Neural Network Components and Architecture

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This document explains the core components of a neural network — layers, neurons, weights, activation functions, loss functions, and optimization algorithms. It also includes flowcharts and structured representations to visualize data flow through the network.

Layers

A layer is a stage in a neural network consisting of multiple neurons that process data. Each layer transforms the input and passes it forward to the next layer.

1. Input Layer: Accepts raw data such as images, text, or numerical values.
2. Hidden Layers: Perform intermediate computations using weights and activation functions.
3. Output Layer: Produces the final predictions or classifications.

Flow Chart:

Input Data → Input Layer → Hidden Layer 1 → Hidden Layer 2 → Output Layer → Prediction

Neurons

Neurons are computational units that perform a weighted sum of inputs followed by an activation function to produce output.

Equation: y = f(Σ(w■ × x■) + b)

Weights

Weights determine the importance of each input to the neuron’s output. They are updated during training to minimize prediction error.

Representation: x■ -- w■ →, x■ -- w■ → [Neuron] → Output

Activation Functions

Activation functions introduce non-linearity, allowing networks to model complex relationships.

1. Sigmoid: Smooth output between 0 and 1.

2. Tanh: Outputs between -1 and 1.
3. ReLU: Returns 0 for negatives and linear for positives.

Loss Functions

Loss functions measure how far predictions are from true values. They guide the model's learning process.

1. Mean Squared Error (MSE): Measures average squared difference for regression tasks.
2. Cross-Entropy Loss: Measures error for classification tasks.

Optimization Algorithms

Optimizers update network weights to minimize loss using gradient-based methods.

1. SGD (Stochastic Gradient Descent): Updates weights gradually per batch.
2. Adam: Combines momentum and adaptive learning rate.
3. RMSProp: Adjusts step size based on recent gradients.

Summary

Neural networks consist of interconnected layers of neurons linked by weights. Activation functions add non-linearity, while loss functions and optimizers guide learning. Visualizing networks helps understand how data transforms at each stage to produce intelligent decisions.