PROJECT STATUS

Problem Statement:

Gender Recognition system from audio files using FFT with Artificial Neural Networks.

Status:

6. Training

Using Artifcial Neural Network to train the model for classification problem.

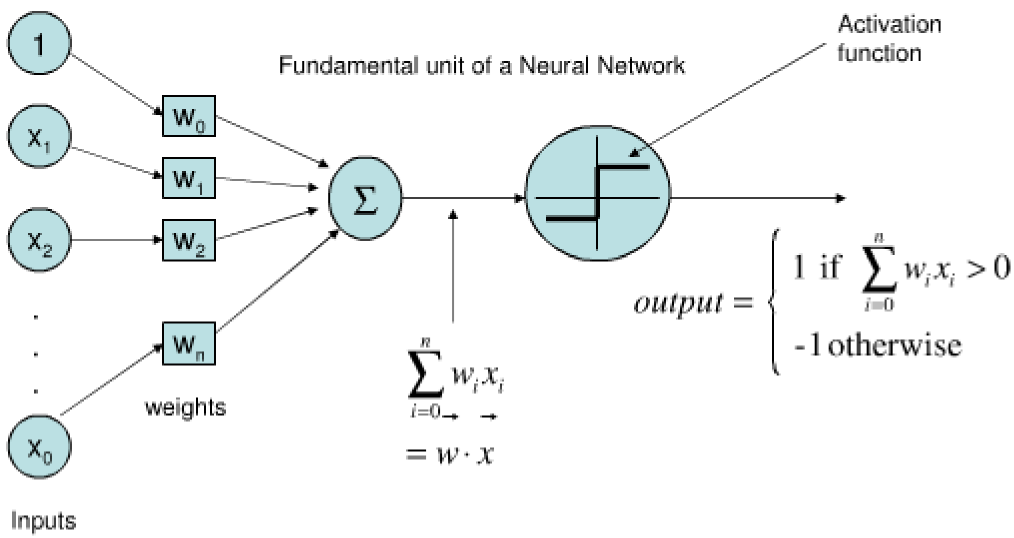


Illustration 1: Artificial Neural Network

The description of the architecture i am using for classification are as follows:

1. 1 input layer , Hidden layer, 1 Output Layer.
2. using 12 input attributes and 1 output attributes.
3. activation function for input and hidden layer is “relu”.
4. activation function for output layer is “sigmoid”.
5. using 10 perceptron in each input and hidden layer.
6. for optimisation algorthm is used “adam”.

Q. What is Perceptron?
Ans :

a computer model or computerized machine devised to represent or simulate the ability of the brain to recognize and discriminate.

Q.What is activation Function?
Ans :

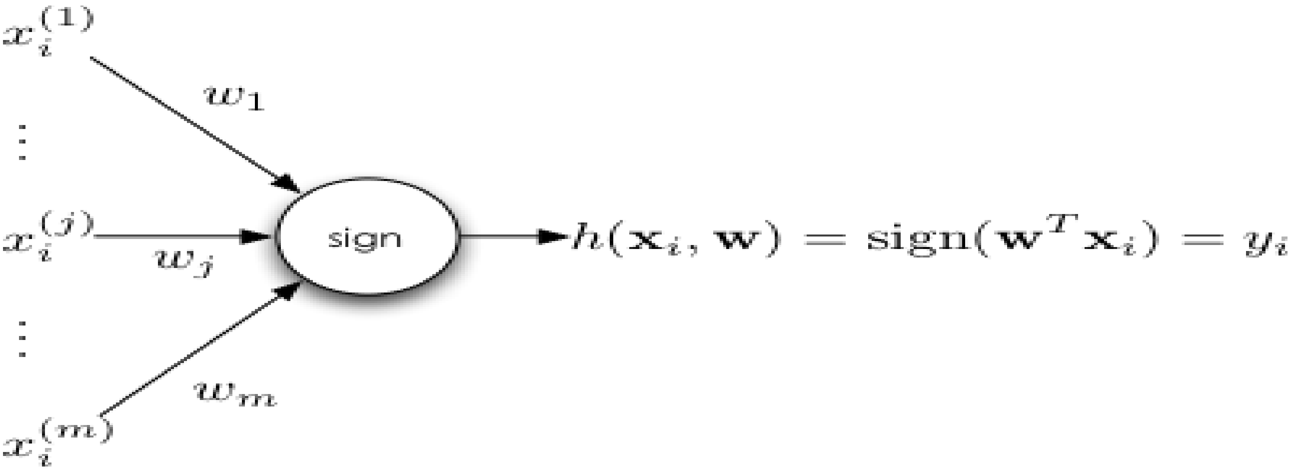


Illustration 2: Perceptron

In artificial neural networks, the activation function of a node defines the output of that node given an input or set of inputs. A standard computer chip circuit can be seen as a digital network of activation functions that can be "ON" (1) or "OFF" (0), depending on input.

