Neural Networks
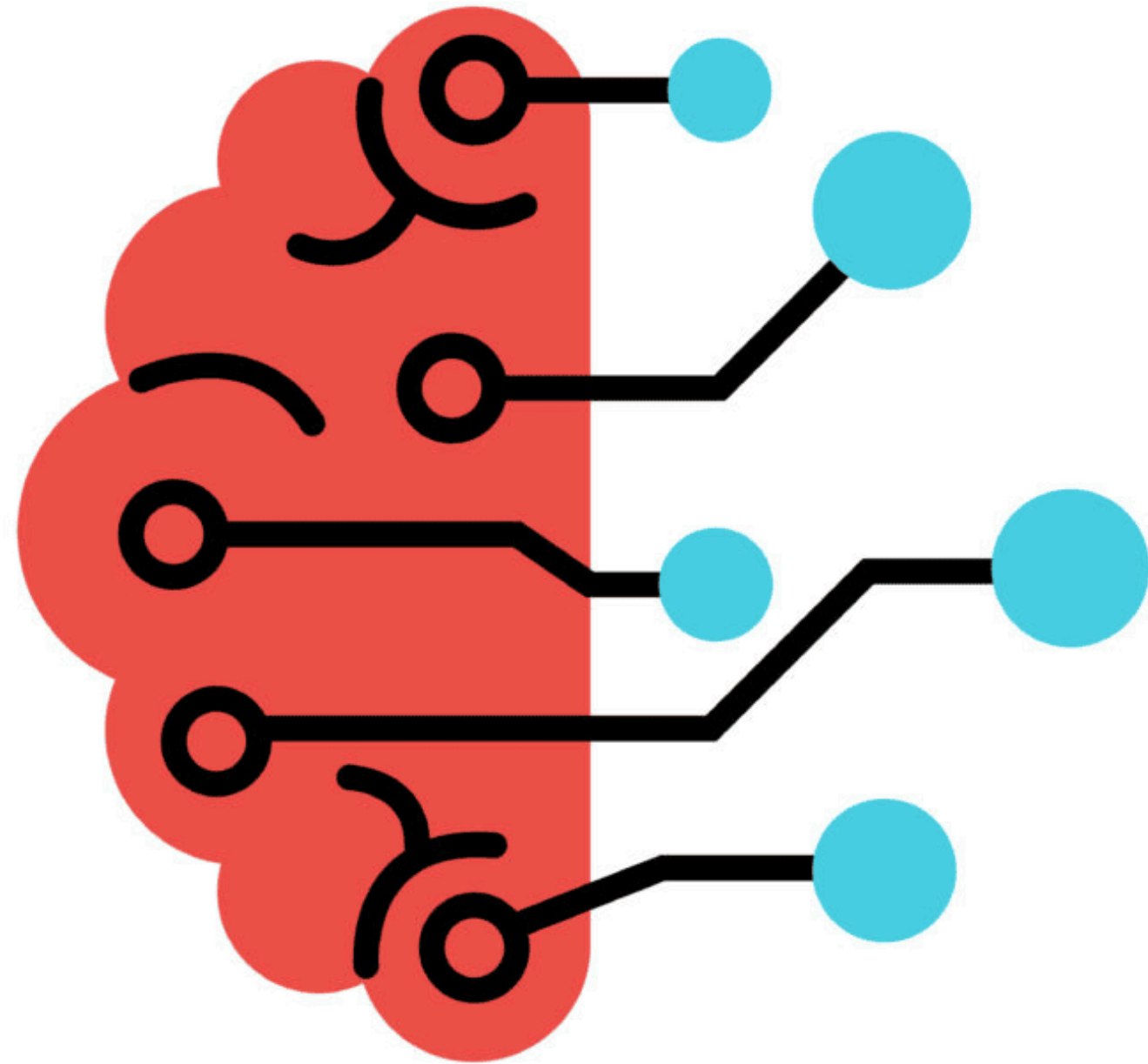
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Introduction

Neural networks are **sophisticated** computational models inspired by the human brain. They have revolutionized **machine learning** and are widely used in various fields. This presentation will delve into the inner workings and applications of neural networks.

