Neural Networks

CSC(372) - Semester VI

St. Xavier's College

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Course Description: Neural Network Network Fundamentals

Underlying Principles

Explore the foundational concepts that govern neural network behavior.

Core Architectures

Understand different network structures from basic to complex.

Learning Processes

Delve into how neural networks learn and adapt.

This course provides an introduction to neural networks. It covers architecture, learning processes, processes, single-layer and multilayer perceptrons, and recurrent neural networks.

Course Objectives: Deep Dive into Neural Networks

1 Grasp Core Principles

Understand the fundamental concepts and design of neural networks.

2 Explore Architectures

Learn about various network structures, including perceptrons.

3 Analyze Learning

Examine how networks learn and adapt through different processes.

4 Discover Advanced Models

Get introduced to recurrent neural networks and their applications.

Course Content Overview

Foundations of Neural Networks

Basic building blocks and historical context.

Network Architectures

Single-layer and multi-layer perceptrons.

Learning Algorithms

Supervised and unsupervised learning methods.

Recurrent Neural Networks

Understanding sequential data processing.

For a detailed breakdown of topics, please refer to the Course Syllabus.

Pioneers of Artificial Intelligence

Geoffrey Everest Hinton

British-Canadian computer scientist known as "the Godfather of AI" for his work on artificial neural networks.

"Read enough to develop your intuitions, then trust your intuitions."

John McCarthy

In 1955, he coined the term "Artificial Intelligence," defining it as "the science and and engineering of making machines that can perform tasks that would normally require normally require human intelligence."

Course Intuition: Why Neural Neural Networks?

An Introduction

Discover the foundational concepts and significance of neural neural networks in modern AI.

Why Consider Them?

Understand the practical advantages and widespread applications of neural networks across industries.

No Convincing Needed

The utility and power of neural networks speak for themselves through their through their diverse capabilities.

Neural Networks: Quick Answers and Deeper Insights

The Short Answer

- They're useful!

- They're fast!

- They're easy to implement!

- They're cute!

- They're **definitely** not taking over the world!

The Long Answer

It's a bit more complicated than that...

OpenAI and Final Fantasy 16 showcase their complexity and powerful applications.

