484 -0.53234924 ... -1.32388956 -1.02997851
  -0.75145272]
 [-0.50025764 -1.62161319 -0.527814   ... -0.0987626   0.35796577
  -0.43906159]
 [ 0.96060511  1.21181916  1.00427242 ...  0.8956983  -1.23064515
   0.50697397]]
```

Building The Neural Network

```
#importing tensorflow and keras    <-- developed by google for creating deep learning models
import tensorflow as tf
tf.random.set_seed(3)
from tensorflow import keras


#setting up the layers of neural network
model = keras.Sequential([
    keras.layers.Flatten(input_shape=(30,)),
    keras.layers.Dense(20,activation='relu'),
    keras.layers.Dense(2,activation='sigmoid')
])


#compiling the neural networks

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


#training the model

history = model.fit(X_train_std,Y_train,validation_split=0.1,epochs=10)
```

```
Epoch 1/10
13/13 [==============================] - 1s 19ms/step - loss: 0.4866 - accuracy: 0.8020 - val_loss: 0.3797 - val_accuracy: 0.9565
Epoch 2/10
13/13 [==============================] - 0s 5ms/step - loss: 0.3194 - accuracy: 0.8924 - val_loss: 0.2560 - val_accuracy: 0.9783
Epoch 3/10
13/13 [==============================] - 0s 6ms/step - loss: 0.2439 - accuracy: 0.9242 - val_loss: 0.1995 - val_accuracy: 0.9783
Epoch 4/10
13/13 [==============================] - 0s 5ms/step - loss: 0.2030 - accuracy: 0.9340 - val_loss: 0.1686 - val_accuracy: 0.9783
Epoch 5/10
13/13 [==============================] - 0s 5ms/step - loss: 0.1762 - accuracy: 0.9413 - val_loss: 0.1496 - val_accuracy: 0.9783
Epoch 6/10
13/13 [==============================] - 0s 5ms/step - loss: 0.1575 - accuracy: 0.9462 - val_loss: 0.1360 - val_accuracy: 0.9783
Epoch 7/10
13/13 [==============================] - 0s 4ms/step - loss: 0.1430 - accuracy: 0.9487 - val_loss: 0.1258 - val_accuracy: 0.9783
Epoch 8/10
13/13 [==============================] - 0s 5ms/step - loss: 0.1313 - accuracy: 0.9560 - val_loss: 0.1181 - val_accuracy: 0.9783
Epoch 9/10
13/13 [==============================] - 0s 5ms/step - loss: 0.1217 - accuracy: 0.9658 - val_loss: 0.1110 - val_accuracy: 0.9783
Epoch 10/10
13/13 [==============================] - 0s 10ms/step - loss: 0.1131 - accuracy: 0.9682 - val_loss: 0.1066 - val_accuracy: 0.9783
```

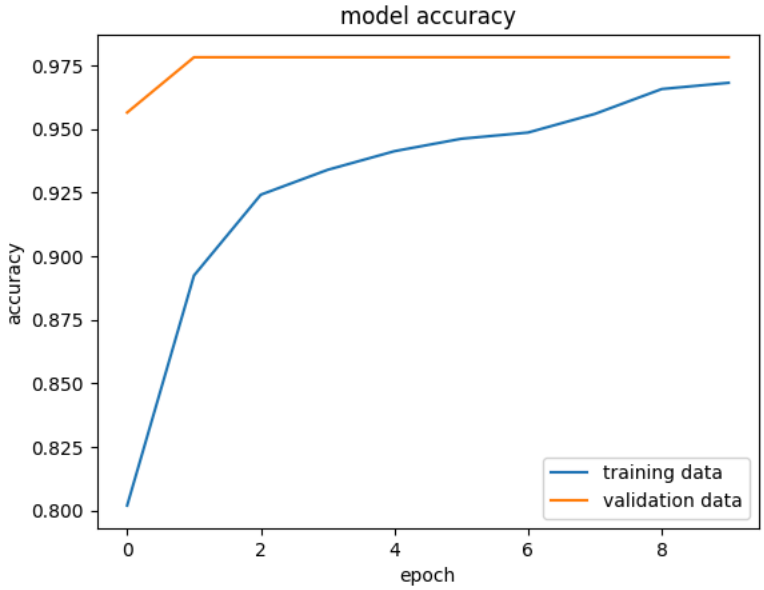
Visulaizing accuracy and loss

