Introduction
Artificial Intelligence

Artificial Intelligent Agents
Task Environment

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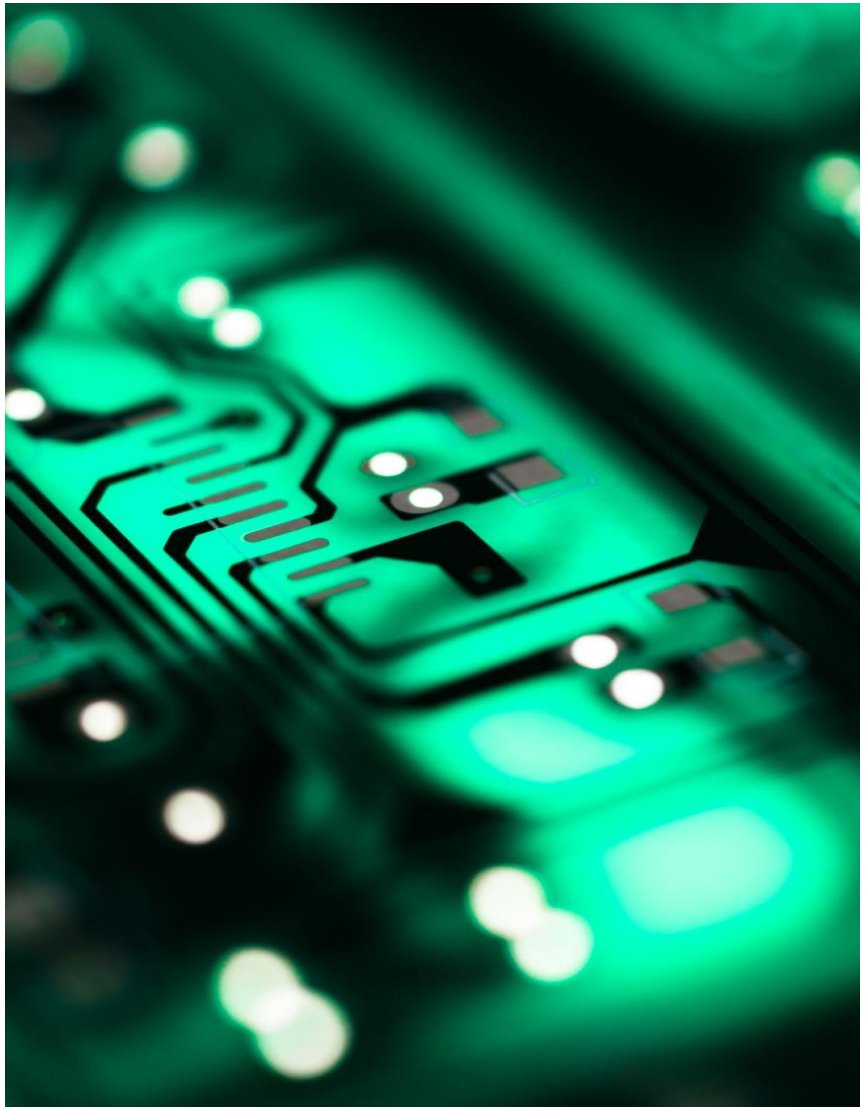


Task Environment

- An environment is everything in the world which surrounds the agent, but it is not a part of an agent itself.

- An environment can be described as a situation in which an agent is present.

- The environment is where agent lives, operate and provide the agent with something to sense and act upon it.

Task Environment

- To design a rational agent, first we must specify its task environment
- Task environment of an agent is often specified as four things: PEAS
  - **P**erformance
  - **E**nvironment
  - **A**ctuators
  - **S**ensors
- In designing an agent, the first step must always be to specify the task environment (PEAS) as fully as possible.

Environment Types

- Fully observable vs. partially observable
- Deterministic vs. stochastic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single agent vs. multi-agent

Fully vs. Partially Observable

- Fully observable (FO) means accessible and partially observable (PO) means inaccessible.