NEURAL NETWORK

Neural Network Basics

Input layer: This is where data is fed into the network. Each node in this layer represents a feature or input variable.

Hidden layers: These layers process the input data through weighted connections and apply activation functions to produce outputs. Deep neural networks have multiple hidden layers, enabling them to learn complex patterns.

Output layer: This layer produces the final output or prediction based on the processed information from the hidden layers.

Types of Neural Networks

Feedforward Neural Networks (FNN): Information flows in one direction from input nodes through hidden layers to output nodes without any feedback loops. They are commonly used for tasks like classification and regression.

Recurrent Neural Networks (RNN): Designed to work with sequence data by incorporating feedback loops, allowing information to persist. They are suitable for tasks such as speech recognition, language modeling, and time series prediction.

Convolutional Neural Networks (CNN): Specialized for processing grid-like data, such as images or videos. CNNs use convolutional layers to automatically learn features from input data, making them powerful for tasks like image recognition, object detection, and image generation.
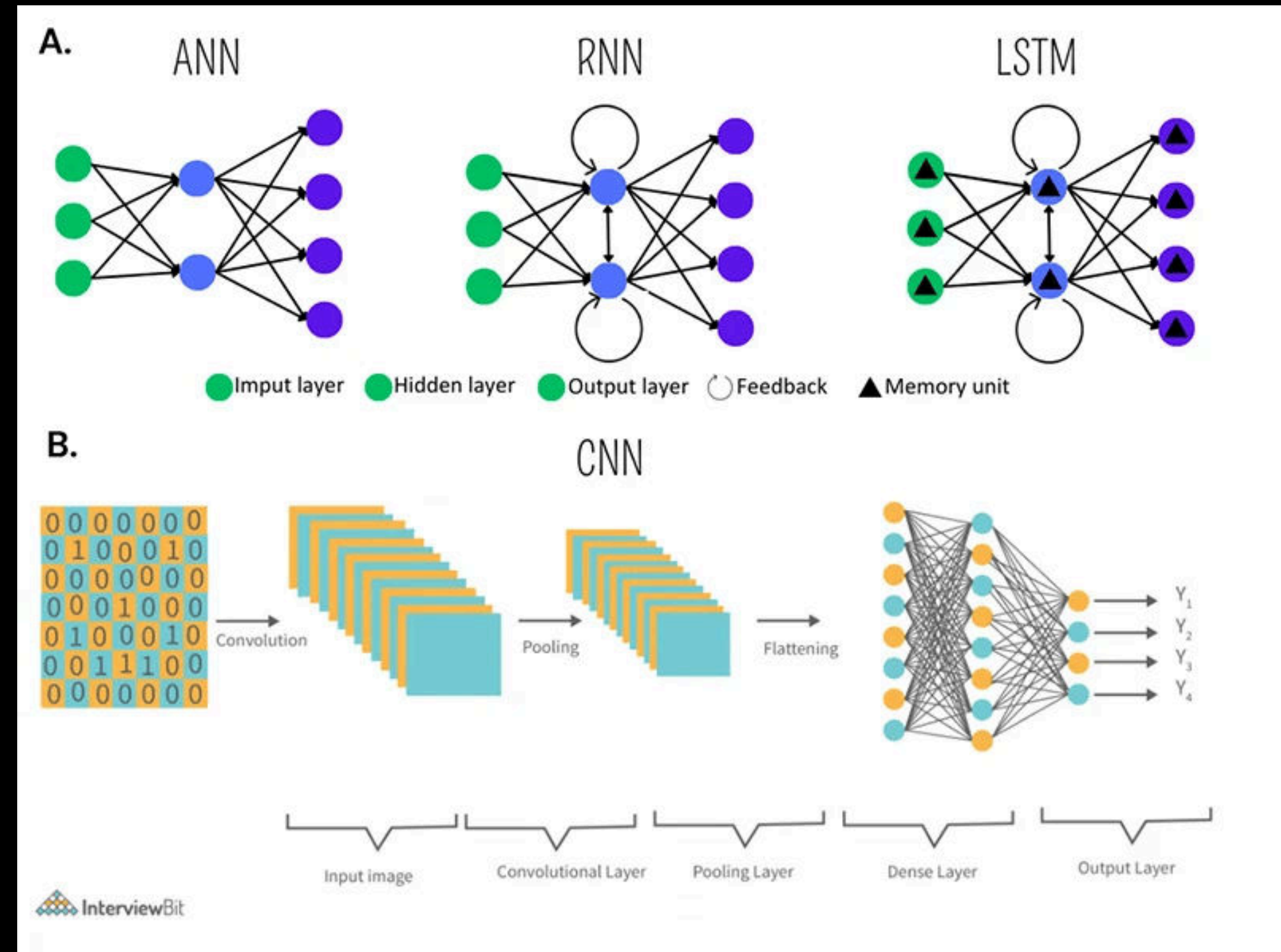
Activation Functions

