📘 Introduction to AI, ML, and DL

🤖 What is Artificial Intelligence (AI)?

Artificial Intelligence is the field of computer science focused on creating systems capable of performing tasks that typically require human intelligence. These tasks include reasoning, learning, problem-solving, perception, and language understanding.

Examples:

- Virtual assistants (Siri, Alexa)
- Autonomous vehicles
- Recommendation systems (Netflix, Amazon)

📊 What is Machine Learning (ML)?

Machine Learning is a subset of AI that enables machines to learn from data and improve their performance over time without being explicitly programmed.

Examples:

- Email spam detection
- Predicting stock prices
- Face recognition

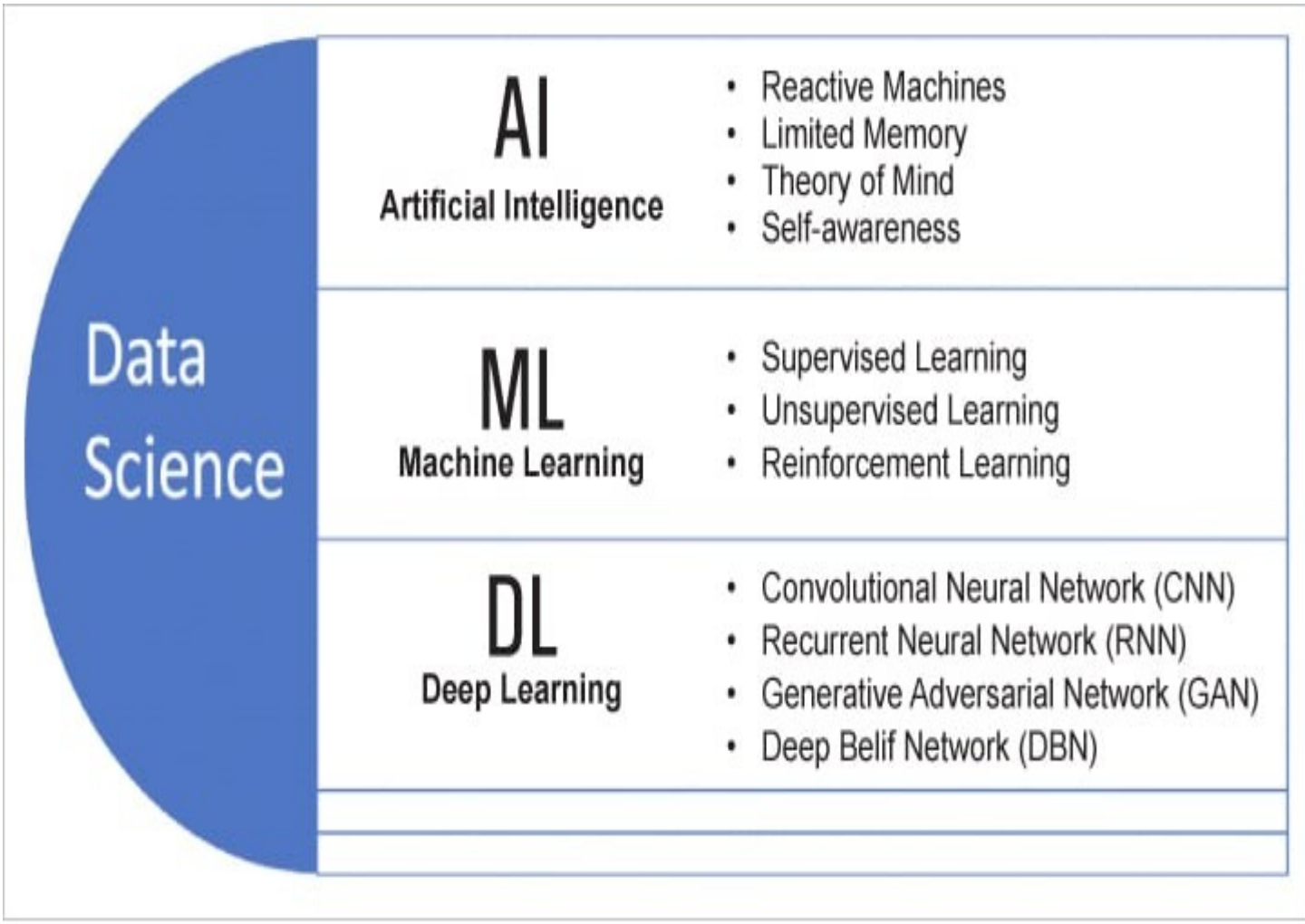
🧠 What is Deep Learning (DL)?

