Artificial Intelligence

Lecture-7

Intelligent Agents

- ***Prepared by:***

  Md. Mijanur Rahman, Prof. Dr.

  Dept. of Computer Science and Engineering

  Jatiya Kabi Kazi Nazrul Islam University, Bangladesh.

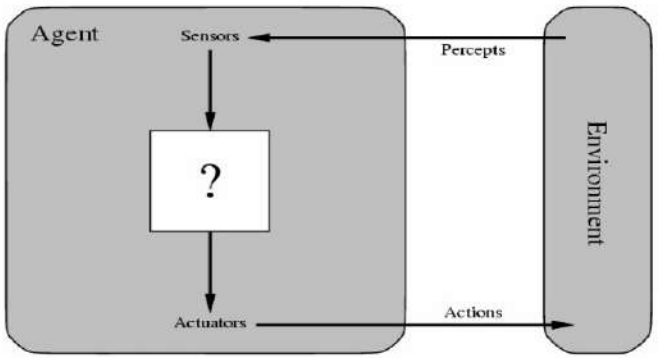
  Email: mijanjkkniu@gmail.com

Lecture Outlines

- ...
  - Overview of Agent Terminology
  - Nature of Environments
  - Properties of Task Environments

Agent Terminology…

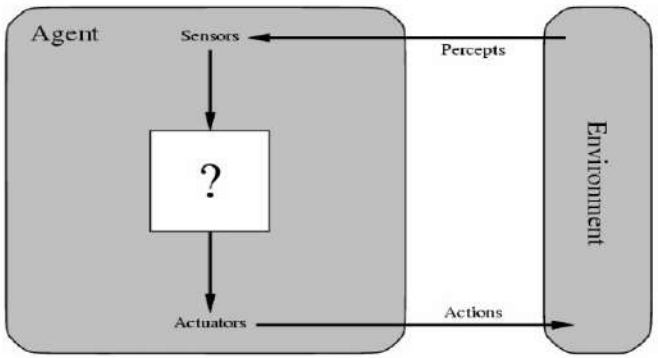
- **Performance Measure of Agent** – It is the criteria, which determines how successful an agent is.
- **Behavior of Agent** – It is the action that agent performs after any given sequence of percepts.
- **Percept** – It is agent's perceptual inputs at a given instance.
- **Percept Sequence** – It is the history of all that an agent has perceived till date.
- **Agent Function** – It is a map from the precept sequence to an action.



Agent Terminology

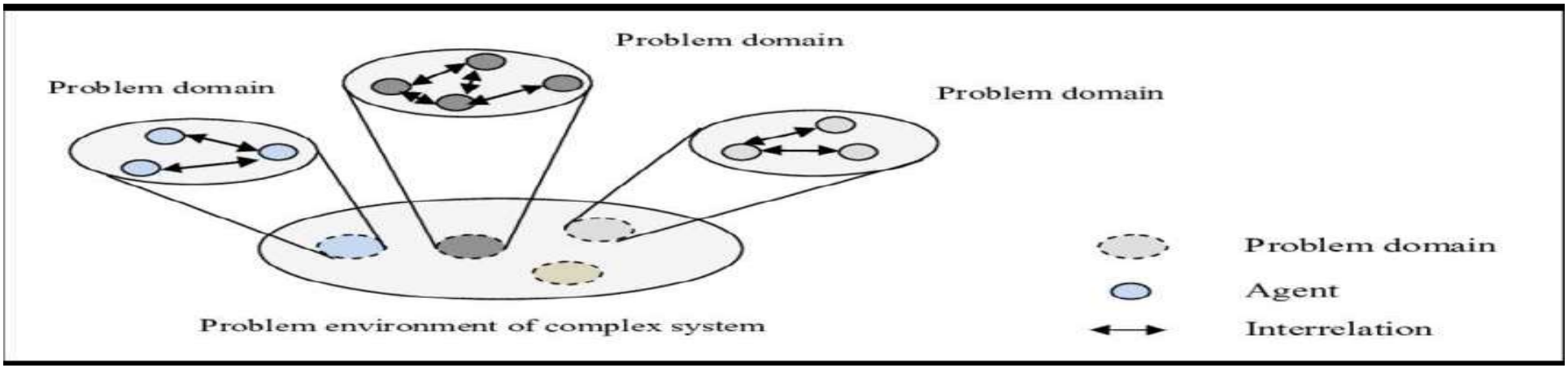
- **Percept (*P*)**
  - The agent's perceptual inputs at any given time.
- **Percept sequence (*P**)**
  - The complete history of everything the agent has ever perceived.
- **Agent function**
  - A mapping of any given percept sequence to an action:

    f: P^* (P_0, P_1, P_2, …, P_n) --> A
  - Agent function is implemented by an agent program
- **Agent program**
  - Run on the physical agent architecture to produce *f*