Goals of This Lecture: Unraveling Unraveling Neural Networks

What & How

Teach what a neural network is and its operational mechanics.
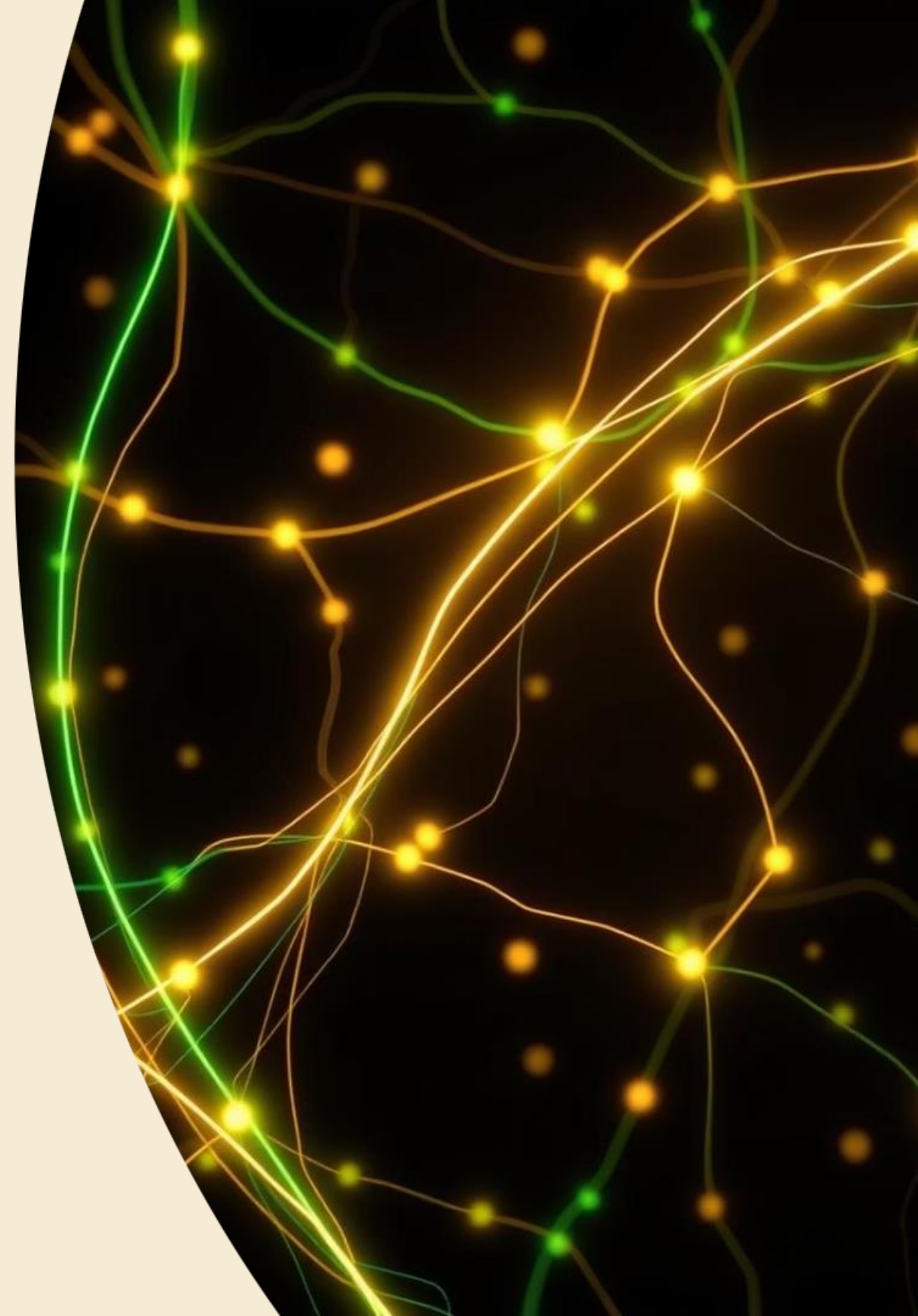
Why & Why Not

Explore the advantages and disadvantages of using them.

Which & Where Next

Identify current networks and future directions.

Along with a simulated environment demo and tips for building networks.

Biological Neurons: The Brain's Building Blocks

Dendrites
Receive signals from other neurons.

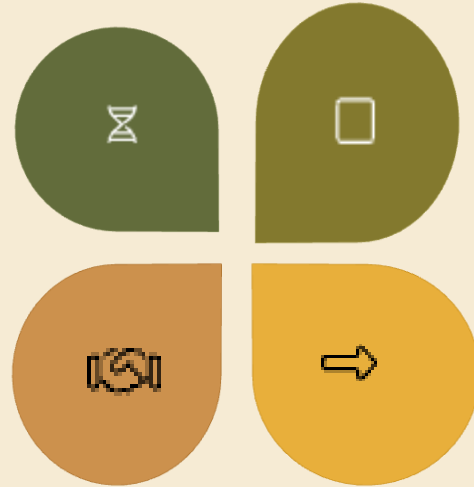## Soma (Cell Body)
Processes incoming signals and generates output.

