Neural Network From Scratch in Python

Demystifying the so-called Black Box of Neural Network

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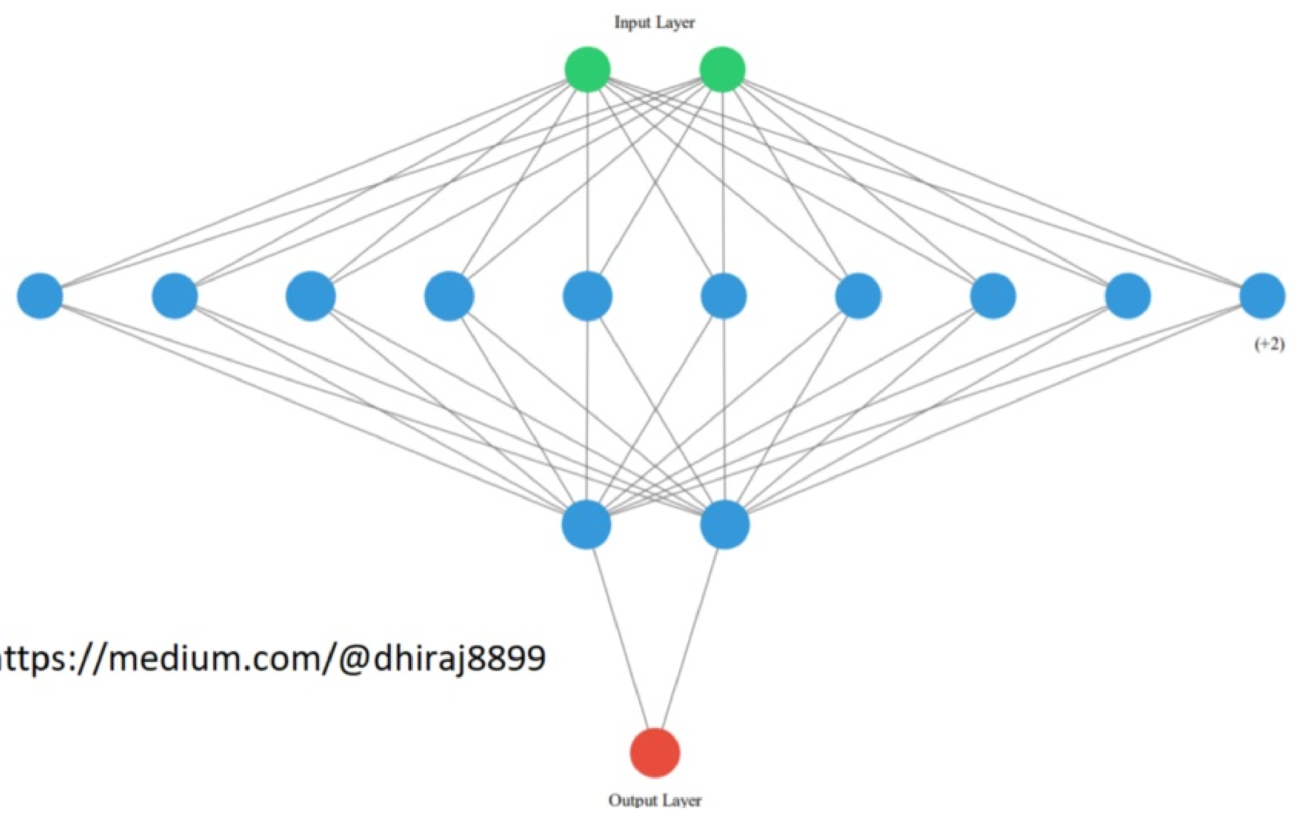

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Introduction:

Do you really think that a neural network is a block box? I believe, a neuron inside the human brain may be very complex, but a neuron in a neural network is certainly not that complex.

It does not matter, what software you are developing right now, if you are not getting up to speed on machine learning…you lose. We are going to an era where one software will create another software and perhaps automate itself.

In this article, we are going to discuss how to implement a neural network from scratch in Python. This means we are not going to use deep learning libraries like TensorFlow, PyTorch, Keras, etc.