An activation function is a mathematical operation applied to the output of each neuron in a neural network. It helps to introduce non-linearity into the network, allowing it to learn complex patterns in data. Without activation functions, a neural network would essentially reduce to a linear model, severely limiting its ability to model and understand complex relationships in data.
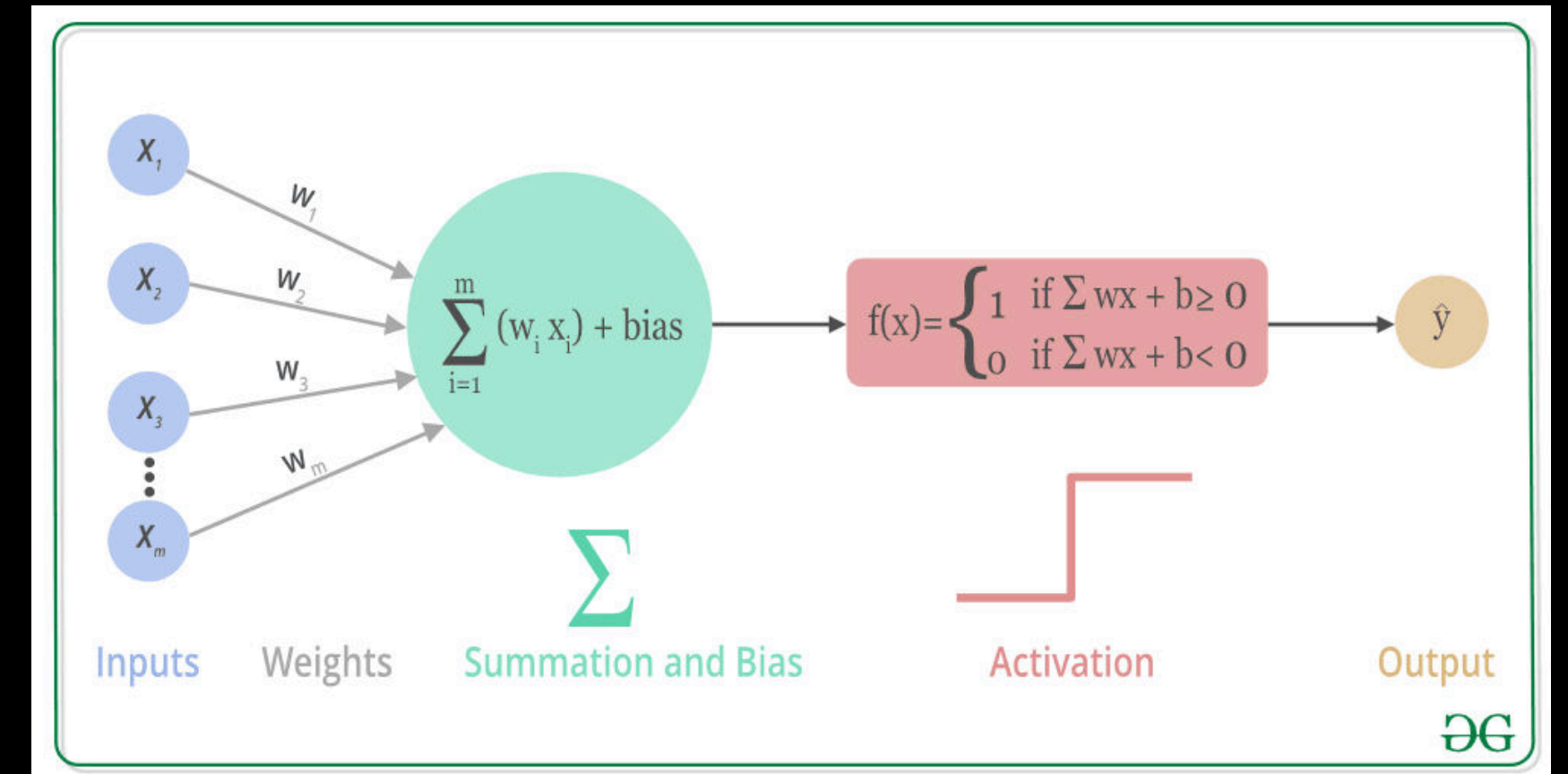
Back Propogation

