**PROJECT STATUS**

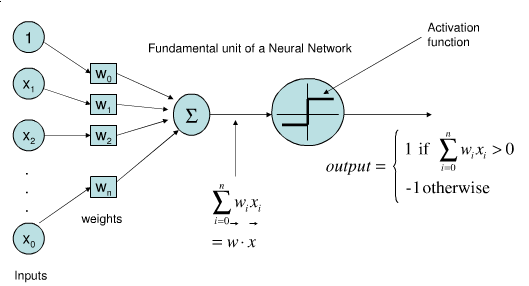
**Problem Statement:**

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”.

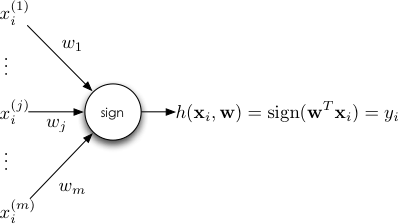
5. using 10 perceptron in each input and hidden layer.

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 :**

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.

**ReLu activation Function:**

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))**

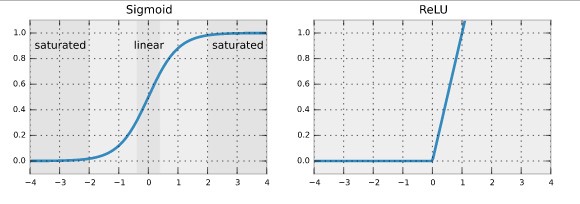
which is called the **softplus** function

**Sigmoid activaton Function:**

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**

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**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'))

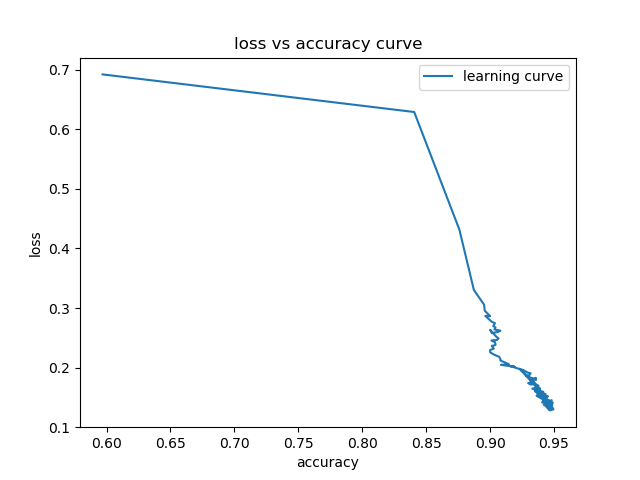
# Compiling the ANN

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:**

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**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

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

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

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

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

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%