ARTIFICIAL INTELLIGENCE

Unit 1

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Artificial Intelligence (AI) is the field of computer science focused on building machines capable of performing tasks that typically require human intelligence.

• These tasks include:

1. **Learning:** Acquiring knowledge and improving from experience.

2. **Reasoning:** Solving problems and making decisions.

3. **Perception:** Interpreting sensory data (e.g., images, sounds).

4. **Natural Language Processing (NLP):** Understanding and generating human language.

- **Weak AI vs. Strong AI**:
  - **Weak AI**: Systems designed for a narrow task, like virtual assistants (e.g., Siri, Alexa).
  - **Strong AI**: The hypothetical ability of a machine to perform any intellectual task a human can, with consciousness and self-awareness, which remains an ongoing research goal.

Goals

Core Goals of AI:

1. Develop systems that can **think and act rationally.**

2. Enable systems to **learn** from data and adapt over time.

3. Build machines that **perceive and interact** with the environment.

4. Create systems to solve problems efficiently and autonomously.

• **Examples**:

• Self-driving cars (perception, decision-making).

• Chatbots (language understanding and conversation).

Definition and History of AI

- **Definition of AI**: Artificial Intelligence refers to the creation of intelligent machines that work and react like humans. This involves the development of algorithms that can perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation.
- **History of AI**: The history of AI can be traced back to the mid-20th century, with key milestones like:
  - **1956**: The term "Artificial Intelligence" was coined at the Dartmouth Conference by John McCarthy, regarded as one of the fathers of AI.
  - **1960s-70s**: Early success in problem-solving and game-playing AI systems, such as the chess-playing programs and Shakey the robot.
  - **1980s-90s**: Introduction of machine learning (ML) techniques and expert systems.
  - **2000s-present**: Deep learning revolution with breakthroughs in AI applications like facial recognition, natural language processing (NLP), and autonomous driving.

History

Early Beginnings:

1. 1943: McCulloch and Pitts propose the first artificial neuron model.

2. 1950: Alan Turing publishes “Computing Machinery and Intelligence” introducing the Turing Test.

3. 1956: Dartmouth Conference – The term “Artificial Intelligence” is coined.

• **Key Developments**:

• 1960s: First AI programs like SHRDLU and ELIZA.

• 1980s: Rise of Expert Systems (DENDRAL, MYCIN).

• 2000s: Deep learning and neural networks revolutionize AI.

Types of AI

- **Narrow AI**:
- Designed for specific tasks (e.g., facial recognition, recommendation systems).
- Current state of AI.
- **General AI**:
- Hypothetical AI capable of performing any intellectual task a human can do.
- **Superintelligence**:
- A future possibility where AI surpasses human intelligence in all domains.

Applications of AI

- **Healthcare**: AI-assisted diagnostics, drug discovery.
- **Transportation**: Self-driving cars, route optimization.
- **Finance**: Fraud detection, algorithmic trading.
- **Retail**: Recommendation systems, inventory management.
- **Entertainment**: Content recommendations (Netflix, Spotify).

Search in AI

• Search is a fundamental part of AI used to solve problems by exploring possible solutions.

• **Examples**:

• Pathfinding in maps (shortest route).

• Game-playing AI (e.g., chess, tic-tac-toe).

• Scheduling tasks efficiently.

• Search is categorized into **uninformed** and **informed** methods.

Uninformed Search

• **Definition**: Search algorithms that explore the state space without any domain-specific knowledge.

• **Examples**:

1. **Breadth-First Search (BFS)**: Explores all nodes level by level.

2. **Depth-First Search (DFS)**: Explores as deeply as possible before backtracking.

• **Strengths**:

• Guarantees solution (if one exists).

• **Weaknesses**:

• Inefficient for large problems.

Informed Search

• **Definition**: Uses domain knowledge to guide the search process.

• **Examples**:

1. **Greedy Best-First Search**: Chooses the node that seems closest to the goal.

2. **A***: Combines cost-to-goal estimation with the cost-so-far for optimality.

• **Strengths**:

• More efficient than uninformed search.

• Guarantees optimal solutions (A*).

Characteristics of Intelligent Agents

• An intelligent agent:

• **Perceives** the environment.