<u>ReLu activation Function:</u>

A unit employing the rectifier is also called a rectified linear unit (ReLU).
A smooth approximation to the rectifier is the analytic function

F(x) = Log(1 + exp(x))

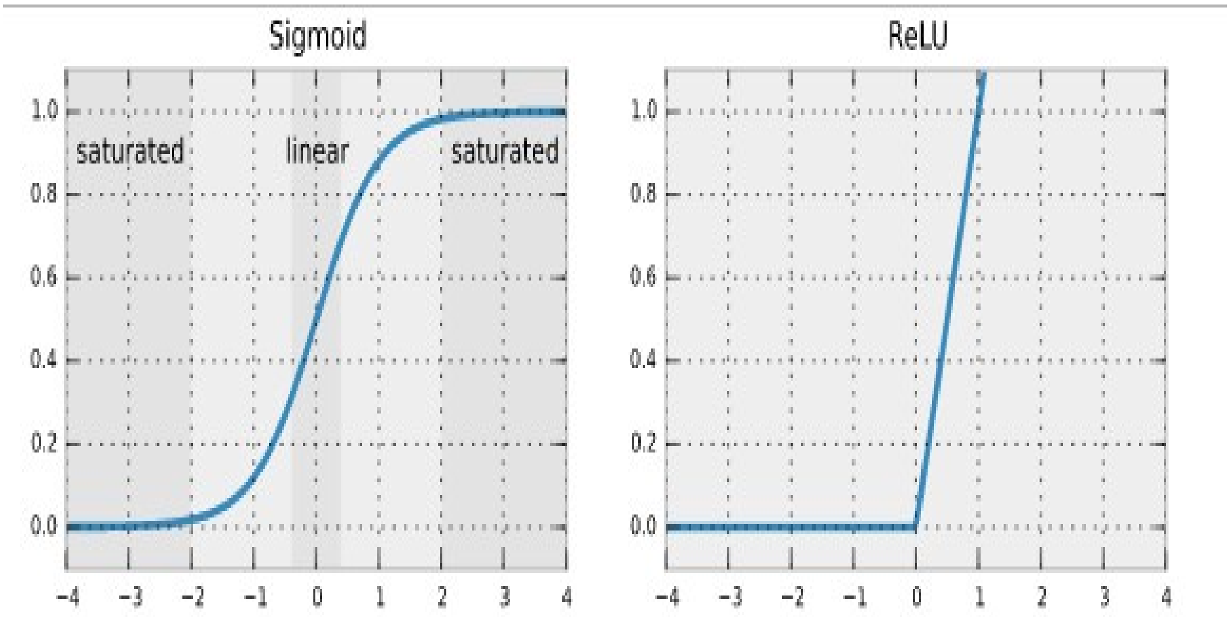
which is called the **softplus** function

<u>Sigmoid activaton Function:</u>

It is used in neural networks to give logistic neurons real-valued output that is a smooth and bounded function of their total input. It also has the added benefit of having nice derivatives which make learning the weights of a neural network easier.

F(x) = 1/ (1 + exp(-x))