Backpropagation is a method used to train neural networks by adjusting the weights and biases based on the error between actual and predicted outputs. It involves propagating the error backward through the network, calculating gradients, and using optimization algorithms to update weights, aiming to minimize the error iteratively.
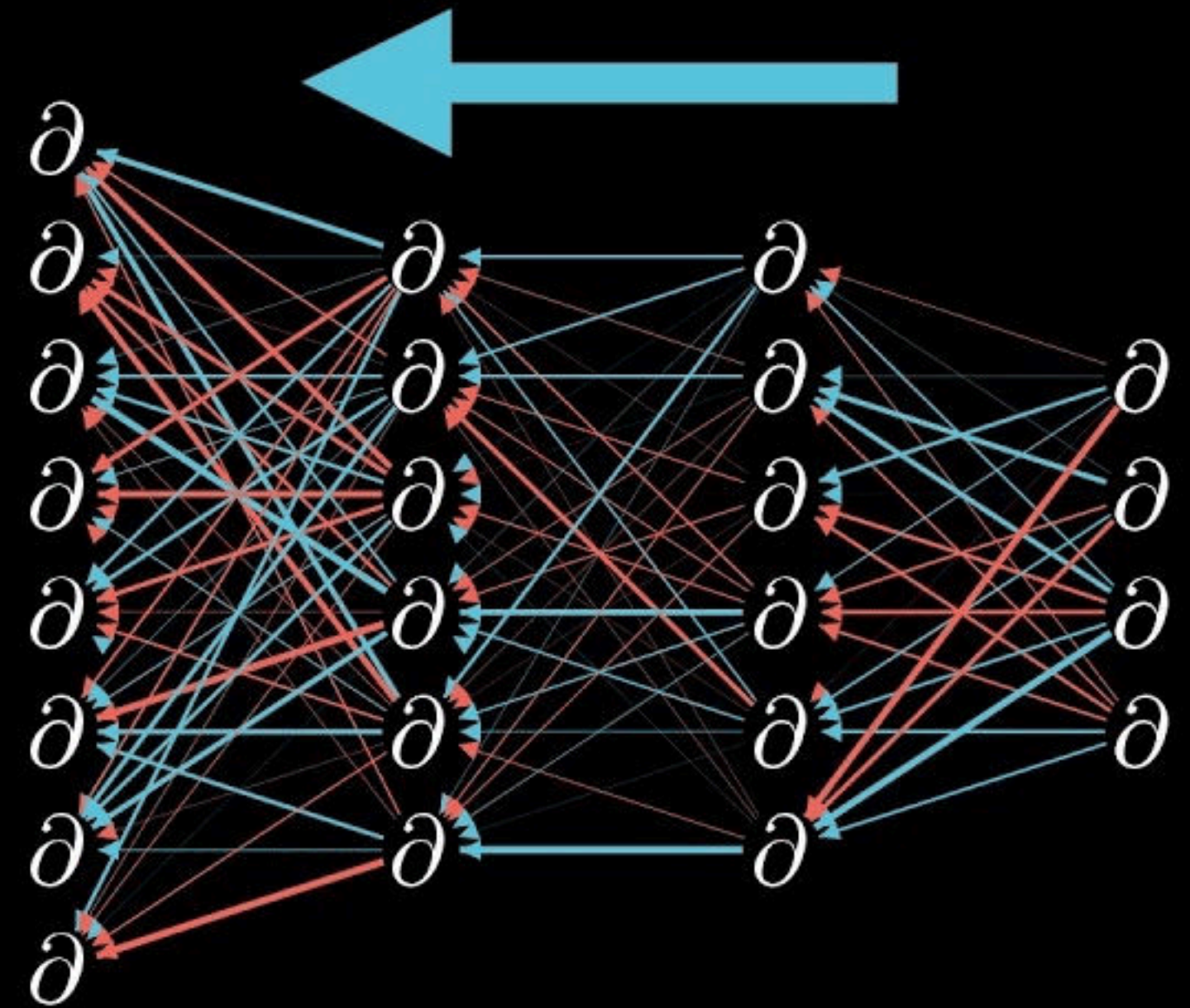
Weight Initialization