Synapse
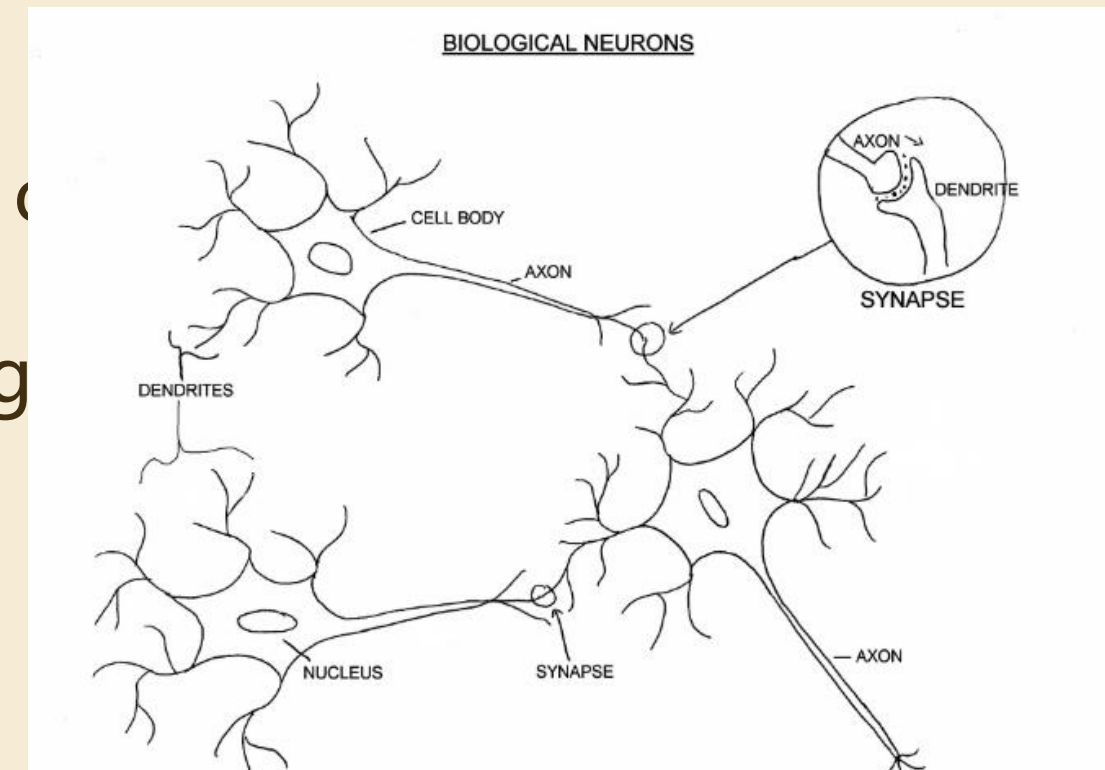Junction where signals are passed between neurons.

Axon
Transmits electrical signals to other neurons.