Graphical Representation



Implementation

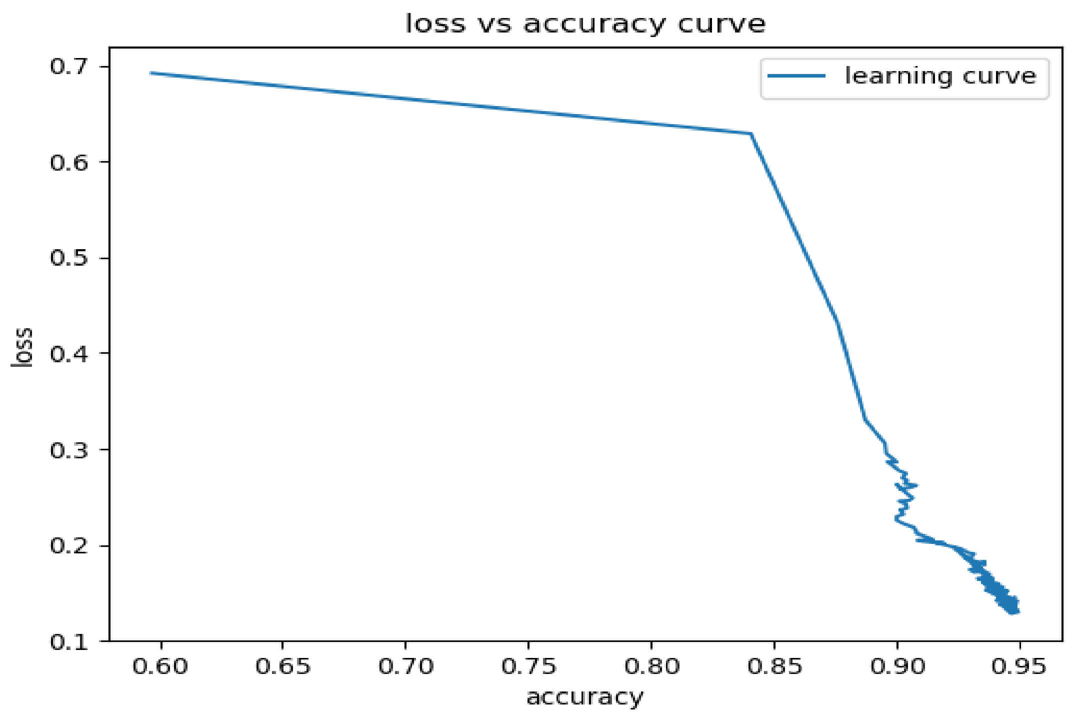
Modules used:

```
import numpy as np
import pandas as pd
import h5py
from sklearn.model_selection import train_test_split
from keras.models import load_model
from keras.models import Sequential
from keras.layers import Dense, Dropout
from keras import optimizers
from sklearn.utils import shuffle
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix
```

Using python keras module for layer creation and compilation:

```
# Initialising the ANN
classifier = Sequential()

# Adding the input layer and the first hidden layer
classifier.add(Dense(output_dim = 10, init = 'uniform', activation = 'relu', input_dim = 12))

# Adding the second hidden layer
classifier.add(Dense(output_dim = 10, init = 'uniform', activation = 'relu'))

# Adding the third hidden layer
classifier.add(Dense(output_dim = 10, init = 'uniform', activation = 'relu'))

# Adding the output layer
classifier.add(Dense(output_dim = 1, init = 'uniform', activation = 'sigmoid'))

# Compiling the ANN
classifier.compile(optimizer = 'adam', loss = 'binary_crossentropy', metrics = ['accuracy'])

# Fitting the ANN to the Training set
history = classifier.fit(x_train, y_train, batch_size = 20, nb_epoch = 200)
```

Learnng Curve:



Trainng process:

Epoch 1/200
2018-06-17 00:32:26.187508: I tensorflow/core/platform/cpu_feature_guard.cc:137] Your CPU supports instructions that this TensorFlow binary was not compiled to use: SSE4.1 SSE4.2 AVX AVX2 FMA
2121/2121 [==============================] - 2s 758us/step - loss: 0.6931 - acc: 0.5158
Epoch 2/200
2121/2121 [==============================] - 0s 186us/step - loss: 0.6824 - acc: 0.6587
Epoch 3/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.6268 - acc: 0.7775
Epoch 4/200
2121/2121 [==============================] - 0s 184us/step - loss: 0.5613 - acc: 0.8345
Epoch 5/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.4890 - acc: 0.8609
Epoch 6/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.4284 - acc: 0.8779
Epoch 7/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.3863 - acc: 0.8821
Epoch 8/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.3598 - acc: 0.8883
Epoch 9/200
2121/2121 [==============================] - 0s 185us/step - loss: 0.3422 - acc: 0.8925
Epoch 10/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.3334 - acc: 0.8949
Epoch 11/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.3231 - acc: 0.8949
Epoch 12/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.3145 - acc: 0.8986
Epoch 13/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.3079 - acc: 0.8996
Epoch 14/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.3035 - acc: 0.9005
Epoch 15/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.2990 - acc: 0.9015
Epoch 16/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.2944 - acc: 0.9010
Epoch 17/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.2920 - acc: 0.9015
Epoch 18/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.2878 - acc: 0.9019
Epoch 19/200