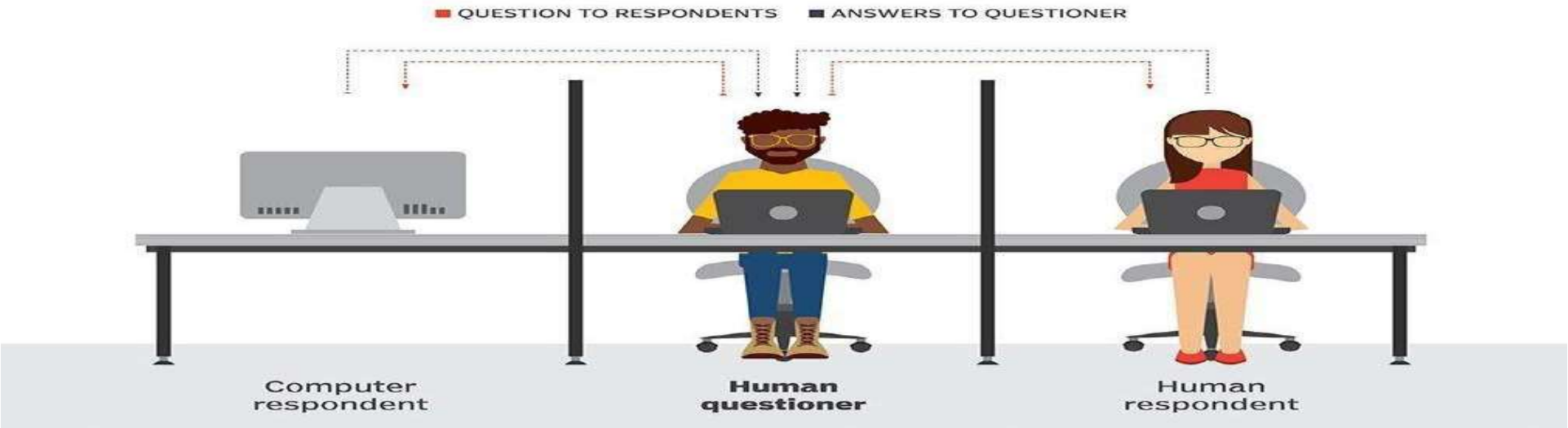
The Nature of Environments

- Some programs operate in the entirely **artificial environment** confined to keyboard input, database, computer file systems and character output on a screen.
- In contrast, some software agents (software robots or softbots) exist in rich, unlimited softbots domains. The simulator has a **very detailed, complex environment**. A softbot designed to scan the online preferences of the customer and show interesting items to the customer works in the **real** as well as an **artificial** environment.
- We need to **analyze the task environment**, which are the "problems" for which the agents are the "solutions". Some of the **common features of the environment** needs to be understood, for they determine the appropriate agent design required.