- An environment is fully observable when the sensors can detect all aspects that are relevant to the choice of action, otherwise it is partially observable.

- When an agent sensor is capable to sense or access the complete state of an agent at each point of time, it is said to be a fully observable environment else it is partially observable.

Fully vs. Partially Observable

- A fully observable AI environment has access to all required information to complete target task.
- Partially observable environments deal with partial information in order to solve AI problems.
- A fully observable environment is easy as there is no need to maintain the internal state to keep track history of the world.
- Fully observable environments do not need memory to make an optimal decision, while as Partially observable environments need memory to make an optimal decision.

Fully vs. Partially Observable

Chess:

The board is fully observable. All information required to make an optimal decision is available. It doesn't matter what happened in the past.

Fully vs. Partially Observable

Cards Game/Poker

Poker is Partially Observable. In Poker, you gain an advantage by knowing what happened in the past. That's why counting cards works.

Deterministic vs. Stochastic (Non-Deterministic)

- The environment is deterministic if the next state of the environment is completely determined by the current state and the action executed by the agent.

- If the environment is partially observable, then it could appear to be stochastic.

- If an agent's current state and selected action can completely determine the next state of the environment, then such environment is called a deterministic environment.

- If the next state of the environment is uncertain to determined by the current state, then it is stochastic environment. There is some randomness involved.

Deterministic vs. Stochastic (Non-Deterministic)

- **Deterministic** = the next state of the environment is completely predictable from the current state and the action executed by the agent.

- **Stochastic** = the next state has some uncertainty associated with it. Uncertainty could come from randomness, lack of a good environment model, or lack of complete sensor coverage.

Examples: Vacuum world is deterministic while taxi driver is not.

What about chess playing environment?

- **Deterministic**

What about autonomous vehicle environment?

- **Stochastic environment.** Here, the decision taken by the autonomous vehicle is based on the probability of action of other vehicles

Episodic vs. Sequential

- In an Episodic environment, there is a series of one-shot actions, and only the current percept is required for the action.

- In Sequential environment, an agent requires memory of past actions to determine the next best actions.

Episodic vs. Sequential

- In an Episodic environment, the agent's experience is divided into atomic episodes.
- each episode consists of the agent perception and then performing a single appropriate action.
- the choice of action in each episode depends only on the episode itself.
- the next episode does not depend on the actions taken in the previous episodes.
- In Sequential environment, the current decision could affect all the future decisions.

Episodic vs. Sequential

Playing Soccer

It is Sequential. The past history of actions in the game can affect the next action in the game.

Episodic vs. Sequential

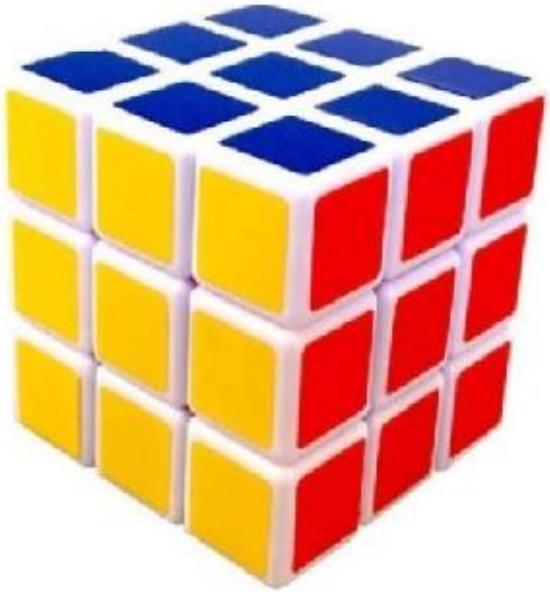
- Examples:
  - Episodic= mail sorting task
  - Sequential= chess playing

