

# Unsupervised Learning Neural Networks

# Introduction

- **Supervised Learning**: trained with labeled data
- **Unsupervised Learning**: trained with unlabeled data
- **Goal**: Discover hidden patterns, groupings, or structures
- **Common tasks**: Clustering, Dimensionality Reduction, Feature Extraction

# Types of Neural Networks for Unsupervised Learning

# Autoencoders

- **Encoder** compresses input into latent representation
- **Decoder** reconstructs input from latent code
- **Applications:** Dimensionality reduction, anomaly detection, denoising, Variational Autoencoders

# Self-Organizing Maps (SOMs)

- Maps high-dimensional data to 2D grid of neurons
- Each neuron represents similar inputs
- **Applications:** Clustering, visualization, exploratory data analysis

# Restricted Boltzmann Machines (RBMs)

- Neural networks that learn probability distributions
- **Layers:** Visible (input) and Hidden (latent)
- **Applications:** Collaborative filtering, feature learning

# Generative Adversarial Networks (GANs)

- Consist of Generator and Discriminator networks
- Generator learns to create realistic samples
- Discriminator distinguishes real vs fake
- **Applications:** Image synthesis, data augmentation, style transfer

# Hebbian Learning Networks

- Inspired by neuroscience: 'neurons that fire together, wire together'
- Weights updated based on correlation of activations
- **Applications:** Associative memory, feature extraction



# Techniques in Unsupervised Neural Learning

- ❑ **Clustering** → Grouping similar data points together without labels.
- ❑ **Dimensionality Reduction** → Compressing high-dimensional data into fewer meaningful features.

# Techniques in Unsupervised Neural Learning

- ❑ **Density Estimation** → Learning the probability distribution of the data.
- ❑ **Manifold Learning** → Finding the lower-dimensional surface (manifold) on which high-dimensional data actually lies.

# Real-World Applications

- Customer segmentation
- Fraud/anomaly detection
- Recommendation systems
- Medical imaging
- NLP (embeddings, self-supervised learning)
- Speech recognition

# Advantages & Challenges

## **Advantages:**

- Leverages massive unlabeled datasets
- Discovers hidden patterns
- Enables feature learning

## **Challenges:**

- Harder to evaluate (no labels)
- Risk of meaningless representations
- Computationally expensive