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2121/2121 [==============================] - 0s 186us/step - loss: 0.2881 - acc: 0.8991
Epoch 20/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.2831 - acc: 0.9029
Epoch 21/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.2815 - acc: 0.9048
Epoch 22/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.2765 - acc: 0.9024
Epoch 23/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.2732 - acc: 0.9038
Epoch 24/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.2708 - acc: 0.9033
Epoch 25/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.2668 - acc: 0.9019
Epoch 26/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.2621 - acc: 0.9033
Epoch 27/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.2559 - acc: 0.9043
Epoch 28/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.2467 - acc: 0.8986
Epoch 29/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.2264 - acc: 0.9052
Epoch 30/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.2173 - acc: 0.9104
Epoch 31/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.2239 - acc: 0.9066
Epoch 32/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.2056 - acc: 0.9175
Epoch 33/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.2006 - acc: 0.9236
Epoch 34/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1979 - acc: 0.9236
Epoch 35/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1970 - acc: 0.9255
Epoch 36/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1932 - acc: 0.9260
Epoch 37/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1917 - acc: 0.9274
Epoch 38/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.1907 - acc: 0.9274
Epoch 39/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1883 - acc: 0.9302
Epoch 40/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1841 - acc: 0.9307
Epoch 41/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1858 - acc: 0.9321
Epoch 42/200
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2121/2121 [==============================] - 0s 190us/step - loss: 0.1862 - acc: 0.9316
Epoch 43/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1831 - acc: 0.9321
Epoch 44/200
2121/2121 [==============================] - 0s 186us/step - loss: 0.1869 - acc: 0.9326
Epoch 45/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1803 - acc: 0.9283
Epoch 46/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1810 - acc: 0.9307
Epoch 47/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1784 - acc: 0.9302
Epoch 48/200
2121/2121 [==============================] - 0s 186us/step - loss: 0.1784 - acc: 0.9298
Epoch 49/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1776 - acc: 0.9382
Epoch 50/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1774 - acc: 0.9312
Epoch 51/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1793 - acc: 0.9326
Epoch 52/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1801 - acc: 0.9302
Epoch 53/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1789 - acc: 0.9321
Epoch 54/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1753 - acc: 0.9354
Epoch 55/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1783 - acc: 0.9312
Epoch 56/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.1790 - acc: 0.9307
Epoch 57/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1744 - acc: 0.9331
Epoch 58/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1735 - acc: 0.9368
Epoch 59/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1756 - acc: 0.9345
Epoch 60/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1749 - acc: 0.9326
Epoch 61/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1762 - acc: 0.9349
Epoch 62/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1733 - acc: 0.9345
Epoch 63/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1740 - acc: 0.9354
Epoch 64/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1716 - acc: 0.9312
Epoch 65/200
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2121/2121 [==============================] - 0s 190us/step - loss: 0.1778 - acc: 0.9340
Epoch 66/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1734 - acc: 0.9364
Epoch 67/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1744 - acc: 0.9354
Epoch 68/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1753 - acc: 0.9340
Epoch 69/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1740 - acc: 0.9349
Epoch 70/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.1738 - acc: 0.9345
Epoch 71/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1767 - acc: 0.9349
Epoch 72/200
2121/2121 [==============================] - 0s 186us/step - loss: 0.1727 - acc: 0.9387
Epoch 73/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1751 - acc: 0.9326
Epoch 74/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1747 - acc: 0.9321
Epoch 75/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1719 - acc: 0.9378
Epoch 76/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.1733 - acc: 0.9354
Epoch 77/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1728 - acc: 0.9368
Epoch 78/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1759 - acc: 0.9359
Epoch 79/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1766 - acc: 0.9349
Epoch 80/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1724 - acc: 0.9345
Epoch 81/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1729 - acc: 0.9321
Epoch 82/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1713 - acc: 0.9359
Epoch 83/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1714 - acc: 0.9387
Epoch 84/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1721 - acc: 0.9406
Epoch 85/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1713 - acc: 0.9378
Epoch 86/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1704 - acc: 0.9378
Epoch 87/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1889 - acc: 0.9283
Epoch 88/200
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2121/2121 [==============================] - 0s 192us/step - loss: 0.1765 - acc: 0.9345
Epoch 89/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1719 - acc: 0.9382
Epoch 90/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1707 - acc: 0.9345
Epoch 91/200
2121/2121 [==============================] - 0s 187us/step - loss: 0.1698 - acc: 0.9373
Epoch 92/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1716 - acc: 0.9359
Epoch 93/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1699 - acc: 0.9359
Epoch 94/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1718 - acc: 0.9397
Epoch 95/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1705 - acc: 0.9378
Epoch 96/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1767 - acc: 0.9368
Epoch 97/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1696 - acc: 0.9387
Epoch 98/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1672 - acc: 0.9411
Epoch 99/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1712 - acc: 0.9326
Epoch 100/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1699 - acc: 0.9378
Epoch 101/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1705 - acc: 0.9378
Epoch 102/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1721 - acc: 0.9382
Epoch 103/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1719 - acc: 0.9364
Epoch 104/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1708 - acc: 0.9387
Epoch 105/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1690 - acc: 0.9368
Epoch 106/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1705 - acc: 0.9387
Epoch 107/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1689 - acc: 0.9406
Epoch 108/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1722 - acc: 0.9359
Epoch 109/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1712 - acc: 0.9387
Epoch 110/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1759 - acc: 0.9349
Epoch 111/200
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2121/2121 [==============================] - 0s 191us/step - loss: 0.1718 - acc: 0.9368
Epoch 112/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1699 - acc: 0.9387
Epoch 113/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1694 - acc: 0.9392
Epoch 114/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1695 - acc: 0.9378
Epoch 115/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1704 - acc: 0.9387
Epoch 116/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1690 - acc: 0.9340
Epoch 117/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1708 - acc: 0.9373
Epoch 118/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1702 - acc: 0.9368
Epoch 119/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1683 - acc: 0.9382
Epoch 120/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1686 - acc: 0.9387
Epoch 121/200
2121/2121 [==============================] - 0s 188us/step - loss: 0.1719 - acc: 0.9411
Epoch 122/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1691 - acc: 0.9382
Epoch 123/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1693 - acc: 0.9378
Epoch 124/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1685 - acc: 0.9373
Epoch 125/200
2121/2121 [==============================] - 0s 207us/step - loss: 0.1679 - acc: 0.9397
Epoch 126/200
2121/2121 [==============================] - 0s 203us/step - loss: 0.1693 - acc: 0.9392
Epoch 127/200
2121/2121 [==============================] - 0s 211us/step - loss: 0.1684 - acc: 0.9401
Epoch 128/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1681 - acc: 0.9387
Epoch 129/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1714 - acc: 0.9368
Epoch 130/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1703 - acc: 0.9373
Epoch 131/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1724 - acc: 0.9378
Epoch 132/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1689 - acc: 0.9415
Epoch 133/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1701 - acc: 0.9397
Epoch 134/200

