Artificial Neural Network

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Abstract

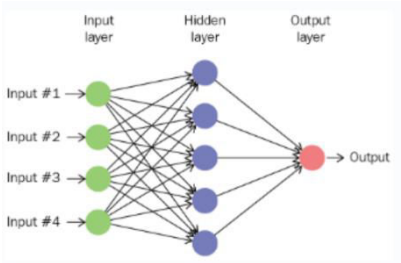
Artificial Neural Network is a mathematical model that is used in a subfield of Deep Learning (DL)- Machine Learning (ML) to perform tasks. The basis of this field lies in the aspiration to imitate the way the human brain works and harness the efficiency of the neuron structure to deal with complex computational challenges. Nowadays, ANN is used for face and speech recognition, machine translation, and medical diagnosis. In this article, we will explain what neural networks are, how they work, and demonstrate them using Python.

Introduction

Artificial neural networks (ANNs) are computing systems inspired by the biological and cognition that occur in the neural networks and are useful as part of Machine Learning (ML).

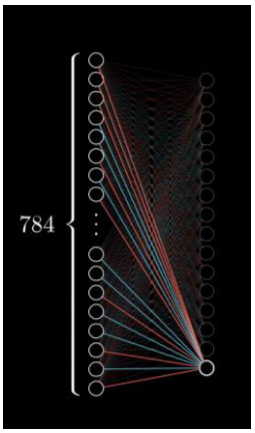
This kind of network usually contains many information units (input and output) linked to each other with links that often pass through "hidden" information units (Hidden Layer). The form of the connection between the units (which contains information about the strength of the connection) simulates the way the neurons are connected in the brain.

Neural networks were born out of Deep Learning, a machine learning technique that uses multiple layers of non-linear transformations to gradually extract features from a raw receiver.



A typical neural network consists of many artificial neurons (usually hundred to million) called units. They are arranged in sets of layers, each of which connects to the layers on both sides. Input units receive

different forms of information that the neural network will try to learn about. Output units located on the opposite side of the network indicate how it reacts to the learned information. Hidden units are located between input and output units and constitute the main part of an "artificial brain". The connections between units are represented by a weight- a positive or negative number. The higher weight corresponds to a higher effect that one unit has on the other.



The input layer: a 28*28 image. A total of 784 pixels that form a digit. Each of the pixels includes a number between 0 and 1 that represents the value of the color of the pixels: 0- black, 1-white and different shades of gray in between.

The hidden layer: each neuron in the second layer will be connected to all 784 neurons in the first layer when each of them has its own weight and each neuron in the second layer has a bias. Every connection between neurons is related to weight. This weight dictates the importance of the input value. The initial weights are determined randomly.

The output layer: in this layer there are 10 pixels as the number of digits (0-9) where each one represents a digit. Here too there are numbers between 0 and 1 that represent the decisiveness of the system. The selection of the network for which digit appears in the picture will be expressed through the brightest (white) neuron.

Neural Networks in Action

The computer receives an image of handwritten number and recognizes which number it is.

For this example, we will use a dataset file called mnist:

Mnist contains the digits 0-9 written by hand in different forms. We will work with it to train the computer. In this example there are 13002 possibilities for different behaviors.

Network training is carried out in several stages:

1. **The model is running.**
2. **The percentage of the result's accuracy is being calculated (or rather the percentage of an error).**
3. **If the accuracy percentage is not as high or low as much as we want it to be, the computer will run again after fixing its parameters.**
4. **Repeat until the computer has reached a satisfactory level of accuracy.**

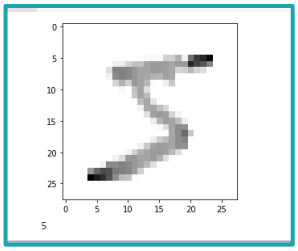
```
Epoch 1/3
1875/1875 [==============================] - 4s 2ms/step - loss: 0.3150 - accuracy: 0.9126
Epoch 2/3
1875/1875 [==============================] - 4s 2ms/step - loss: 0.1199 - accuracy: 0.9632
Epoch 3/3
1875/1875 [==============================] - 4s 2ms/step - loss: 0.0821 - accuracy: 0.9743
313/313 [==============================] - 0s 1ms/step - loss: 0.1099 - accuracy: 0.9675

Validation Loss: 0.1098889410495758
Validation Accuracy: 0.9674999713897705
```

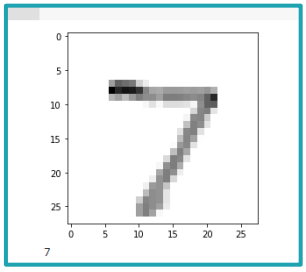
It can be seen in the results of the code that the accuracy percentage is 91.26% in the first run.
in the second run the accuracy percentage improves to 96.32% and on the third run it stands on 96.75%.

Summary

We have created a piece of code in Python that will recognize numbers written by hand in different forms. The course of the computer to learn how people write numbers was conducted by training the computer on a data structure in which there were many different numbers written in human handwriting.

After training the computer to recognize the numbers, the computer knew to calculate its accuracy percentage for new numbers (which was not in the data model). Thereby evaluating which number is displayed in front of it. The piece of code will be able in further development to determine which number was written by hand (in addition to the percentage of accuracy):





This piece of code can be used to recognize numbers and with the right development, will in the future be able to recognize handwriting of words in different languages. It could also recognize handwriting and help read texts written by people with clumsy handwriting (doctors for example) and more.

Link for the example we made in Python: [Artificial neural network.ipynb - Colaboratory (google.com)]

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