Fundamentals of Artificial Intelligence

1. What is AI?

- AI (Artificial Intelligence) is the simulation of human intelligence processes by machines.
- AI enables machines to think, reason, learn, and solve problems.

2. Applications of AI

- Healthcare: Diagnosis systems, robotic surgery, treatment recommendations.
- Education: Intelligent tutoring systems.
- Marketing: Predict customer behavior.
- Gaming: Smart NPCs, adaptive game difficulty.
- Robotics: Autonomous robots.
- Finance: Fraud detection, automated trading.

3. Agents and Environments

3.1 Agent

An agent perceives the environment through sensors and acts upon the environment through actuators.

Simple Diagram of an Agent

[Agent Diagram: Sensors → Percepts → Agent → Actions → Actuators]

3.2 PEAS Framework

Aspect	Meaning	Example: Self-Driving Car
Performance	What is measured as success	Safe driving, speed, rules followed
Environment	Where the agent operates	Roads, traffic, pedestrians
Actuators	What it can use to act	Wheels, brakes, steering
Sensors	How it perceives environment	Cameras, LIDAR, radar

3.3 Environment Types

- Fully Observable vs Partially Observable

Type	Explanation	Example
Fully Observable	The agent's sensors give **complete information** about the entire environment at each point in time.	Chess game: board is fully visible.
Partially Observable	The agent's sensors give **only partial or noisy information** about the environment.	Driving in fog: cannot see everything clearly.

- Deterministic vs Stochastic

Type	Explanation	Example
Deterministic	The next state of the environment is **completely determined** by the current state and the action taken by the agent.	Solving a crossword puzzle: your input fully controls the next state.
Stochastic	The next state **involves randomness**; action outcomes are not completely predictable.	Rolling dice in a game: random outcomes.

- Episodic vs Sequential

Type	Explanation	Example
Episodic	Agent's current decision **does not depend** on previous decisions. Each episode is independent.	Image classification: each image is classified individually.
Sequential	Current decisions **affect future decisions**; there is a dependency across steps.	Chess: one move impacts the future of the game.

- Static vs Dynamic

Type	Explanation	Example
Static	Environment **does not change** while the agent is thinking/deciding.	Chess (assuming opponent waits).
Dynamic	Environment **changes over time** even if the agent does nothing.	Self-driving car (road conditions, moving vehicles).

- Discrete vs Continuous

Type	Explanation	Example
Discrete	A limited number of distinct, clearly defined states or actions.	Chess (finite number of moves).
Continuous	Infinite possible states or actions.	Robot navigating in the real world (continuous space, movement angles).

Lisp factorial code

```
(defun factorial (n)
 (if (<= n 1)
    1
    (* n (factorial (- n 1)))))
```

4. Types of Agents

Type	Description	Example
Simple Reflex Agent	Acts based only on current perception	Thermostat
Model-based Reflex Agent	Uses internal state to track the world	Driver in fog
Goal-based Agent	Takes actions towards a goal	Chess player
Utility-based Agent	Maximizes a happiness-utility function	Bisnss ngotiation bot
Learning Agent	Improves over time from experience	Self-improving chess engine

5. Search Algorithms

- Breadth-First Search (BFS): Explore all nodes level-by-level.
- Depth-First Search (DFS): Explore as deep as possible along one branch before backtracking.
- Best-First Search: Expand most promising node first based on heuristic.
- A*: Combines cost to reach node and heuristic estimate of goal distance.

6. Game Playing — Minimax Algorithm

Used in two-player games like chess, tic-tac-toe.
Minimax Principle:
- Maximizing player: Tries to maximize the score.
- Minimizing player: Tries to minimize the score.
Minimax Simple Diagram:
[Max]

/ \
[Min] [Min]
/ \ / \
[3] [5] [2] [9]

7. Machine Learning Overview

- Supervised Learning: Train with labeled data (input → output).
- Unsupervised Learning: Train with unlabeled data (discover patterns).
- Reinforcement Learning: Learn by trial and error, rewards and penalties.

8. Knowledge Representation

- AI agents use Knowledge Bases (KB) to store facts and rules.
- Inference Engine derives new knowledge based on existing facts using logic.

9. Additional Important Topics

- Heuristics: A rule of thumb to guide search algorithms.
- Adversarial Search: Two agents compete (Example: Minimax with Alpha-Beta Pruning).

Final Mindmap Overview

Artificial Intelligence
└── Agents
    └── Sensors, Actuators
    └── Types (Simple Reflex, Model-based, Goal-based, Utility-based, Learning)
└── PEAS
└── Environments (Fully Observable, Stochastic, Episodic, etc.)
└── Search (BFS, DFS, A*, Minimax)
└── Machine Learning (Supervised, Unsupervised, Reinforcement)
└── Knowledge Bases and Inference