2121/2121 [==============================] - 0s 196us/step - loss: 0.1698 - acc: 0.9392
Epoch 135/200
2121/2121 [==============================] - 0s 196us/step - loss: 0.1677 - acc: 0.9411
Epoch 136/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1684 - acc: 0.9425
Epoch 137/200
2121/2121 [==============================] - 0s 196us/step - loss: 0.1688 - acc: 0.9373
Epoch 138/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1673 - acc: 0.9382
Epoch 139/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1755 - acc: 0.9387
Epoch 140/200
2121/2121 [==============================] - 0s 195us/step - loss: 0.1685 - acc: 0.9382
Epoch 141/200
2121/2121 [==============================] - 0s 196us/step - loss: 0.1699 - acc: 0.9382
Epoch 142/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1712 - acc: 0.9364
Epoch 143/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1694 - acc: 0.9364
Epoch 144/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1662 - acc: 0.9401
Epoch 145/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1679 - acc: 0.9382
Epoch 146/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1663 - acc: 0.9430
Epoch 147/200
2121/2121 [==============================] - 0s 202us/step - loss: 0.1686 - acc: 0.9378
Epoch 148/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1743 - acc: 0.9340
Epoch 149/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1675 - acc: 0.9406
Epoch 150/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1668 - acc: 0.9392
Epoch 151/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1676 - acc: 0.9415
Epoch 152/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1676 - acc: 0.9392
Epoch 153/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1680 - acc: 0.9382
Epoch 154/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1679 - acc: 0.9434
Epoch 155/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1669 - acc: 0.9397
Epoch 156/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1690 - acc: 0.9345
Epoch 157/200