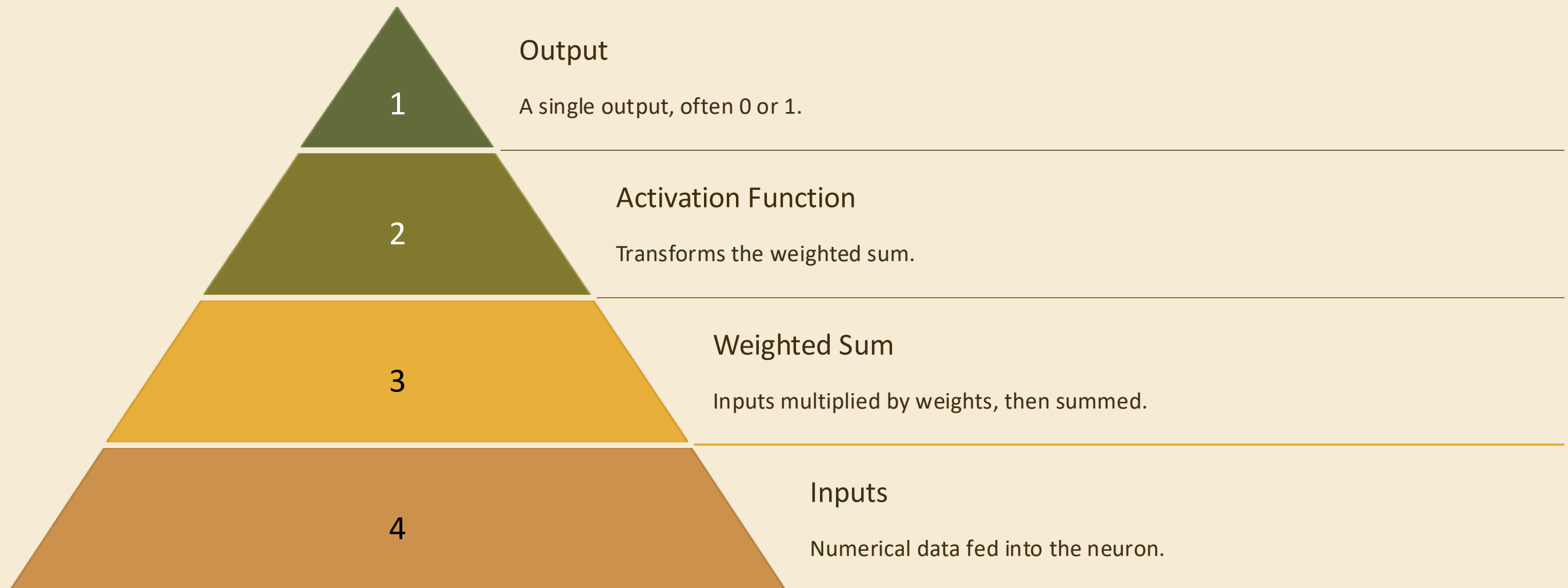Biological neurons are the fundamental units of the nervous system.
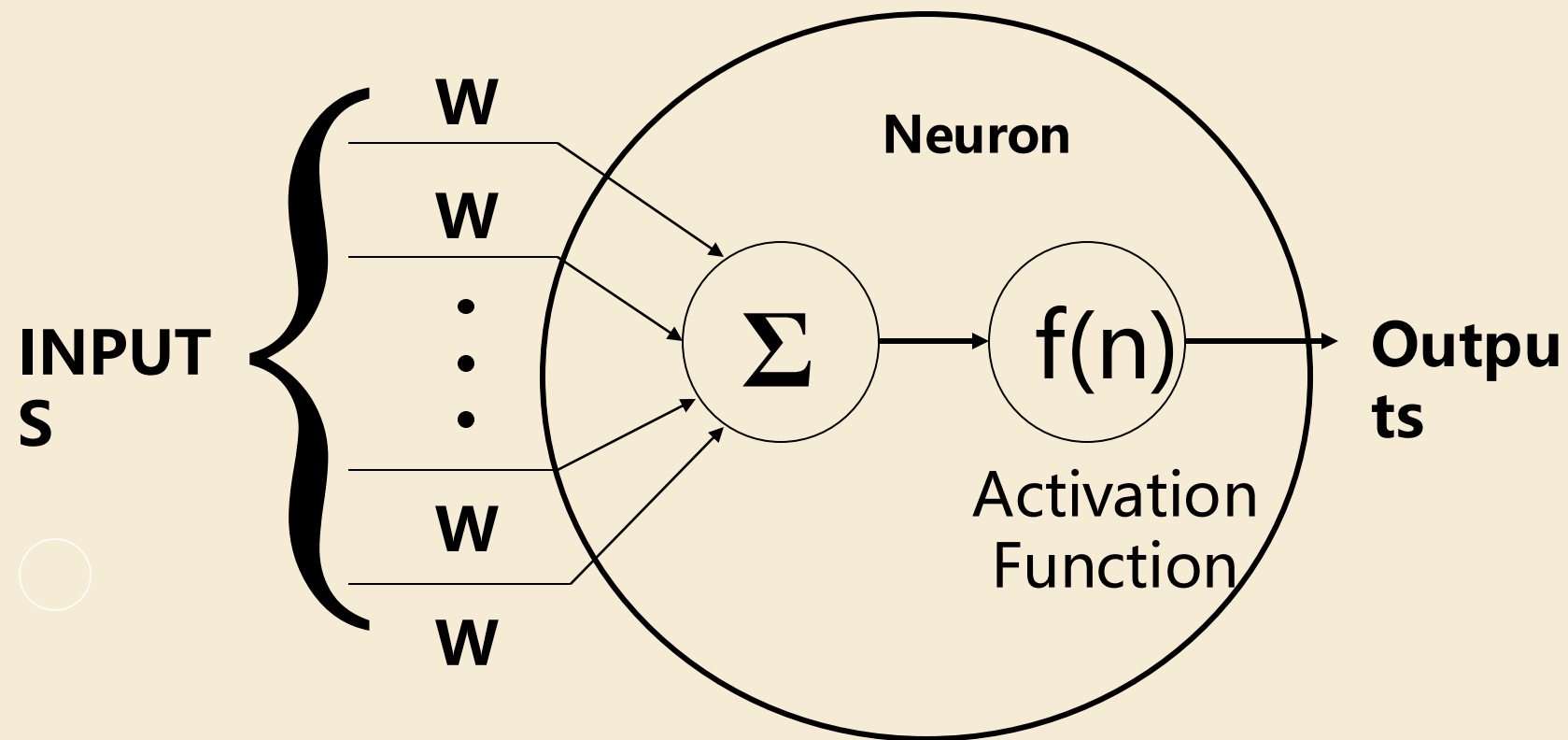They process and transmit information through electrical and chemical signals.

