**ADTA-5550: Assignment 2**

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**Part I**

**Describe (including images for illustration) the human biological neural network and how it works.**

Human brains are very powerful and indigenous creation and gifted the human brains. Brains are crucial part which gives human beings a unique quality of thinking and solving the problems.

There is a lot of research work performed on human brain and its ways of processing information since many centuries and contemplate world.

Human brain structure is very sophisticated and dense neural network. Human brain is made of trillions of nerve cells also known as neurons. Neurons are the building blocks of the complete neural system of the living being.

A diagram of a nerve cell

Description automatically generated

The neuron serves as the element of networks. In systems a neuron is essentially a cell, like any other cell in the body. It possesses its DNA code and is generated in a similar manner to other cells. Despite differences in DNA its function remains consistent across organisms. A neuron consists of three components. They are the cell body, also known as the Soma along with dendrites and an axon. The dendrites resemble fibers that extend in directions and establish connections with cells, within that particular cluster.

In the brain, each neuron is connected with another neuron with the help of dendrites and the connection between two neurons is called Axon. The brain is made up connections and neurons. Sensory information is passed from the senses to brain using nerves. The neurons in the brain understands it and responds to the sense with the appropriate decision. Artificial neural networks are also built in the similar idea.

**Describe (including images for illustration) the McCulloch-Pitt neuron model, a.k.a. Threshold Logic Unit, that is considered as the simplest neural network and how it works.**

As we understood that information or signals from sensory organs are traversed and processed using neurons, in the similar way, the first of mimicking the functionality of biological neuron is introduced in 1943 by MuCulloch and Pitts.

The first computational model of the neuron is proposed by Warren MuCulloch who is a neuroscientist and Pitts, a logician in 1943. The basic component of the model is divided into two parts. The first part is about summing up or collecting all the inputs to the model while the second part is to perform decisioning based on the parameter and taken decision as Boolean response. So, the resultant is Yes or No. For example, When we give a picture of animal and ask whether it’s an animal, then the response is The Animal or Not Animal.

A diagram of a mathematical equation

Description automatically generated

We can see below image which interprets the above explanation in the form of expression. So, in this case, g(x) is the input function which is the addition of all inputs given to the model.

Secondly, f(g(x)) is the decisioning. If the input value is greater than theta than the result of this function will be 1 and 0 otherwise.

A math equations on a white background

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The decision function can be anything which is favorable to the model’s usecase and input parameters. For example, it can be algebraic, geometric, trigonometric or Boolean algebra.

However, this model imitates the real neuron, however there are few limitations. Firstly, the result of the model is limited to Boolean, there is no importance or prioritization for the inputs.

Reference: <https://towardsdatascience.com/mcculloch-pitts-model-5fdf65ac5dd1>

**Discuss (including images for illustration) how the pioneers in the AI field did imitate the human biological brain system to conceive the first artificial neural networks.**

There are lots of research work happened on building artificial neural networks and in the field of AI based on the first model introduced about computational neuron. Nowadays, we can see many companies have invested and doing intense research in building artificial human brain. One of the first artificial human brain research project is Blue Brain project.

The first step in imitating the human brain was to design artificial neurons, or "nodes," which would serve as the building blocks of their artificial neural networks. These nodes were inspired by the biological neurons in our brains, which transmit electrical signals and process information. Much like the dendrites and axons of biological neurons, artificial neurons were designed to receive inputs, perform computations on those inputs, and produce an output.

To imitate the interconnectedness of biological neurons, early AI pioneers created layers of these artificial neurons and connected them through a web of weighted connections. These connections, often represented as synapses, would strengthen or weaken based on the learning process, just as synapses in the human brain change in response to experiences and learning.

A diagram of a function

Description automatically generated

Moreover, the pioneers also introduced the concept of activation functions, which was inspired by the way biological neurons fire when they reach a certain threshold of input signals. Activation functions in artificial neural networks determine when an artificial neuron should transmit information to the next layer, simulating the firing of neurons in the human brain.

Reference:

* <https://www.geeksforgeeks.org/introduction-of-blue-brain-worlds-first-artificial-brain/>
* https://towardsdatascience.com/a-concise-history-of-neural-networks-2070655d3fec

**Part II**

A = B=

C = A \* B

The order of the matrix A is 2X3 and matrix B is 3X2 hence matrix multiplication is possible. So the resultant matrix will have 2 rows and 2 columns.

C =

**Part III**

**A screenshot of a computer

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Vector 1: [2, 1, 3, 4, 5]

Vector 2: [0, 0, 1, 4, 2]

Vector 3: [4, 2, 5, 8, 10]

Vector 4: [6, 3, 14, 35, 33]

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[ 2 1 3 4 5 3 3 4 7 5 4 2 6 8 10 6 3 14 35 33]

**Part IV**

I have connected to the deeplearning VM instance hosted on GCP, then I opened Jupyter notebook in my local machine browser. Later, I have imported tensorflow module.

Question 1:

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1. I have taken 2 constants const15 and const45
2. I have created new tensorflow session with default graph
3. I have used run function and added already defined constants
4. Later, I printed the result of the summation.

Question 2:

A screenshot of a computer code

Description automatically generated

1. I have taken 2 variables a and b
2. I have created new initializer with global variable initializer function.
3. I have created new tensorflow session with default graph
4. I have used run function and multiplied defined variables
5. Later, I printed the result of the multiplication.

Question 3

A screenshot of a computer code

Description automatically generated

1. I have taken 2 placeholders x, y with float32 as datatype
2. I have created operation to multiply 2 placeholders
3. I have created new tensorflow session with default graph
4. I have used run function and passed operation and input values as per question.
5. Later, I printed the result of the multiplication.

Question 4

A screenshot of a computer program

Description automatically generated

1. A placeholder, z is defined with float as datatype
2. Mult3 variable is created with operation
3. I have created new tensorflow session with default graph
4. I have used run function and passed operation and input values list as per question.
5. Later, I printed the result of the multiplication.

Question 5

A screenshot of a computer

Description automatically generated

1. I have created new constant matrix with ones and shape 8x8.
2. I have created new variable with random values of uniform distribution in the shape of 8x8.
3. I have initialized the variable we defined earlier.
4. I have created new tensorflow session with default graph.
5. I have used run function to print constant and variable.
6. Then, I used new run function to add constant and variable.
7. Later, I printed the result of the summation.
8. The session will automatically close after evaluation.