```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])

plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')

plt.legend(['training data','validation data'],loc = 'lower right')
```

```
<matplotlib.legend.Legend at 0x7e64791ef880>
```

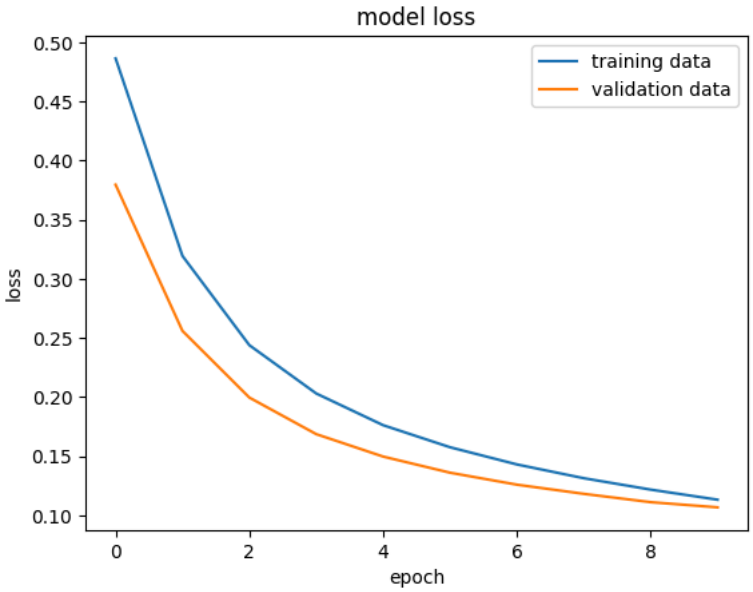



```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])

plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')

plt.legend(['training data','validation data'],loc = 'upper right')
```

```
<matplotlib.legend.Legend at 0x7e647cd696c0>
```



Accuracy of the model on test data

```
loss,accuracy = model.evaluate(X_test_std,Y_test)
print(accuracy)
```

```
4/4 [==============================] - 0s 3ms/step - loss: 0.1164 - accuracy: 0.9386
0.9385964870452881
```

Build a Predictive System

```
print(X_test_std.shape)
print(X_test_std[0])
```

```
(114, 30)
[-0.04462793 -1.41612656 -0.05903514 -0.16234067  2.0202457  -0.11323672
  0.18500609  0.47102419  0.63336386  0.26335737  0.53209124  2.62763999
  0.62351167  0.11405261  1.01246781  0.41126289  0.63848593  2.88971815
 -0.41675911  0.74270853 -0.32983699 -1.67435595 -0.36854552 -0.38767294
```

```
       0.32655007 -0.74858917 -0.54689089 -0.18278004 -1.23064515 -0.6268286 ]
```