Deep Learning is a subset of ML that uses neural networks with many layers (deep architectures) to model complex patterns in data.

Examples:

- Image classification
- Natural Language Processing (NLP)
- Voice recognition

Differences Between AI, ML, and DL



📚 Types of Machine Learning

✔️ Supervised Learning

- **Definition**: Learning from labeled data (input-output pairs).
- **Goal**: Predict output for new inputs.
- **Applications**: Fraud detection, medical diagnosis, spam filtering.

🔍 Unsupervised Learning

- **Definition**: Learning from unlabeled data.
- **Goal**: Discover hidden patterns or groupings.
- **Applications**: Customer segmentation, anomaly detection.

🎮 Reinforcement Learning

- **Definition**: Learning by interacting with an environment and receiving feedback (rewards or penalties).
- **Goal**: Maximize cumulative reward.
- **Applications**: Game playing (e.g., AlphaGo), robotics, self-driving cars

🔍 Supervised Learning

1. **Linear Regression**
    - Predicts continuous values.
    - Example: House price prediction.
2. **Logistic Regression**
    - Binary classification.
    - Example: Spam vs. non-spam emails.
3. **Decision Trees**
    - Tree-like model of decisions.
    - Easy to interpret.
4. **Random Forest**
    - Ensemble of decision trees.
    - Reduces overfitting.
5. **Support Vector Machines (SVM)**
    - Finds optimal boundary between classes.
    - Effective in high-dimensional spaces.
6. **K-Nearest Neighbors (KNN)**
    - Classifies based on closest data points.
    - Simple and intuitive.
7. **Naive Bayes**
    - Probabilistic classifier based on Bayes' theorem.
    - Good for text classification.

🔍 Unsupervised Learning Algorithms

1. **K-Means Clustering**
    - Groups data into K clusters.
    - Example: Customer segmentation.
2. **Hierarchical Clustering**
    - Builds a tree of clusters.
    - Useful for visualizing data structure.
3. **Principal Component Analysis (PCA)**
    - Reduces dimensionality.
    - Preserves variance.
4. **Autoencoders**
    - Neural networks for feature learning.
    - Used in anomaly detection and data compression.

🎯 Reinforcement Learning Algorithms

1. **Q-Learning**
    - Value-based learning.
    - Learns optimal action-value function.
2. **SARSA (State-Action-Reward-State-Action)**
    - On-policy learning.
    - Learns from current policy.
3. **Deep Q-Networks (DQN)**
    - Combines Q-learning with deep neural networks.
    - Used in complex environments.
4. **Policy Gradient Methods**
    - Directly optimize the policy.
    - Suitable for continuous action spaces.

🧠 Deep Learning Overview

1. **Neural Networks**
    - Composed of layers of interconnected nodes.
    - Learn complex patterns.
2. **Convolutional Neural Networks (CNNs)**
    - Specialized for image data.
    - Detect spatial hierarchies.
3. **Recurrent Neural Networks (RNNs)**
    - Handle sequential data.
    - Used in time series and NLP.
4. **Transformers**
    - Use attention mechanisms.
    - Power modern NLP models like BERT and GPT.

🌍 Applications of ML and DL

- **Healthcare**: Disease prediction, medical imaging.
- **Finance**: Fraud detection, credit scoring.
- **Retail**: Personalized recommendations, inventory optimization.
- **Autonomous Vehicles**: Perception, decision-making.
- **Natural Language Processing**: Translation, sentiment analysis, chatbots.