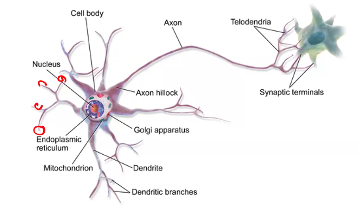
**PART I: Biological Neural Network & Artificial Neural Network**

**Question 1.1: Human biological neural network**

**Answer:** Human nervous system is responsible for carrying signals from our brain to different parts of our body and vice-versa. The building block of human nervous system is the cell named as “neuron”. The below figure shows a neuron and its parts. It is one of the longest cell in the human body due to its tail like structure called **axon** and **dendrites**. The dendrites connect through **synaptic terminals** to form the neural network. These cells transmit the signals to and from the brain using the neural network. These signals are nothing but electrical signals, these signals should have a minimum threshold to get transmitted.

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**Fig: Human neuron (source: class lecture 2)**

**Question 1.2: McCulloch-Pitt neuron model (Threshold Logic Unit)**

**Answer:** In 1943, the first research paper was presented by McCulloch & Pitts. It was called “A Logical Calculus of Ideas Immanent in Nervous Activity”. McCulloch & Pitts model is the simplest single layer neural network.

McCulloch–Pitts neuron is the unit of this model. The below image describes the same.

A diagram of a diagram

Description automatically generated

**Image description:**

* The **neuron** is the computational unit which takes multiple inputs as in1, in2, in3 etc.
* **Summation Function:** calculates the sum of the inputs.
* **Activation Function/Step Function:** if the sum is greater than the threshold, then it the output is 1 else 0.

**Question 1.3: Imitation the human biological brain system to build the first artificial neural networks**

**Answer:** McCulloch-Pitts Neuron also referred as MCP neuron served as a foundation building block of the initial neural network. It was inspired by the human brain cell which takes multiple input, processes it and send the single output to another cell. As this was the very first model of its kind, it could not perform complex operations like multiple classifications.

**Back Propagation:** In the next phase, a mechanism called as “**Back Propagation**” was implemented. It was inspired by synaptic plasticity of the brain cell which means the process in which the brain modifies the strength of connections among the neurons and improves performance.

**Multilayer Perceptrons:**  it is the extension of single layer perceptrons into multiple layers. It follows the similar principle of MCP in multiple layers.

A diagram of a cell and a cell

Description automatically generated

Figure: Comparing brain cells with the MCP (Source: <https://www.freecodecamp.org/news/the-brain-inspired-approach-to-ai>)

**PART II: Linear Algebra for Deep Learning: Matrices**

**Question:**

**A number with numbers on it

Description automatically generated with medium confidence**

**Answer:** Dimension of matrix A is 2X3 (2 rows and 3 columns). Matrix B should be of dimension 3X2 (3 rows and 2 columns). The result matrix C will be of dimension 2X2.

Let matrix B, b11=2, b12=4, b21= 1, b22=5, b31=3, b32=6

A close up of a paper

Description automatically generated

**Explanation of dot product (matrix multiplication):**

* Result matrix C will have dimension of 2X2. Let the elements be c11, c12, c21, c22
* C11=a11\*b11+a12\*b21+a13\*b31.
* C12=a11\*b21+a12\*b22+a13\*b32
* C21=a21\*b11+a22\*b21+a23\*b31
* C22=a21\*b12+a22\*b22+a23\*b32

For the sake of simplicity, I have performed the matrix multiplication on paper which is shown below. The result matrix C = c11=37, c12=83, c21=24, c22=45.

**A notebook with writing on it

Description automatically generated**

Figure: Showing matrix multiplication

**PART III: Linear Algebra for Deep Learning: Matrices**

**Question 3.1:** Let’s consider this matrix as a vector of vectors. How many vector elements does this matrix have? Show each vector element, one by one.

Given 2D array:

A number set on a white background

Description automatically generated

**Answer:** This can be considered as vector of vectors. Each row represents a vector. As the matrix has four rows there are four vectors.

Vector1= [2 1 3 4 5]

Vector 2= [0 0 1 4 2]

Vector 3=[4 2 6 8 10]

Vector 4=[6 3 14 35 33]

**Question 3.2:** Let’s consider this matrix as a vector of vectors. Add 3 to the element vector (of the matrix) at the index = 1. The addition is performed element-wise along Axis 1. Display the matrix with all its scalar elements after the operation has been done in the format of a 2D matrix.

**Answer:**

Given 2D array:

A number set on a white background

Description automatically generated

Index=1 🡺 [0 0 1 4 2]

Adding 3 to the element vector

* [0+3 0+3 1+3 4+3 2+3]
* [3 3 4 7 5]

Resultant Matrix:

A number set on a white background

Description automatically generated

**Question 3.3:** Continuing from Question 3.2, i.e., after the above addition of 3 has been done: Flatten the matrix and display the result.

Input Array:

A number set on a white background

Description automatically generated

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

**PART IV: TensorFlow Code in Jupyter Notebook**

**Note:** The jupyter notebook with the code is submitted along with the document for this section.