$$W^{[l]} = \begin{bmatrix} w_{11}^{[l]} & w_{12}^{[l]} & \cdots & w_{1n^{[l-1]}}^{[l]} \\ w_{21}^{[l]} & w_{21}^{[l]} & \cdots & w_{2n^{[l-1]}}^{[l]} \\ \vdots & \vdots & \cdots & \vdots \\ w_{n^{[l]}1}^{[l]} & w_{n^{[l]}2}^{[l]} & \cdots & w_{n^{[l]}n^{[l-1]}}^{[l]} \end{bmatrix}$$
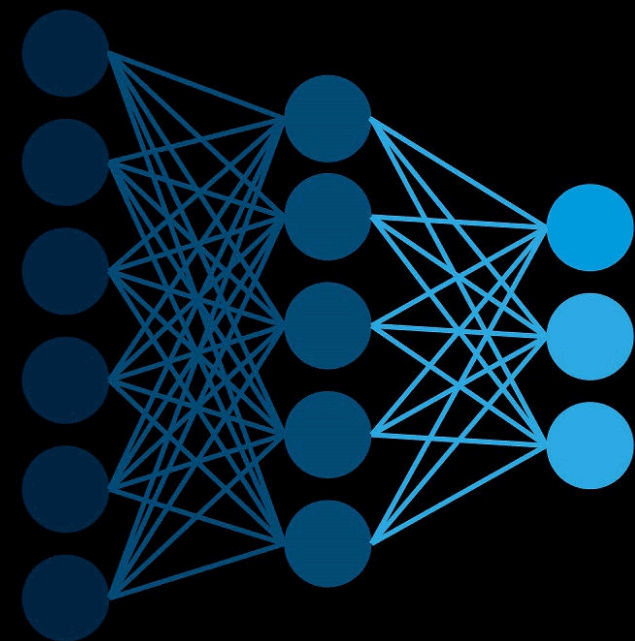
Weights in Neural Network

Weights in a neural network control how input data is processed and transformed. They encode feature importance, adjust during training to learn representations, and influence model behavior. Optimizing weights minimizes errors and helps the network make accurate predictions