BIOLOGICAL NEURONS

CELL BODY

AXON

AXON

DENDRITE

SYNAPSE

DENDRITES

NUCLEUS

SYNAPSE

AXON

Artificial Neuron: The Perceptron

Output

A single output, often 0 or 1.

(1)

Activation Function

Transforms the weighted sum.

(2)

Weighted Sum

Inputs multiplied by weights, then summed.

(3)

Inputs

Numerical data fed into the neuron.

(4)

An artificial neuron, or perceptron, is a mathematical function inspired by biological neurons. It takes multiple inputs, applies weights, sums them, and passes sums them, and passes the result through an activation function to produce an output.
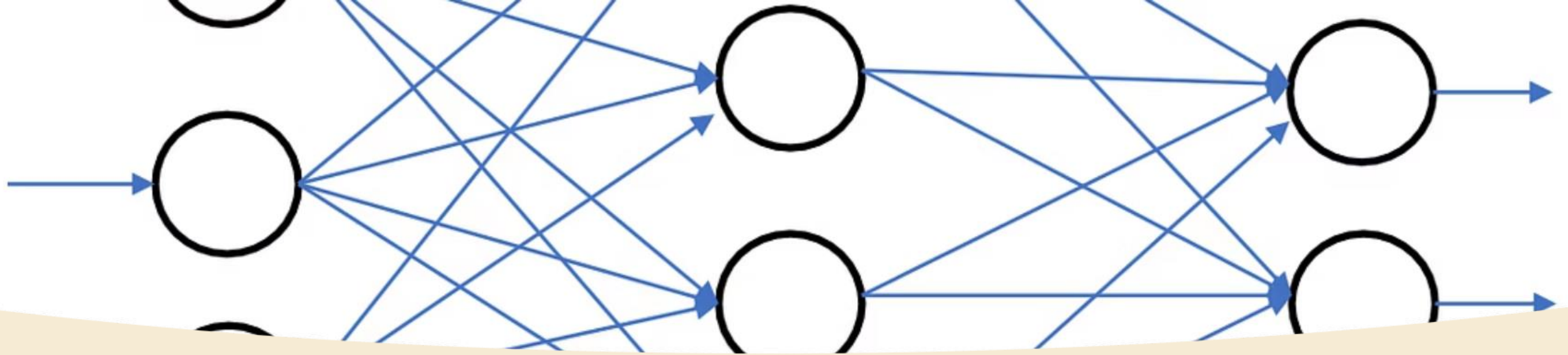
Unveiling Artificial Neurons and and Neural Networks

INPUTS

W

W

W

W

W

Neuron

Σ

f(n)

Activation Function

Outputs

W=Weight

Neural Network Terminologies: The Basics

1 Input Layer

Receives initial data for processing. processing. Each node represents a represents a feature.

2 Hidden Layers

Intermediate layers. They perform perform complex computations. Multiple layers can exist.
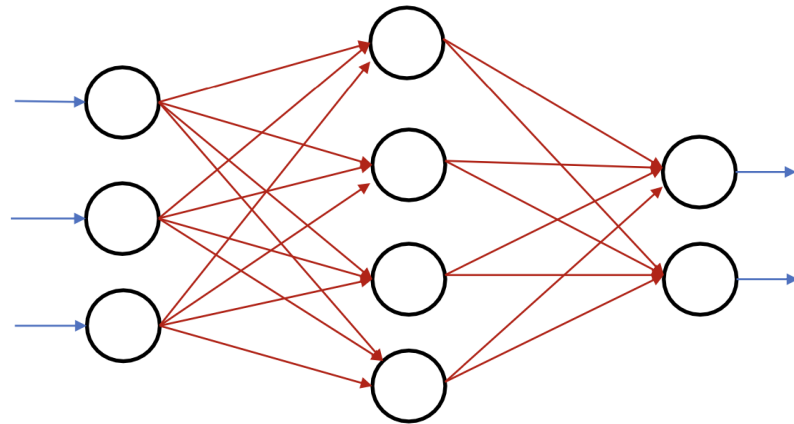
3 Output Layer