Note that this is one of the posts in the series Machine Learning from Scratch. You may like to read other similar posts like **Gradient Descent From Scratch**, **Linear Regression from Scratch**, **Logistic Regression from Scratch**, **Decision Tree from Scratch.**

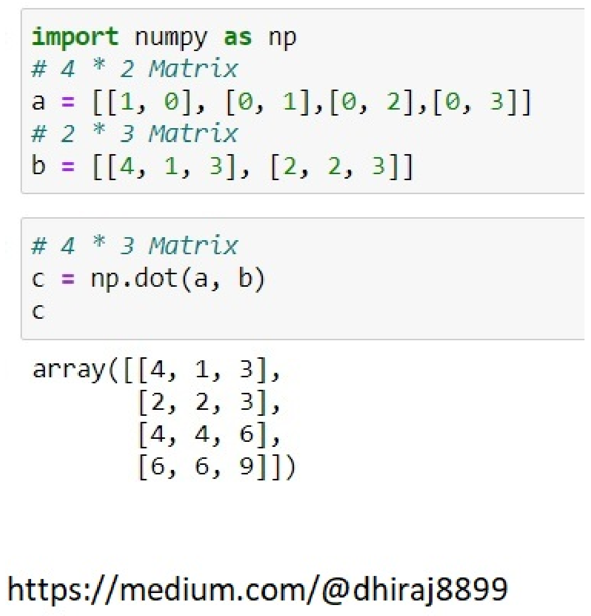
You may like to watch a video version of this article for a more detailed explanation…

General Terms:

Let us first discuss a few statistical concepts used in this post.

Dot Product of Matrix: Dot product of two matrices is one of the most important operations in deep learning. In mathematics, the dot product is a mathematical operation that takes as input, two equal-length sequences of numbers, and outputs a single number.

Not all matrices are eligible for multiplication. To carry out the dot product of two matrices, The number of columns of the 1st matrix must equal the number of rows of the 2nd. Therefore, If we multiply an **m×n** matrix by an **n×p** matrix, then the result is an **m×p** matrix. Here the first dimension represents rows and the second dimension represents columns in a matrix. Note that the number of columns in the first matrix should be the same as the number of rows in the second matrix. This is represented by the letter **n** here.



```python
import numpy as np
# 4 * 2 Matrix
a = [[1, 0], [0, 1],[0, 2],[0, 3]]
# 2 * 3 Matrix
b = [[4, 1, 3], [2, 2, 3]]
```

```python
# 4 * 3 Matrix
c = np.dot(a, b)
c
```

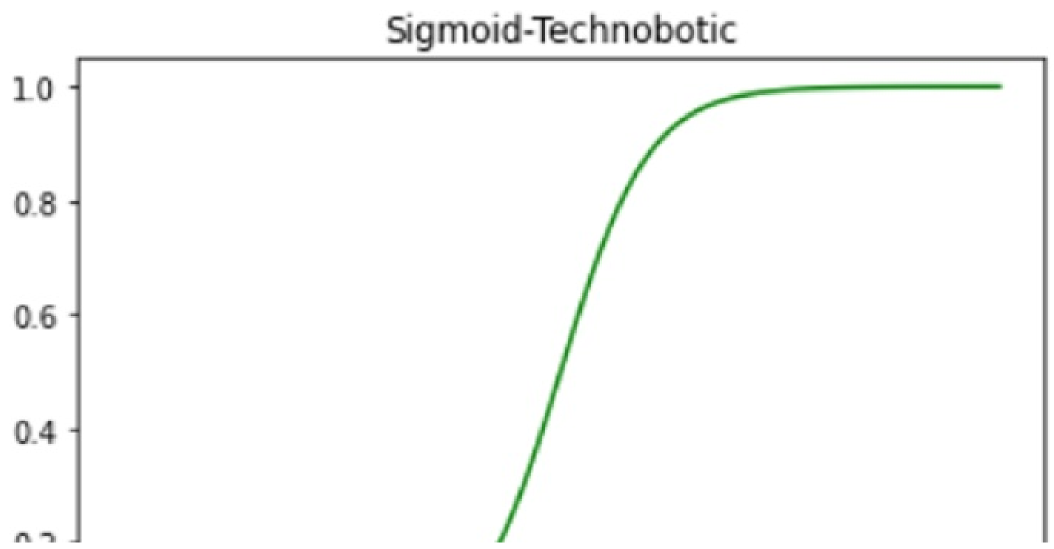
```
array([[4, 1, 3],
       [2, 2, 3],
       [4, 4, 6],
       [6, 6, 9]])
```

