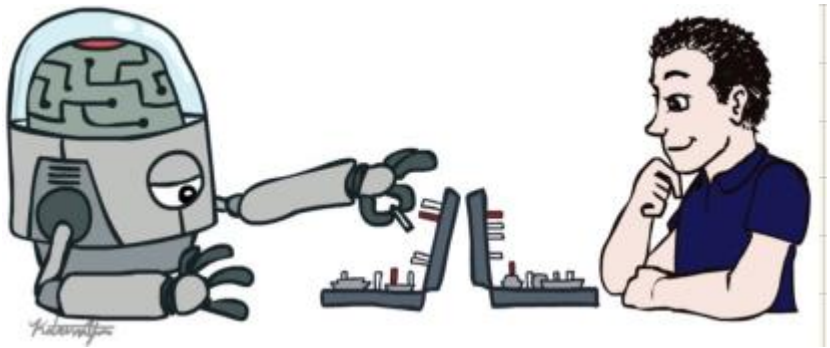
# Artificial Intelligence (BCSE306L)

## Module 01 - Introduction



Dr. Durgesh Kumar

Assistant Professor (Senior),
SCOPE VIT Vellore

# Lecture Outline

- Agent definition
  - Agent vs Human
  - Example of Agent – Cleaning Robot
- The Nature of Environments
  - Specifying the task environment – **P.E.A.S**
  - Properties of the task environment
    - Observable – Full/partially/Non-observable
    - # of Agents – Single, Multi Agents
    - Deterministic – Deterministic / Stochastic
    - Episodic – Sequential /Episodic
    - Static – static/ Dynamic
    - Discrete – Discrete / Continuous

# What is an Agent?

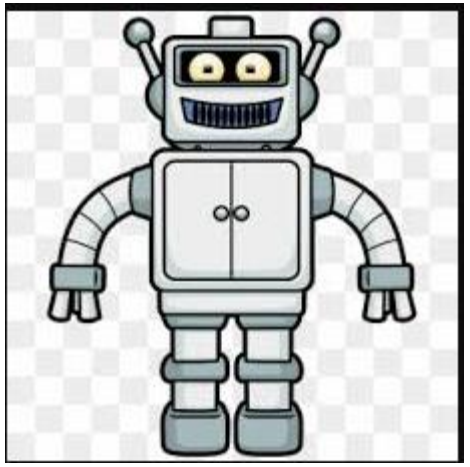
- Artificial intelligence is defined as the study of **rational agents**.
- A rational agent could be anything that makes decisions, as a person, firm, machine, or software.
- An AI system is composed of an **agent and its environment**. The agents act in their environment. The environment may contain other agents.
- An agent is anything that can be viewed as :

  - *perceiving its environment through **sensors** and*
  - *acting upon that environment through **actuators***

# Human VS Agent

- **HUMAN**
  - **Sensors (Percepts):** eyes, ears, and other organs
  - **Actuators:** hands, legs...

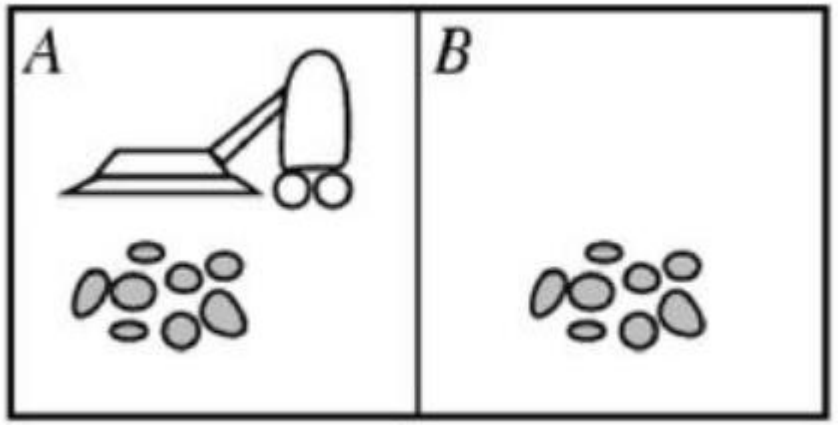
- **ROBOT**
  - **Sensors (Percepts):** cameras and infrared
  - **Actuators:** Various Motors...