Produces the final result. Its structure structure depends on the task.
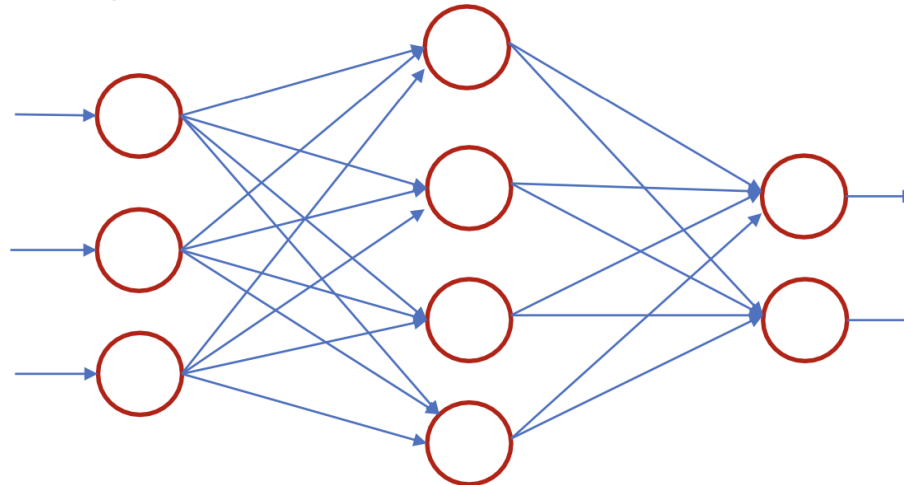
Neural Network Terminologies: Connections