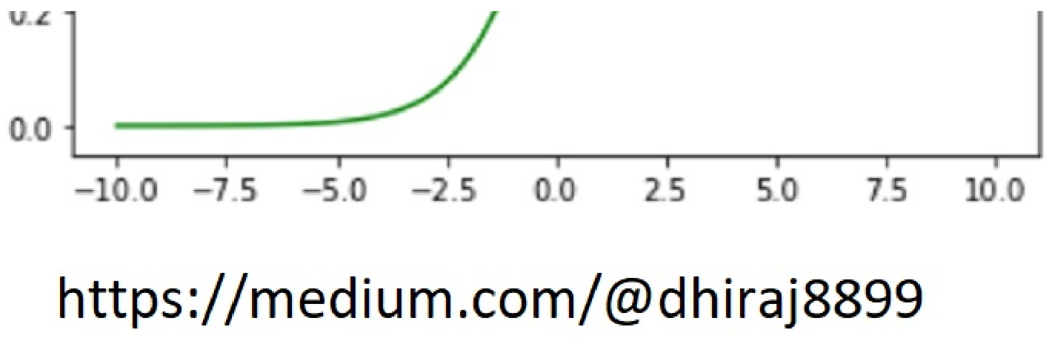
Dot Product of Matrix

Sigmoid: A sigmoid function is an activation function. For any given input number n, the sigmoid function maps that number to output between 0 and 1.
When the value of n gets larger, the value of the output gets closer to 1 and when n gets smaller, the value of the output gets closer to 0.

$$\sigma(x) \Rightarrow \frac{1}{1+e^{-x}}$$

Sigmoid Function





Sigmoid Function used in Machine Learning Classification

Sigmoid Derivative: the derivative of the sigmoid function, is the sigmoid multiplied by one minus the sigmoid.

$$\Rightarrow \sigma(x) \times (1 - \sigma(x))$$

The derivative of the Sigmoid Function

Implementation:

Import Libraries:

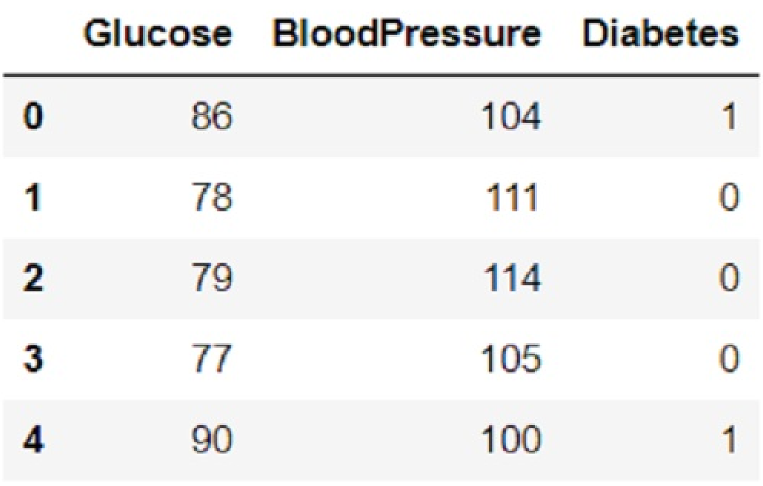
We are going to import NumPy and the pandas library.

```
import numpy as np
import pandas as pd
```

Load Data:

We will be using pandas to load the CSV data to a pandas data frame.

```
df = pd.read_csv('Data.csv')
df.head()
```



	Glucose	BloodPressure	Diabetes
0	86	104	1
1	78	111	0
2	79	114	0
3	77	105	0
4	90	100	1

Classification Data for Neural Network from Scratch

To proceed further we need to separate the features and labels.

```
x = df[['Glucose','BloodPressure']]
y = df['Diabetes']
```

After that let us define the **sigmoid function**.

```
def sigmoid(input):
    output = 1 / (1 + np.exp(-input))
    return output
```

There is one more function that we are going to use. It is related to sigmoid and called the **sigmoid derivative function**.

```
# Define the sigmoid derivative function
def sigmoid_derivative(input):
    return sigmoid(input) * (1.0 - sigmoid(input))
```

