# Unit 1: Artificial Intelligence Fundamentals

## 1. Concept of Intelligence

### 1.1 Definition

Intelligence refers to the **ability to learn, understand, reason, and apply knowledge** to solve problems and adapt to new situations. It is a key characteristic of human cognition and is studied in various fields, including psychology, neuroscience, and artificial intelligence (AI).

### 1.2 Characteristics of Intelligence

- **Learning**: The ability to acquire and apply new knowledge.
- **Reasoning**: Logical thinking and problem-solving skills.
- **Adaptability**: Adjusting to new environments and challenges.
- **Creativity**: Generating new ideas and innovative solutions.
- **Decision Making**: Choosing the best course of action based on available information.

### 1.3 Types of Intelligence

1. **Natural Intelligence**: Human and animal intelligence.
2. **Artificial Intelligence (AI)**: Machine-based intelligence that mimics human cognitive abilities.

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## 2. Artificial Intelligence (AI)

### 2.1 Definition

Artificial Intelligence (AI) is the **simulation of human intelligence** in machines, allowing them to **learn, reason, and make decisions** without human intervention.

### 2.2 Goals of AI

- **Automation of tasks**
- **Mimicking human intelligence**
- **Improving efficiency and accuracy**
- **Solving complex problems**

### 2.3 Categories of AI

1. **Weak AI (Narrow AI)**: Performs specific tasks (e.g., Siri, Google Assistant).
2. **Strong AI (General AI)**: Has human-like cognitive abilities (still theoretical).
3. **Super AI**: AI surpassing human intelligence (hypothetical).

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## 3. Turing Test

### 3.1 Definition

The **Turing Test**, proposed by Alan Turing in 1950, is a method to determine whether a machine exhibits intelligent behavior **equivalent to or indistinguishable from a human**.

### 3.2 How the Turing Test Works

- A human judge interacts with both a human and a machine through text-based communication.
- If the judge **cannot reliably distinguish** the machine from the human, the machine is said to have passed the test.

### 3.3 Limitations of the Turing Test

- Does not measure **true understanding or consciousness**.
- A machine can trick humans without being genuinely intelligent.

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## 4. Areas of Application of AI

### 4.1 Healthcare

- **Medical Diagnosis** (AI-powered diagnostics like IBM Watson).
- **Drug Discovery** (AI accelerates new drug development).

### 4.2 Finance

- **Algorithmic Trading** (AI optimizes stock market trading).
- **Fraud Detection** (AI detects suspicious transactions).

### 4.3 Autonomous Systems

- **Self-driving cars** (Tesla, Waymo).
- **Drones and robotics** (used in logistics and military).

### 4.4 Natural Language Processing (NLP)

- **Chatbots** (Siri, Alexa, Google Assistant).
- **Translation systems** (Google Translate).

### 4.5 Manufacturing and Automation

- **AI-powered robotics** in assembly lines.
- **Predictive maintenance** in industries.

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## 5. Search Techniques in AI

### 5.1 Definition

Search techniques are algorithms that help AI systems **explore possible solutions** to a problem and find the most optimal one.

### 5.2 Types of Search Techniques

1. **Uninformed (Blind) Search**: No additional information about the goal state is used.
2. **Informed (Heuristic) Search**: Uses knowledge to improve efficiency.

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## 6. State Space Representation

### 6.1 Definition

State space represents all possible **configurations (states)** of a problem and the possible transitions between them.

### 6.2 Components

1. **Initial State**: The starting point.
2. **Goal State**: The desired solution.

3. **Operators**: Actions that transform one state into another.
4. **Path Cost**: The cost of reaching a state.

### 6.3 Example

In the **8-puzzle problem**, each tile arrangement is a state, and moving a tile is an operator.

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## 7. Production Rules

### 7.1 Definition

A **Production Rule** consists of a condition (IF) and an action (THEN), forming a rule-based approach to problem-solving.

### 7.2 Example

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IF (temperature > 100°C) THEN (turn on the cooling system).
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## 8. Problem Characteristics in AI

AI problems can be classified based on:

1. **Search Space**: Finite vs. Infinite.
2. **Solution Type**: Single vs. Multiple solutions.
3. **State Change**: Static vs. Dynamic problems.
4. **Complexity**: Simple vs. Complex problems.

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## 9. Production System Characteristics

### 9.1 Definition

A **Production System** is a framework that defines how AI systems apply rules to **solve problems** using state transitions.

### 9.2 Characteristics

1. **Monotonicity**: Knowledge does not change after a rule is applied.
2. **Determinism**: The same input always produces the same output.
3. **Completeness**: The system should find a solution if one exists.

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# 10. Search Methods in AI

## 10.1 Depth-First Search (DFS)

- **Explores deeper nodes first** before backtracking.
- Uses **stack (LIFO) data structure**.
- **Efficient in memory usage**, but may **get stuck in infinite loops**.

### Example

Solving a **maze** by exploring a single path until a dead-end, then backtracking.

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## 10.2 Breadth-First Search (BFS)

- **Explores all nodes at the same level** before moving deeper.
- Uses **queue (FIFO) data structure**.
- **Guarantees shortest path** but requires **more memory**.

### Example

Finding the shortest route in **Google Maps**.

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