

Advanced Programming Course - HW1

Dr.Amir Jahanshahi

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- You must not alter the main.cpp file at all. Just write all your codes in the hw1.cpp and hw1.h
- For test your code just uncomment codes in unittest.cpp

In this homework you are going to implement an algorithm to classified data using perceptron.

- A biological neuron receives its input signals from other neurons through dendrites (small fibers). Likewise, a perceptron receives its data from other perceptrons through input neurons that take numbers.
- The connection points between dendrites and biological neurons are called synapses. Likewise, the connections between inputs and perceptrons are called weights. They measure the importance level of each input.
- In a biological neuron, the nucleus produces an output signal based on the signals provided by dendrites. Likewise, the nucleus (colored in blue) in a perceptron performs some calculations based on the input values and produces an output.
- In a biological neuron, the output signal is carried away by the axon. Likewise, the axon in a perceptron is the output value which will be the input for the next perceptrons.

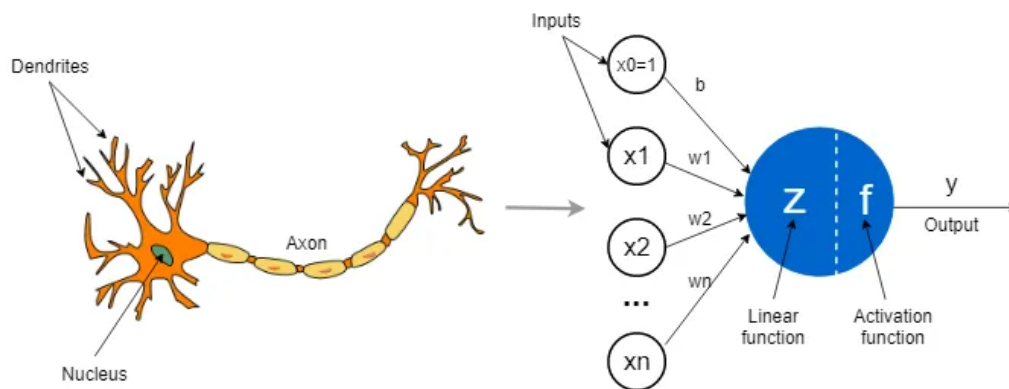


Figure 1:

The following image shows a detailed structure of a perceptron. In some contexts, the bias, b is denoted by w_0 . The input, x_0 always takes the value 1. So, $b \cdot 1 = b$.

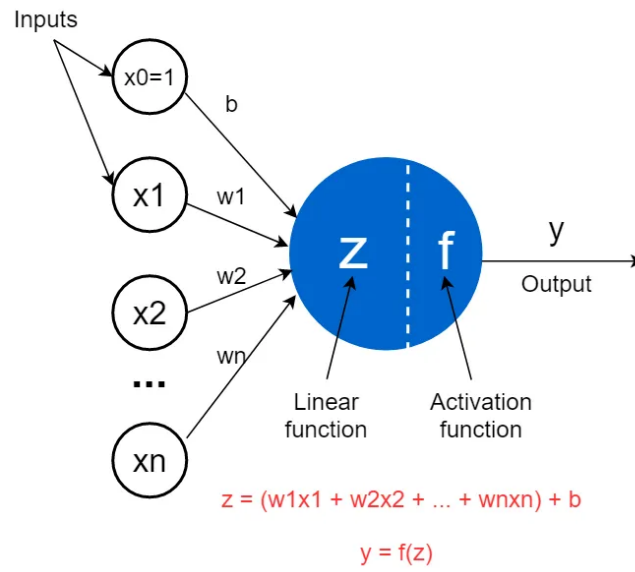


Figure 2:

The activation function takes the output of z as its input and calculates the output y based on the type of activation function we use. For now, we use the sigmoid activation function defined below.

$$\text{sigmoid}(z) = \frac{1}{1 + e^{-z}}$$

The entire calculation process can be denoted in the following diagram.

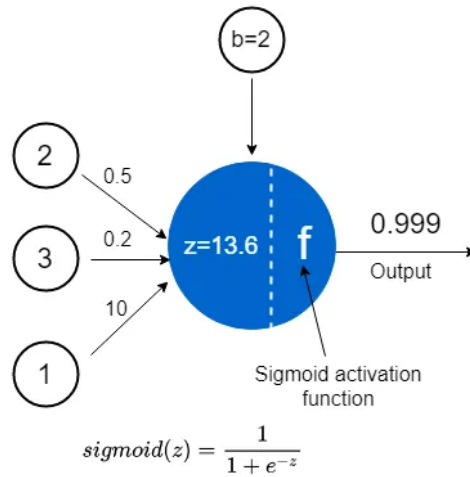


Figure 3:

Perceptron use an iterative algorithm to train weights and find optimum ones. This algorithm updates each weight with below equation.

$$w_k[i + 1] = w_k[i] + learning_rate \times (real_value - predicted_value) \times x_k \quad (1)$$

Questions

1. write sigmoid function to measure output of z in Figure 2;
2. At first you need to write function to import data from csv file and store it in vector.

```
std::vector<std::shared_ptr<std::vector<double>>> read_csv(std::string filename);
```

Figure 4:

3. The inputs of perceptron are bias that is scalar and x, y of data. Now you must train weight with data; so implement train function. num_iter is the number of repeating algorithm. you must repeat 1 equation num_iter times.

```
std::vector<double> train(std::vector<std::shared_ptr<std::vector<double>>> train_data,  
                          double learning_rate, int num_iter);
```

Figure 5:

4. First use *data.csv* to train and predict data next use *moons.csv*.
5. Calculate accuracy of model. $(\frac{\text{number of true predictions}}{\text{number of all points}})$

Good Luck