• **Acts** to maximize performance.

• **Adapts** to changes in the environment.

❖ **Characteristics:**

1. **Rationality**: Always chooses actions leading to the best outcome.

2. **Autonomy**: Can operate without human intervention.

3. **Learning**: Improves over time using data.

Types of Intelligent Agents

- **Simple Reflex Agents**: React to current conditions (e.g., thermostat).
- **Model-Based Agents**: Maintain a model of the world to make decisions.
- **Goal-Based Agents**: Make decisions based on goals (e.g., pathfinding).
- **Utility-Based Agents**: Optimize for satisfaction or performance (e.g., recommendation systems).

Problem-Solving in AI

1. **Define the Problem**: Identify state space, actions, goal state, and constraints.

2. **Choose a Search Strategy**: Decide on BFS, DFS, or heuristic-based approaches.

3. **Evaluate Solutions**: Analyze solution quality (optimality and cost).

4. **Act on Solution**: Implement the best action sequence.

Explainable AI (XAI)

Making AI Transparent and Accountable

• XAI aims to make AI systems more understandable to humans.

• Provides clear reasoning behind AI decisions.

• **Why is it Important?**

• Helps build trust in AI systems.

• Critical in sensitive domains like healthcare, finance, and law.

• **Key Challenges**:

1. Balancing accuracy and interpretability.

2. Simplifying complex models like deep learning.

• **Applications**:

• Explaining credit risk assessments in banking.

• Decision support for doctors in diagnosing diseases.

AI Ethics

Ethical Considerations in AI Development

• AI impacts society in significant ways, including privacy, bias, and fairness.

• **Major Concerns**:

1. **Bias in AI Systems**: Discriminatory outcomes due to biased training data.

2. **Privacy Risks**: Misuse of personal data in AI-driven systems.

3. **Accountability**: Ensuring developers take responsibility for AI's actions.

• **Solutions**:

• Regular audits of AI systems for fairness and accuracy.

• Ethical frameworks like the EU's "AI Act."

Integration with Quantum Computing

• Combines quantum computing and AI to solve highly complex problems.

• Exploits quantum principles like superposition and entanglement.

• **Potential Advantages**:

• Accelerating AI training on large datasets.

• Improving optimization problems (e.g., logistics, supply chain).

• Advancing drug discovery through quantum simulations.

• **Challenges**:

• Quantum hardware is still in its infancy.

• High cost and energy consumption.

Google Maps – AI in Pathfinding

- **Working**:
- AI uses **graph-based search algorithms** (e.g., A*) to find the shortest path.
- Machine learning predicts traffic patterns based on real-time and historical data.
- **Features Enabled by AI**:
- Turn-by-turn navigation.
- Estimated time of arrival (ETA).
- Multi-modal travel options (car, bus, walking).
- **Challenges**:
- Handling incomplete or noisy data.
- Adapting to rapidly changing conditions (e.g., accidents, weather).

AlphaGo – AI in Game Playing

•**AlphaGo?**

• A program developed by DeepMind to play the board game Go.

• Combines **deep learning** with **reinforcement learning**.

• **Key Achievements**:

• Defeated world champion Lee Sedol in 2016.

• Demonstrated AI’s ability to learn complex strategies.

• **How It Works**:

• Uses a Monte Carlo Tree Search (MCTS) to evaluate possible moves.

• Deep neural networks estimate board positions and optimal moves.

• **Impact**:

• Pioneered AI research in decision-making and strategic planning.

• Inspired applications in finance, logistics, and healthcare.

1. **Applications of AI**:
    - Current real-world applications of AI, including healthcare, finance, robotics, and natural language processing (NLP).
    - Future directions and potential in AI research and development.
2. **Problem-Solving Techniques**:
    - Formal problem definition in AI.
    - Problem-solving methods: State-space search, production systems, and strategies for solving problems efficiently.
3. **Search Strategies**:
    - Uninformed search techniques: breadth-first search (BFS), depth-first search (DFS).
    - Informed search techniques: best-first search, A*, and heuristic functions.

Thank You

“The science of today is the technology of tomorrow.” **— Edward Teller**