Brain, Neurons, and Models (HW1)

1. How does natural neuron work?

Ans: Natural neurons enter excitation state and convey this excitation through its axons and dendrites. The axons and dendrites terminate at synapses, facilitating the transmission of excitation (electrical potential) to other neurons. When a neuron receives a signal that surpasses a specific threshold, it transitions into the firing mode or excited state, initiating the transmission of signals through its axons and dendrites to communicate with other neurons.

2. How does natural neuron transmit signal to other neurons?

Ans: At the end of the axon are axon terminals, which are near the dendrites or cell body of another neuron. The gap between an axon terminal and the next neuron is called a synapse. When the action potential reaches the axon terminals, it causes the release of neurotransmitters into the synaptic cleft (the gap between neurons). The neurotransmitters diffuse across the synaptic cleft and bind to receptor molecules on the membrane of the next neuron. This binding can either excite or inhibit the neuron and thus helping transmission of signal between neurons.

3. Describe the McCulloch and Pitts model of artificial neuron?

Ans:

The McCulloch and Pitts neuron model, crafted by Warren McCulloch and Walter Pitts back in 1943, stands as a pioneering framework in the realm of neural computation. It laid the groundwork for what we now know as artificial neural networks, a cornerstone of modern machine learning.

The model works as follows:

1. **Binary State:** Neurons in this model have two states: active (1) or inactive (0), determined by a threshold level.
2. **Inputs and Weights:** Each neuron receives binary inputs (0 or 1) which are associated with weights. Weights signify the significance of each input in the neuron's processing.
3. **Weighted Sum:** The neuron computes the sum of the weighted inputs, effectively integrating the incoming signals based on their respective weights.
4. **Threshold Activation:** The neuron activates (outputs 1) if the weighted sum exceeds a predefined threshold. Otherwise, it remains inactive (outputs 0).

The output *y* is given by the function:

$$\begin{cases} 1 & \text{if } \sum_i w_i x_i \geq \text{threshold} \\ 0 & \text{otherwise} \end{cases}$$

Here, w is the weight and x is the input.

5. **Boolean Operations:** By adjusting weights and thresholds, the neuron can perform basic logical operations (AND, OR, NOT), showcasing its computational capability.
6. **Network Potential:** When combined into networks, these neurons can engage in more complex computations, highlighting the model's scalability and versatility in problem-solving.