2121/2121 [==============================] - 0s 195us/step - loss: 0.1719 - acc: 0.9387
Epoch 158/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1695 - acc: 0.9382
Epoch 159/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1681 - acc: 0.9420
Epoch 160/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1665 - acc: 0.9382
Epoch 161/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1662 - acc: 0.9420
Epoch 162/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1718 - acc: 0.9378
Epoch 163/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1651 - acc: 0.9401
Epoch 164/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1687 - acc: 0.9411
Epoch 165/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1661 - acc: 0.9420
Epoch 166/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1665 - acc: 0.9420
Epoch 167/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1675 - acc: 0.9387
Epoch 168/200
2121/2121 [==============================] - 0s 195us/step - loss: 0.1656 - acc: 0.9420
Epoch 169/200
2121/2121 [==============================] - 0s 196us/step - loss: 0.1678 - acc: 0.9411
Epoch 170/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1661 - acc: 0.9434
Epoch 171/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1657 - acc: 0.9401
Epoch 172/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1655 - acc: 0.9387
Epoch 173/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1693 - acc: 0.9397
Epoch 174/200
2121/2121 [==============================] - 0s 195us/step - loss: 0.1673 - acc: 0.9420
Epoch 175/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1654 - acc: 0.9373
Epoch 176/200
2121/2121 [==============================] - 0s 189us/step - loss: 0.1691 - acc: 0.9406
Epoch 177/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1700 - acc: 0.9335
Epoch 178/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1662 - acc: 0.9411
Epoch 179/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1652 - acc: 0.9415
Epoch 180/200

```
2121/2121 [==============================] - 0s 195us/step - loss: 0.1736 - acc: 0.9321
Epoch 181/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1768 - acc: 0.9354
Epoch 182/200
2121/2121 [==============================] - 0s 193us/step - loss: 0.1675 - acc: 0.9420
Epoch 183/200
2121/2121 [==============================] - 0s 196us/step - loss: 0.1677 - acc: 0.9406
Epoch 184/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1657 - acc: 0.9415
Epoch 185/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1673 - acc: 0.9401
Epoch 186/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1662 - acc: 0.9397
Epoch 187/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1655 - acc: 0.9401
Epoch 188/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1754 - acc: 0.9354
Epoch 189/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1661 - acc: 0.9382
Epoch 190/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1654 - acc: 0.9406
Epoch 191/200
2121/2121 [==============================] - 0s 191us/step - loss: 0.1666 - acc: 0.9401
Epoch 192/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1649 - acc: 0.9425
Epoch 193/200
2121/2121 [==============================] - 0s 195us/step - loss: 0.1671 - acc: 0.9387
Epoch 194/200
2121/2121 [==============================] - 0s 221us/step - loss: 0.1649 - acc: 0.9378
Epoch 195/200
2121/2121 [==============================] - 0s 195us/step - loss: 0.1662 - acc: 0.9397
Epoch 196/200
2121/2121 [==============================] - 0s 190us/step - loss: 0.1634 - acc: 0.9406
Epoch 197/200
2121/2121 [==============================] - 0s 195us/step - loss: 0.1711 - acc: 0.9373
Epoch 198/200
2121/2121 [==============================] - 0s 194us/step - loss: 0.1639 - acc: 0.9420
Epoch 199/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1646 - acc: 0.9387
Epoch 200/200
2121/2121 [==============================] - 0s 192us/step - loss: 0.1654 - acc: 0.9411
```

7. Testing and Evaluation

Q.What is Confusion Matrix?
Ans :

A confusion matrix is a table that is often used to describe the performance of a classification model (or "classifier") on a set of test data for which the true values are known.

For the above Model :

cm = **[[478 39]**
[[40 489]]

Accuracy : **(correctly predicted class / total testing class) × 100%**

Training :- 94%
Testing :- 92.44%

Precision = TP / TP + FP

= 489/(489+39)
= 0.9261363636363636
= 92.61%

Recall = TP/TP+FN

= 489/(489+40)
= 0.9243856332703214
= 92.43%

F1-Score: = 2*(Recall * Precision) / (Recall + Precision)

= 2*(0.9261363636363636*0.9243856332703214)/(0.9261363636363636+0.9243856332703214)
= 0.925252443830496
= 92.52%

Note : As our F1-Score is more than 90% that means our model is fitted correctly as which gives better testng testing results.