Connections/Dendrites

Nodes/Neurons

Weights

Strength of connections between neurons. They They determine signal influence.
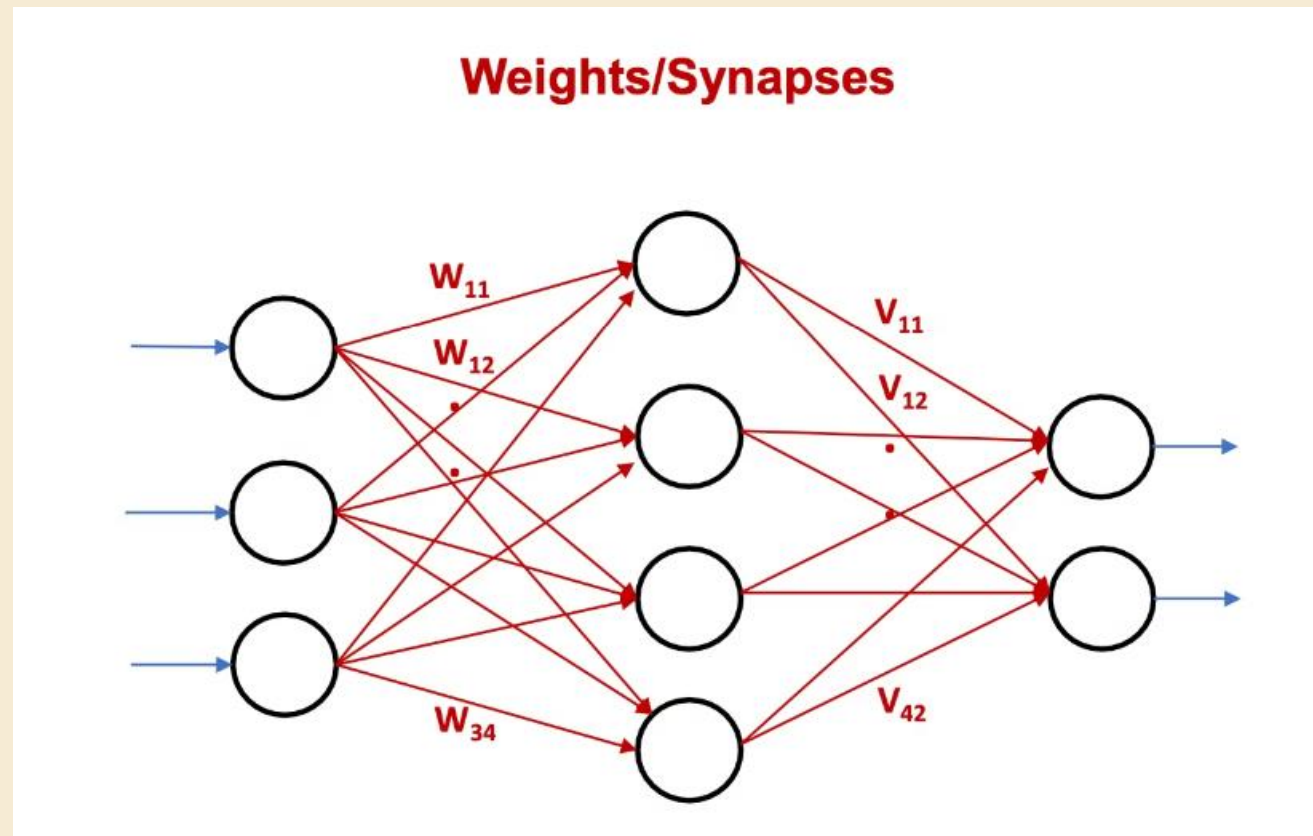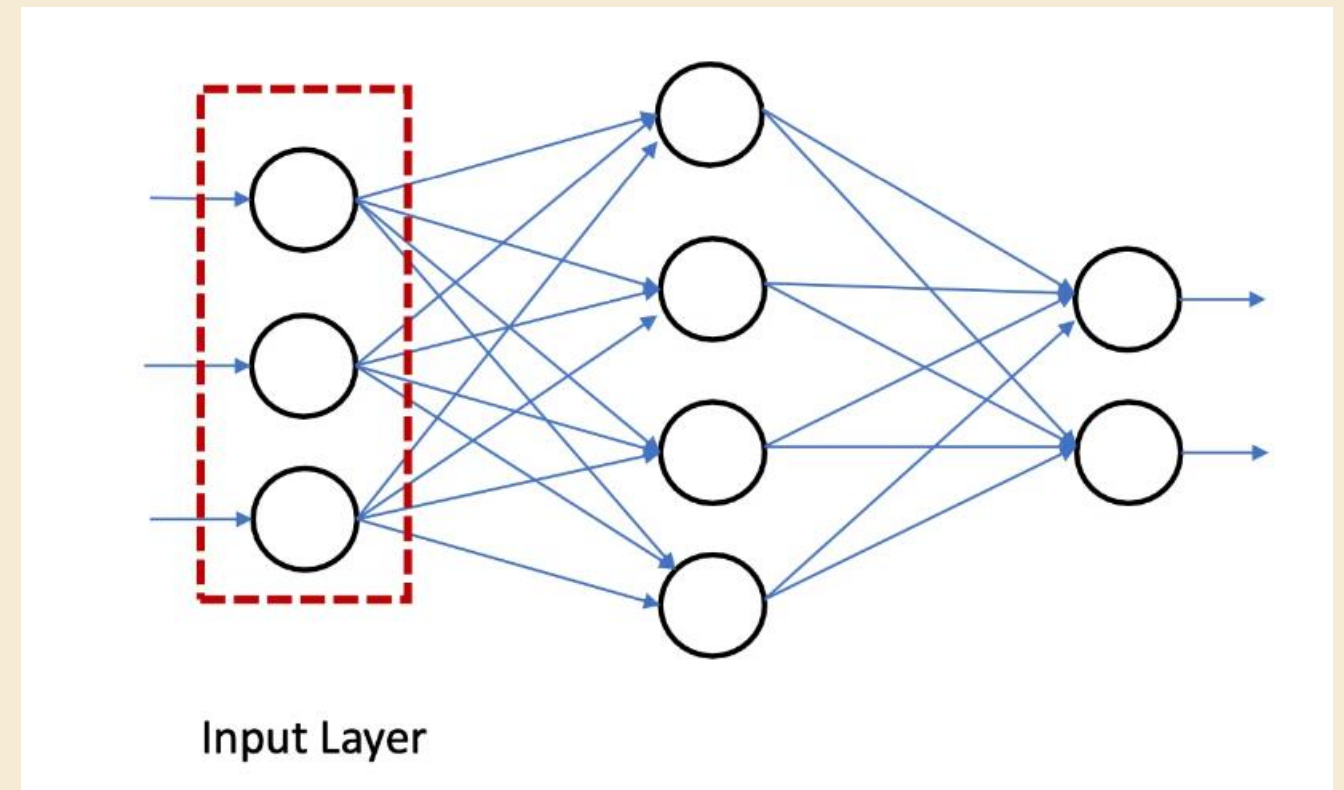
Bias