Bias in Neural Networks

Fine-tuning Outputs: Bias allows neural networks to adjust outputs, aiding in fitting complex patterns in data.
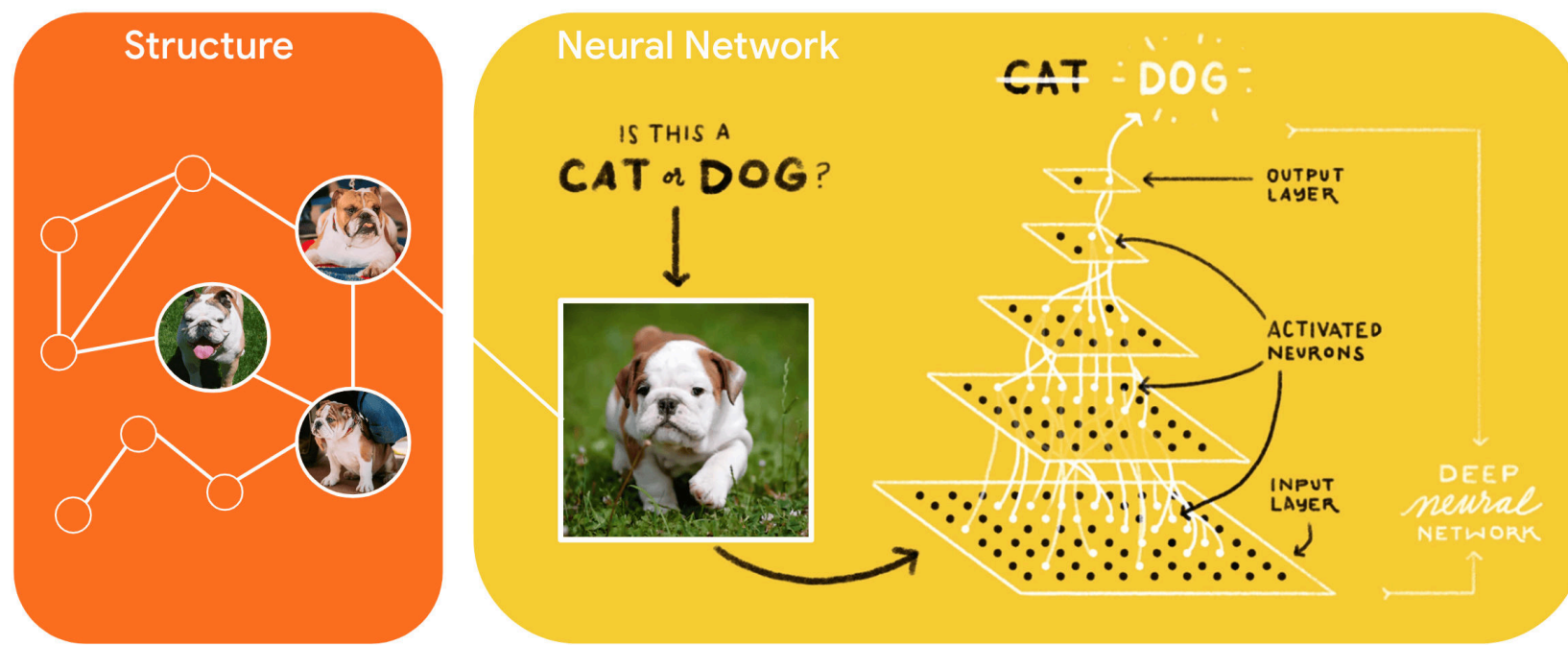
Non-linear Adjustments: Bias introduces non-linearity, helping capture nuanced relationships in data.

Improved Generalization: Including bias terms aids in generalizing to new data, reducing overfitting risks.

