

## **SCI-121 – Medical Science For AI Engineering Nervous System**

**Name: Thanawin Pattanaphol**

**ID: 01324096**

### **AI and the Brain**

Neurons in the human brain have inspired the design of artificial intelligence (AI) systems, particularly artificial neural networks (ANNs). Both biological and artificial neural networks share some structural and functional similarities but they also have significant differences in processing, learning, and adaptability.

Biological neurons communicate using electrochemical signals and form highly complex, adaptable networks that allow real-time learning and flexibility. They rely on synaptic plasticity, meaning the strength of connections between neurons changes dynamically based on experience and stimuli, allowing humans to learn from single experiences instantly. The brain is excellent in generalization, reasoning, and energy-efficient processing, consuming around 20 watts to run the entire organ. Additionally, biological neural networks process information in parallel through a complex web of interconnected neurons without a central control unit, making them highly resilient and capable of adapting to new information and damage.

On the other hand, artificial neurons operate using mathematical functions and process information digitally through weighted sums and activation functions. ANNs require large amounts of labeled data and many iterations to learn, normally using backpropagation algorithms to adjust weights based on errors. Artificial neurons can process data much faster than biological neurons, due to silicon-based hardware like CPUs and GPUs, however, they lack the efficiency, adaptability, and contextual awareness of biological neurons. Along with the fact that ANNs have a predefined architecture and are exposed to overfitting or corruption, while biological networks are robust to neuron loss owing to their distributed information storage.

Current advances in AI research are increasingly inspired by biological principles to bridge these gaps. For example, brain-inspired network topographies organize artificial neurons to be similar to the clustering seen in biological networks for similar tasks, aiming to improve performance and learning efficiency. Neuromorphic computing develops architectures like spiking neural networks that mimic biological neuron dynamics, leading to efficient, low-power AI systems that adapt to changing inputs in real time. These approaches try to combine the processing power of ANNs with the flexibility and self-adaptive qualities of biological systems to create more robust and intelligent AI.

In summary, neurons inspired AI designs by providing a conceptual framework of interconnected parts that process and transmit signals to learn and make decisions. Biological neural networks remain vastly superior in adaptability, energy efficiency, and learning with minimal data, while artificial neural networks provide speed and scalability. The future of AI is now essentially based in integrating biological insights into artificial systems to develop more learning and reasoning abilities similar to human brains.

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