An additional input to a neuron. It shifts the activation function.

Neural Network Terminologies: Processing

Weights/Synapses

Activation Function

Determines neuron output. Introduces non-linearity for complex patterns.

Input Layer

Forward Propagation

Data moves from input to output. Neurons calculate their outputs outputs sequentially.

Neural Network Terminologies: Learning

1

Loss Function

Measures prediction error. Quantifies model performance.

2

Backpropagation

Adjusts weights and biases. Minimizes the loss function iteratively.
iteratively.

Training and Optimization

Epochs

One full pass through the dataset. Multiple epochs refine learning.
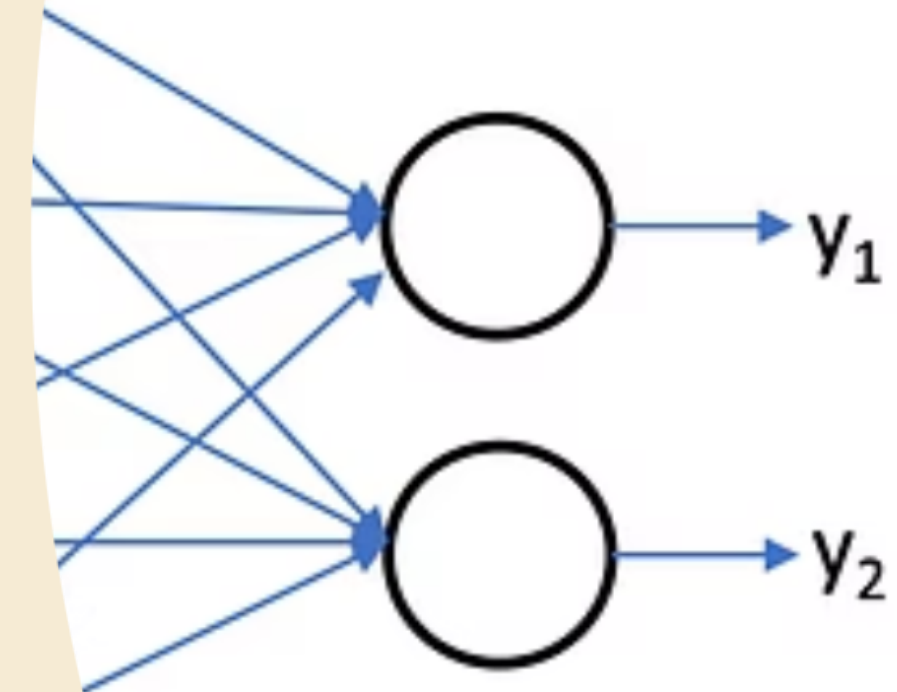learning.

Batch Size

Number of samples processed at once. Influences training speed and stability.

Learning Rate

Controls weight adjustment speed. A crucial hyperparameter.
hyperparameter.

i_1

i_2

i_3

y_1

y_2

Output Layer

Thank You!

We've covered the core concepts of artificial neurons and neural networks.

networks. Understanding these terminologies is crucial for your journey into AI and

into AI and machine learning. Keep exploring and building!