Handling Data Biases: Bias terms help deal with data distributions not centered at zero.
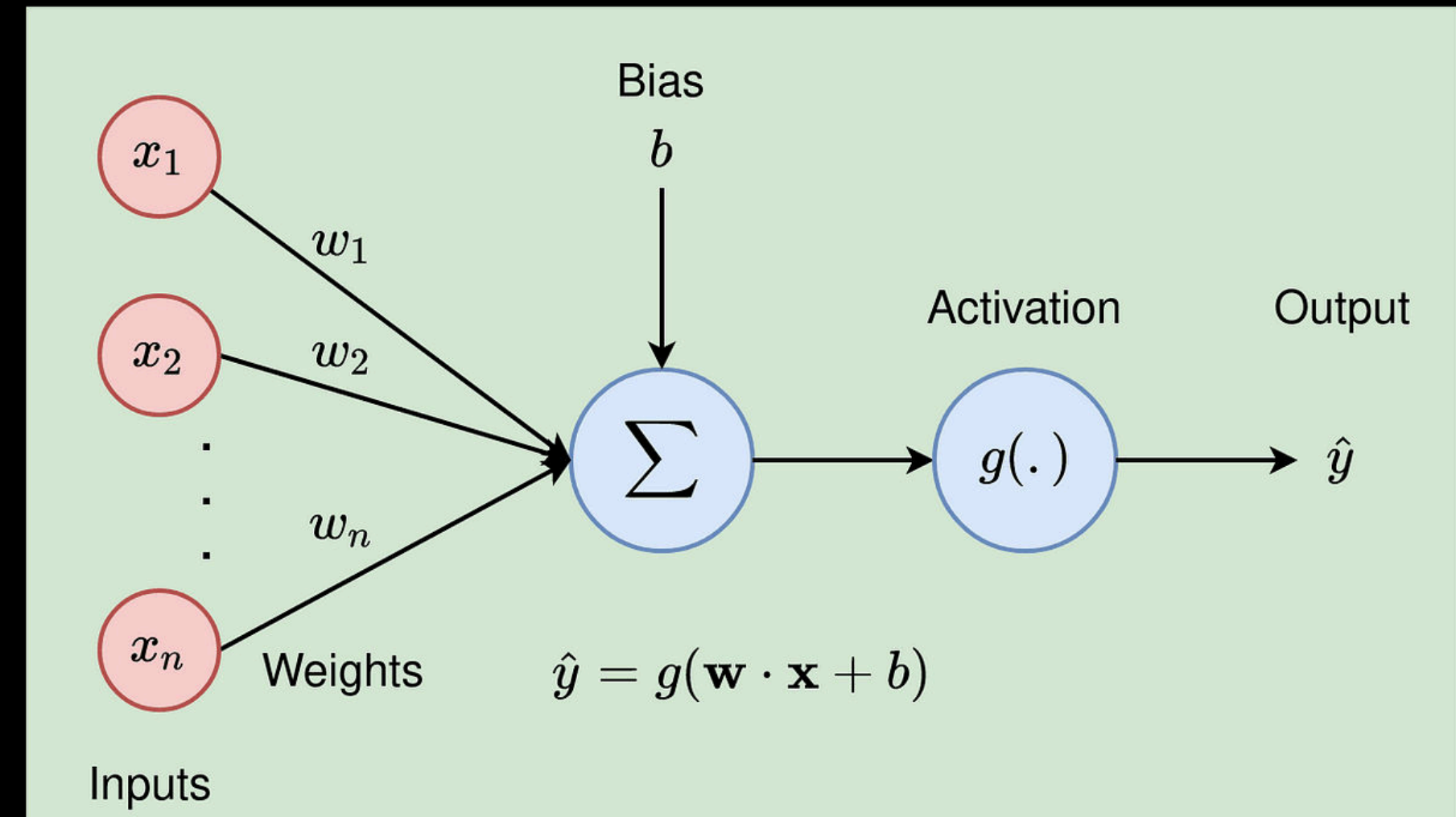
Training Neural Network

Data Collection: Gather and preprocess your data.

Model Selection: Choose a neural network architecture suitable for your task.

Training Setup: Define loss function, optimizer, and metrics.

Training Loop: Iterate through data to adjust model weights using backpropagation.

Validation: Assess model performance on a separate dataset to avoid overfitting.

Hyperparameter Tuning: Adjust learning rate, batch size, etc., for optimal performance.

Testing: Evaluate the final model on unseen data to measure real-world performance.

Applications in Neural Networks

Finance: Neural networks help detect fraud in transactions and forecast market trends for investment decisions.

Healthcare: They assist in medical image analysis for disease diagnosis and predict patient outcomes based on medical data.

Face Recognition: They enable accurate identification of individuals in security systems, access control, and surveillance applications.