# Example of Agent?

**Agent :** Vacuum Cleaner Agent
**Percepts:** location and contents (e.g., [A, Dirty])
**Actions:** Left, Right, Clean, NoOp
**Agent Function:** Mapping from percepts to actions

**Percept to Action Mapping**
[A, clean] -> Right
[A, dirty] -> Clean
[B, clean] -> Left
[B, dirty] -> Clean




# Classification of Intelligent Agents

- **Simple Reflex Agents**
  - Act only on current percepts.
  - No memory of past actions or percepts.
  - **Example:** Automatic door sensor.

- **Model-Based Reflex Agents**
  - Maintain internal state based on percept history.
  - More sophisticated than simple reflex agents.
  - **Example:** Thermostat considering temperature trends.

- **Learning Agents**
  - Learn from past experience to improve performance.
  - Consist of learning element, performance element, critic, and problem generator.
  - **Example:** Chess AI learning from matches.

- **Goal-Based Agents**
  - Use goal information to make decisions.
  - Can consider future consequences of actions.
  - **Example:** Robot navigating a maze toward a target.

- **Utility-Based Agents**
  - Choose actions based on a utility function (happiness/success score).
  - Help make rational choices among conflicting goals.
  - **Example:** AI recommending optimal products.

# PEAS in Artificial Intelligence

- **PEAS** stands for a *Performance measure*, *Environment*, *Actuator*, *Sensor*.
- **Performance Measure:** Performance measure is the unit to define the success of an agent. Performance varies with agents based on their different precepts. e.g. Precision, Recall, F-1 measure, Accuracy for ML models
- **Environment**: Environment is the surrounding of an agent at every instant. It keeps changing with time if the agent is set in motion. There are 5 major types of environments:
  a) Fully Observable & Partially Observable
  b) Episodic & Sequential
  c) Static & Dynamic
  d) Discrete & Continuous
  e) Deterministic & Stochastic

# PEAS description (Contd.)

- **Actuator**: An actuator is a part of the agent that delivers the output of action to the environment.

- **Sensor**: Sensors are the receptive parts of an agent that takes in the input for the agent.

| Agent | Performance Measure | Environment | Actuators | Sensors |
|---|---|---|---|---|
| Taxi Driver | Safe, fast, legal, Navigation or routing, maximize profits(time, fuel), impact on other road users | Roads, other traffic, police, pedestrians, customers, weather | Steering, Accelerator, brake, Signal, horn, display, speech | Cameras, speedometer, GPS, engine sensors, accelerometer, microphones, touchscreen |

# Some More Examples….

| Agent | Performance Measure | Environment | Actuator | Sensor |
|---|---|---|---|---|
| Hospital Management System | | | | |
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# Some More Examples….

| Agent | Performance Measure | Environment | Actuator | Sensor |
|---|---|---|---|---|
| Hospital Management System | Patient's health, Admission process, Payment | Hospital, Doctors, Patients | Prescription, Diagnosis, Scan report | Symptoms, Patient's response |
| Automated Car Drive | | | | |
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| Automated Car Drive | The comfortable trip, Safety, Maximum Distance | Roads, Traffic, Vehicles | Steering wheel, Accelerator, Brake, Mirror | Camera, GPS, Odometer |
| Subject Tutoring | | | | |
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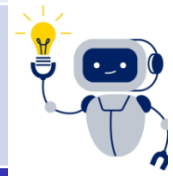

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| Subject Tutoring | Maximize scores, Improvement is students | Classroom, Desk, Chair, Board, Staff, Students | Smart displays, Corrections | Eyes, Ears, Notebooks |
| Part-picking robot | | | | |
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| Satellite image analysis system | | | | |

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| Satellite image analysis system | Correct image categorization | Downlink from orbiting satellite | Display categorization of scene | Colour pixel arrays |

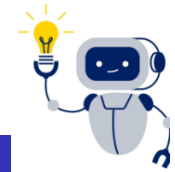
# Types of Environments in AI

- An environment in artificial intelligence is the surrounding of the agent.
- The agent takes input from the environment through sensors and delivers the output to the environment through actuators.
- There are several types of environments:

1. Fully Observable vs Partially Observable
2. Deterministic vs Non-Deterministic (Stochastic)
3. Competitive vs Collaborative
4. Single-agent vs Multi-agent
5. Static vs Dynamic
6. Discrete vs Continuous
7. Episodic vs Sequential
8. Known vs Unknown

# 1.Fully Observable vs Partially Observable

- When an **agent sensor** is capable to sense or access the complete state of an agent at each point in time, it is said to be a **fully observable environment** else it is **partially observable**.
- **Examples:**
  - **Chess –** the board is **fully observable**, and so are the opponent's moves.
  - **Driving –** the environment is **partially observable** because what's around the corner is not known.



# 2.Deterministic vs Non-Deterministic

- **Deterministic**: If the next state of the environment is completely determined by current state and actions executed by agents.
- The **stochastic environment** is random in nature which is not unique and cannot be completely determined by ***current state of environment*** and the agent's action.
- **Examples:**
  - **Chess** – there would be only a few possible moves for a coin at the current state and these moves can be determined.
  - **Self-Driving Cars-** the actions of a self-driving car are not unique, it varies time to time.

# 3. Competitive vs Collaborative

- An agent is said to be in a **competitive environment** when it competes against another agent to optimize the output.
  - The **game of chess** is competitive as the agents compete with each other to win the game which is the output.

- An agent is said to be in a **collaborative environment** when multiple agents cooperate to produce the desired output.
  - **multiple self-driving cars** are found on the roads, they cooperate with each other to avoid collisions and reach their destination which is the output desired.

# 4.Single-agent vs Multi-agent

- An environment consisting of only **one agent** is said to be a **single-agent environment.**
  - A person left alone in a maze is an example of the single-agent system.

- An environment involving more than one agent is a multi-agent environment.
  - The game of football is multi-agent as it involves 11 players in each team.

# 5.Dynamic vs Static

- An environment that keeps constantly changing itself when the agent is up with some action is said to be **dynamic**.
  - A roller coaster ride is dynamic as it is set in motion and the environment keeps changing every instant.
- An idle environment with no change in its state is called a static environment.
  - An empty house is static as there's no change in the surroundings when an agent enters.

# 6. Discrete vs Continuous

- If an environment consists of a **finite number of actions** that can be deliberated in the environment to obtain the output, it is said to be a discrete environment.
- The environment in which the actions are performed cannot be numbered i.e. is not discrete, is said to be continuous.
- The **game of chess** is **discrete** as it has only a **finite number of moves**.
- **Self-driving** cars are an example of **continuous environments** as their actions are driving, parking, etc. which cannot be numbered.

# 7.Episodic vs Sequential

- In **an Episodic task environment,** each of the agent's actions is divided into atomic incidents or episodes. There is no dependency between current and previous incidents.
  - **Example:** Consider an example of Pick **and** Place robot, which is used to detect defective parts from the conveyor belts.

- In a **Sequential environment**, the previous decisions can affect all future decisions. The next action of the agent depends on what action he has taken previously and what action he is supposed to take in the future
  - **Checkers-** Where the previous move can affect all the following moves.

# 8. Known vs Unknown

- In a known environment, the output for all probable actions is given.
- Obviously, in case of unknown environment, for an agent to make a decision, it has to gain knowledge about how the environment works.

# Task Environments and Their Characteristics

| Task Environment | Observable | Agents | Deterministic | Episodic | Static | Discrete |
|---|---|---|---|---|---|---|
| Crossword puzzle | Fully | Single | Deterministic | Sequential | Static | Discrete |
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| Poker | | | | | | |
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| Poker | Partially | Multi | Stochastic | Sequential | Static | Discrete |
| Backgammon | | | | | | |
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| Taxi driving | | | | | | |

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| Image analysis | | | | | | |
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| Refinery controller | | | | | | |
| Interactive English tutor | | | | | | |

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| Interactive English tutor | Partially | Multi | Stochastic | Sequential | Dynamic | Discrete |

# Thank you

Questions ?