Static vs. Dynamic

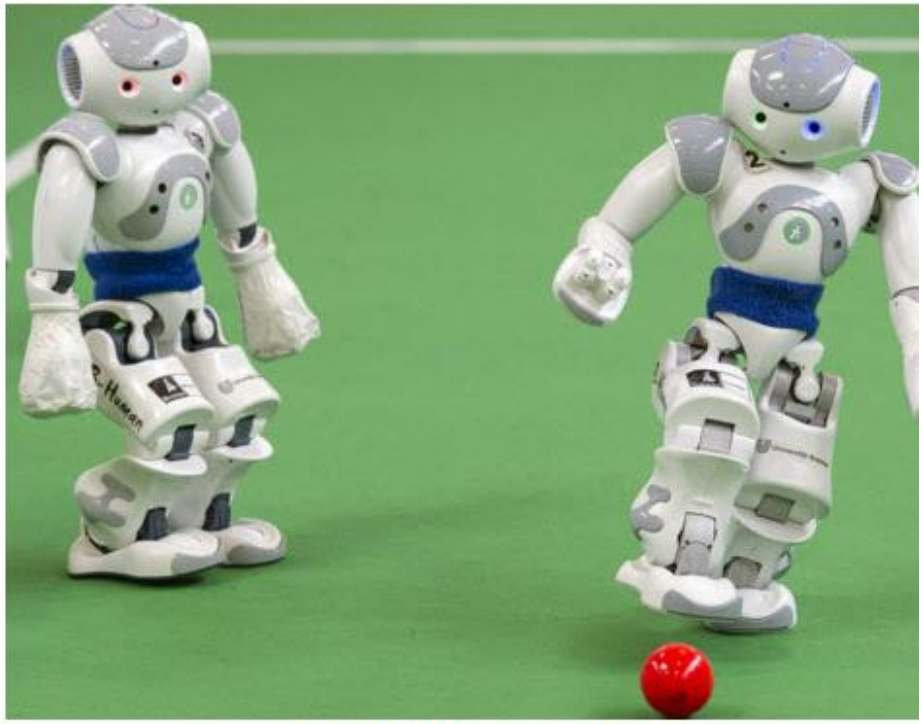
- A static environment is unchanged while dynamic environment may change.

- Static environments are easy to deal with.

- Dynamic environments are continuously asking the agent what it wants to do. If it has not decided yet, that counts as deciding to do nothing.



Rubik's Cube



Football Playing Robots

Static vs. Dynamic

Rubik's cube is Static environment.

The paid are remain unchanged during the playing. No change during an action.

Football playing is dynamic environment.

The other robots do move from their places while robot move with football. So, there is continuous change in the playground.

Discrete vs. Continuous

- A **discrete environment** has a finite and clearly defined states, percepts and actions.
- If the number of distinct percepts and actions is limited, the environment is **discrete**.

- Otherwise, it is **continuous environment**.

- Examples
  - Chess has finite number of discrete states, and has discrete set of percepts and actions
  - Taxi driving has continuous states and actions

Poker

Autonomus Car

Discrete vs. Continuous

Poker.

Poker is played with limited or discrete set of percepts or actions, so it is discrete environment.

Autonomous Car.

Speed and location of car is changing over time. Steering, Brake, acceleration etc. are continuous environment.

Single vs. Multi-Agent

- In a **single agent environment**, an agent operates by itself in the environment, while in a **multi-agent environment** more than one agents act.

- If only one agent is involved in an environment and operating by itself, then such an environment is called single agent environment.

- However, if multiple agents are operating in an environment, then such an environment is called a multi-agent environment.

Robot helping an old patient to walk

Car manufacturing robots

Single-Agent vs. Multi-Agent

Robot helping an old patient to walk

This is single-agent environment.

Car manufacturing robots.

Robots are cooperating with each other, and all of them are jointly to be accounted for their actions. This is multi-agent environment.

Environment Types: Summary

- The environment type largely determines the agent design
- The real world is partially observable, stochastic, sequential, dynamic, continuous, and multi-agent.
- Building an autonomous agent in such complex environments is a hard AI task

QUIZ

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Next Class