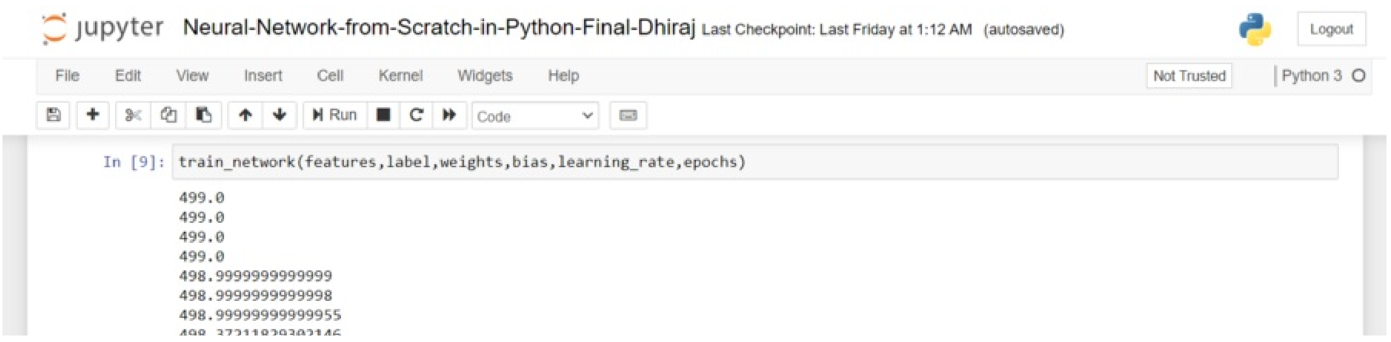
Then we need to define the network training function as below.

```
def train_network(features,label,weights,bias,learning_rate,epochs):
for epoch in range(epochs):
        dot_prod = np.dot(features, weights) + bias
        # using sigmoid
        preds = sigmoid(dot_prod)
        # Error
        errors = preds - label
        deriva_cost_funct = errors
        deriva_preds = sigmoid_derivative(pred)
        deriva_product = deriva_cost_funct * deriva_pred
        #update the weights
        weights = weights -  np.dot(featurest, deriva_product) * learning_rate
        loss = errors.sum()
        print(loss)
    for i in deriva_product:
        bias = bias -  i * learning_rate
```

After that let us initialize the required parameters

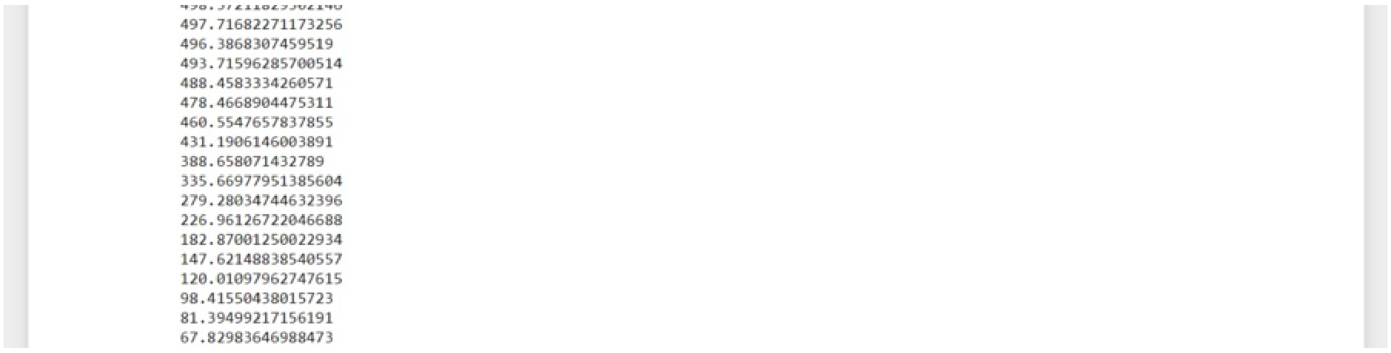
```
np.random.seed(10)
features  = x
label = y.values.reshape(1000,1)
weights = np.random.rand(1,2)
bias = np.random.rand(1)
learning_rate = 0.0004
epochs = 100
```

We are ready to train the network now:


jupyter
Neural-Network-from-Scratch-in-Python-Final-Dhiraj Last Checkpoint: Last Friday at 1:12 AM (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Not Trusted
Python 3
Run
Code

```
In [9]: train_network(features,label,weights,bias,learning_rate,epochs)

        499.0
        499.0
        499.0
        499.0
        498.9999999999999
        498.9999999999998
        498.99999999999955
```



```
[illegible]
497.71682271173256
496.3868307459519
493.71596285700514
488.4583334260571
478.4668904475311
460.5547657837855
431.1906146003891
388.658071432789
335.66977951385604
279.28034744632396
226.96126722046688
182.87001250022934
147.62148838540557
120.01097962747615
98.41550438015723
81.39499217156191
67.82983646988473
```

Training Neural Network from Scratch in Python

End Notes:

In this article, we discussed, how to implement a Neural Network model from scratch without using a deep learning library. However, if you will compare it with the implementations using the libraries, it will give nearly the same result.

The code is uploaded to Github here.

Happy Coding !!

Neural Networks | Python | Machine Learning | Artificial Intelligence | Sigmoid