```
Y_pred = model.predict(X_test_std)
```

```
4/4 [==============================] - 0s 3ms/step
```

```
print(Y_pred.shape)
print(Y_pred[0])
```

```
(114, 2)
[0.159299  0.7513883]
```

```
print(Y_pred)
```

```
[[2.45191544e-01 9.08973157e-01]
 [4.52882946e-02 9.10310149e-01]
 [5.23319244e-01 2.35378742e-02]
 [2.72058219e-01 9.28914607e-01]
 [3.88937235e-01 6.48908556e-01]
 [9.18239117e-01 1.03692420e-01]
 [1.91242203e-01 9.52847540e-01]
 [7.85486937e-01 1.70325059e-02]
 [8.13573420e-01 3.63627560e-02]
 [5.92141449e-01 7.87646413e-01]
 [9.18471038e-01 2.10727402e-03]
 [7.23274410e-01 2.61995681e-02]
 [6.21686816e-01 6.15288019e-01]
 [3.23766828e-01 3.61053884e-01]
 [5.83733022e-01 2.14822069e-01]
 [8.32518280e-01 9.67573840e-03]
 [1.45588398e-01 9.13623810e-01]
 [6.71616495e-01 1.39173612e-01]
 [1.55286267e-01 9.58647609e-01]
 [6.04783535e-01 1.22176632e-01]
 [1.49034157e-01 8.74401391e-01]
 [1.88912660e-01 9.74478543e-01]
 [3.64527762e-01 6.12152040e-01]
 [5.74265659e-01 2.73325294e-01]
 [8.67894590e-01 1.88622549e-02]
 [6.34752631e-01 2.47963086e-01]
 [8.27198744e-01 1.38601158e-02]
 [2.65208453e-01 8.45021904e-01]
 [2.10084021e-01 8.06344211e-01]
 [5.08449018e-01 5.54542243e-01]
 [1.23695612e-01 9.59269643e-01]
 [1.93218455e-01 8.48353505e-01]
 [4.20540303e-01 8.25776041e-01]
 [9.34040010e-01 1.68232583e-02]
 [2.28489354e-01 9.43438649e-01]
 [3.82782042e-01 9.00061727e-01]
 [2.22888008e-01 9.55945611e-01]
 [8.23915243e-01 1.10778555e-01]
 [5.57724357e-01 8.70296955e-02]
 [2.65221149e-01 8.42225730e-01]
 [8.54155481e-01 4.83367452e-03]
 [8.51505458e-01 3.37263122e-02]
 [1.77255452e-01 8.36346805e-01]
 [1.63465813e-01 9.61011887e-01]
 [1.61149725e-01 9.88198698e-01]
 [5.53071678e-01 1.82995602e-01]
 [9.66395378e-01 2.51073536e-04]
 [9.50252712e-01 6.19956874e-04]
 [2.16956675e-01 8.82590592e-01]
 [1.43900380e-01 9.60179210e-01]
 [1.02038063e-01 9.81731057e-01]
 [2.09759340e-01 9.51954126e-01]
 [1.52745489e-02 9.71510172e-01]
 [2.43146315e-01 6.91956639e-01]
 [9.25043941e-01 4.57590539e-03]
 [7.31664360e-01 2.48165708e-03]
 [6.49302602e-01 5.24360240e-01]
 [8.16598535e-01 4.29233164e-02]]
```

model.predict gives me the probability of each class datapoint

```
#converting probability to label

Y_pred_label = [np.argmax(i) for i in Y_pred]
print(Y_pred_label)
```

```
[1, 0, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1,
```

```
#predictive system

input_data = (17.99,10.38,122.8,1001,0.1184,0.2776,0.3001,0.1471,0.2419,0.07871,1.095,0.9053,8.589,153.4,0.006399,0.04904,0.05373,0.015

#change the input data to numpy array
input_data_as_numpy_array = np.asarray(input_data)

#reshape the numpy array as we are predicting for one data point
input_data_reshaped = input_data_as_numpy_array.reshape(1,-1)

#standardize the data
std_data = scaler.transform(input_data_reshaped)

prediction = model.predict(std_data)
print(prediction)

prediction_label = [np.argmax(prediction)]
print(prediction_label)

if(prediction_label[0] == 0):
  print('The tumor is Malignant')

else:
  print('The tumor is Benign')
```

```
1/1 [==============================] - 0s 32ms/step
[[8.1881064e-01 3.9951672e-04]]
[0]
The tumor is Malignant
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not have valid feature names, but StandardScaler wa
  warnings.warn(
```