Language Processing: Neural networks drive chatbots, sentiment analysis, and language translation services.
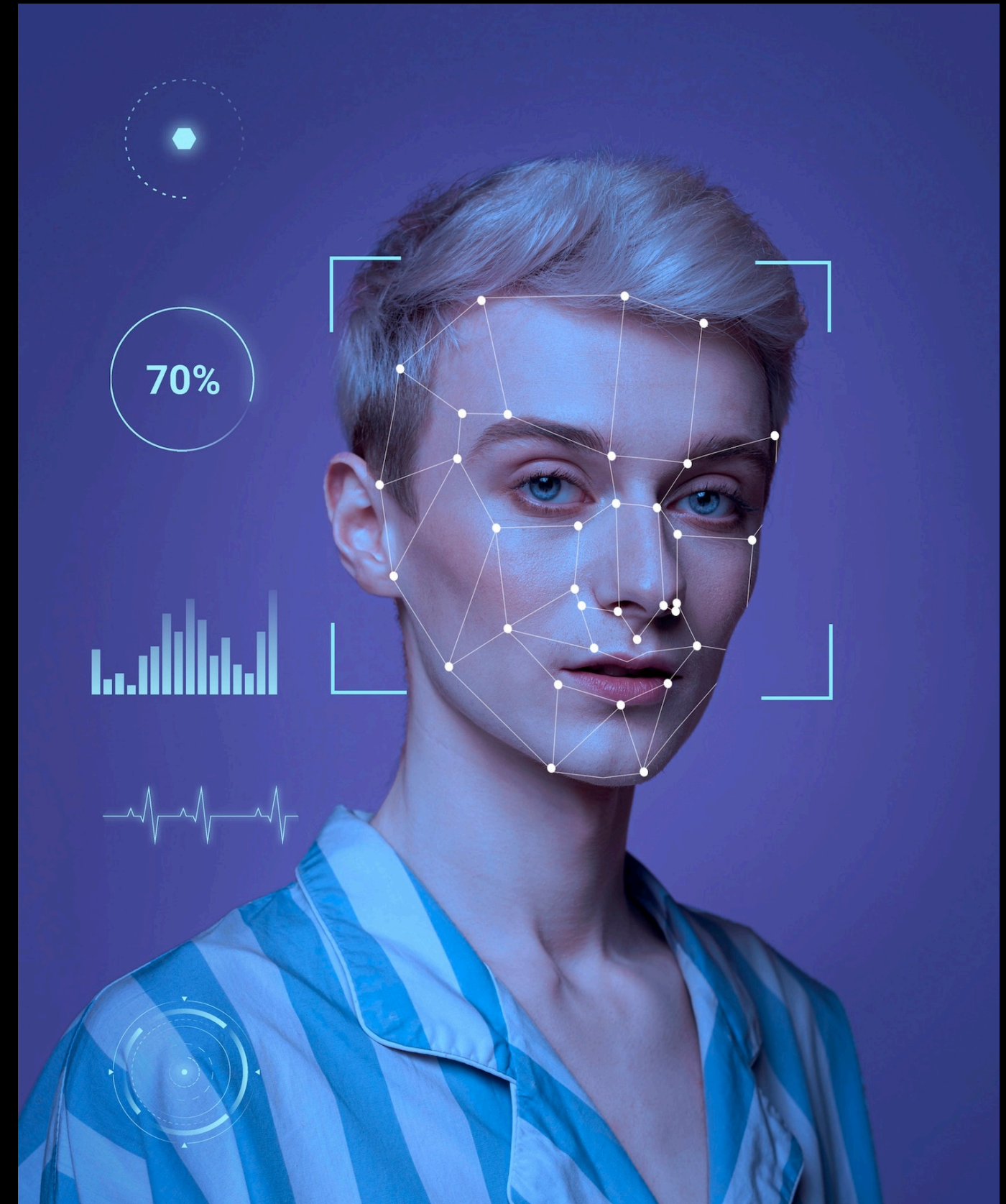
Conclusion

In summary, neural networks are a vital aspect of artificial intelligence and machine learning, enabling us to learn complex patterns and improve predictive accuracy. Their versatility spans industries, from image recognition to natural language processing, driving innovation and progress toward smarter systems.

Quiz: https://quizizz.com/join?gc=981875

Thanks!

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