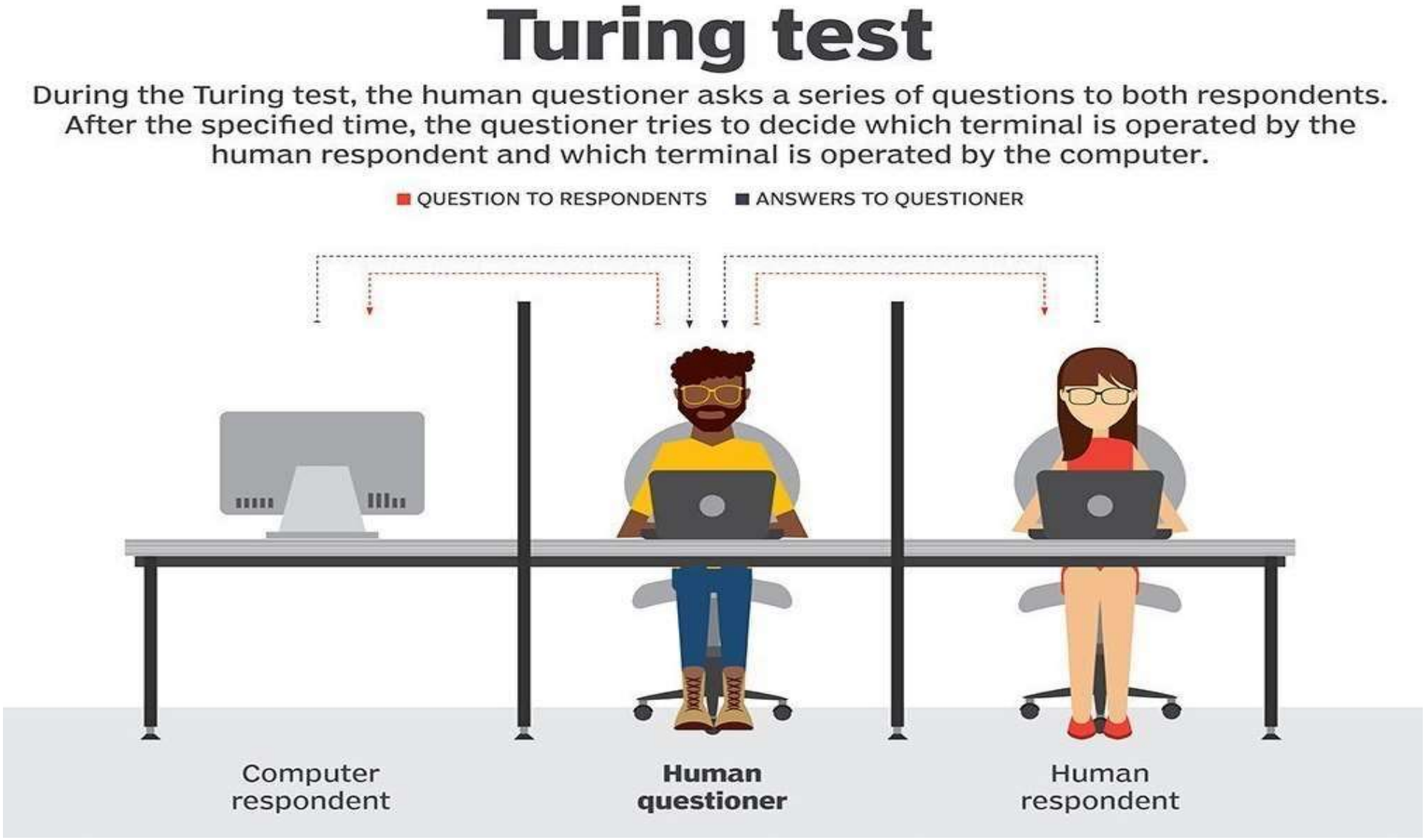


Turing Test: Environments…

- The most famous **artificial environment** is the **Turing Test environment**, in which one real and other artificial agents are tested on equal ground. This is a very challenging environment as it is highly difficult for a software agent to perform as well as a human.
- **Two persons and a machine** to be evaluated participate in the test. Out of the two persons, one plays the role of the **questioner**. Each of them sits in different rooms. The questioner is unaware of who is machine/computer and who is a human. He interrogates the questions by typing and sending them to both intelligences, to which he receives typed responses.
- This test aims at fooling the questioner. If the questioner fails to determine machine's response from the human response, then **the machine is said to be intelligent**.



Turing Test: Environments



Task Environments...

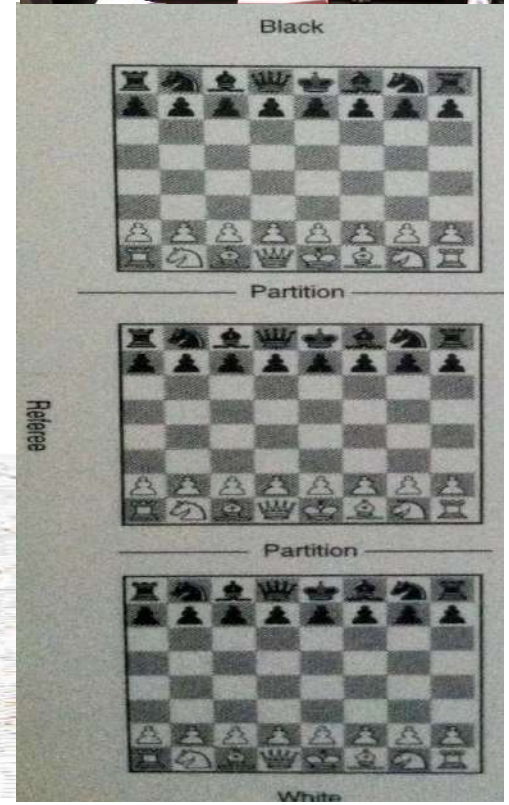
- When thinking about building a rational agent, we must specify the task environments.
- The task environment has multifold properties: Informally identified (categorized) in some dimensions
- **Discrete / Continuous**
  - If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete (For example, chess); otherwise it is continuous (For example, driving).
- **Observable / Partially Observable**
  - If it is possible to determine the complete state of the environment at each time point from the percepts it is observable; otherwise it is only partially observable.
- **Static / Dynamic**
  - If the environment does not change while an agent is acting, then it is static; otherwise it is dynamic.

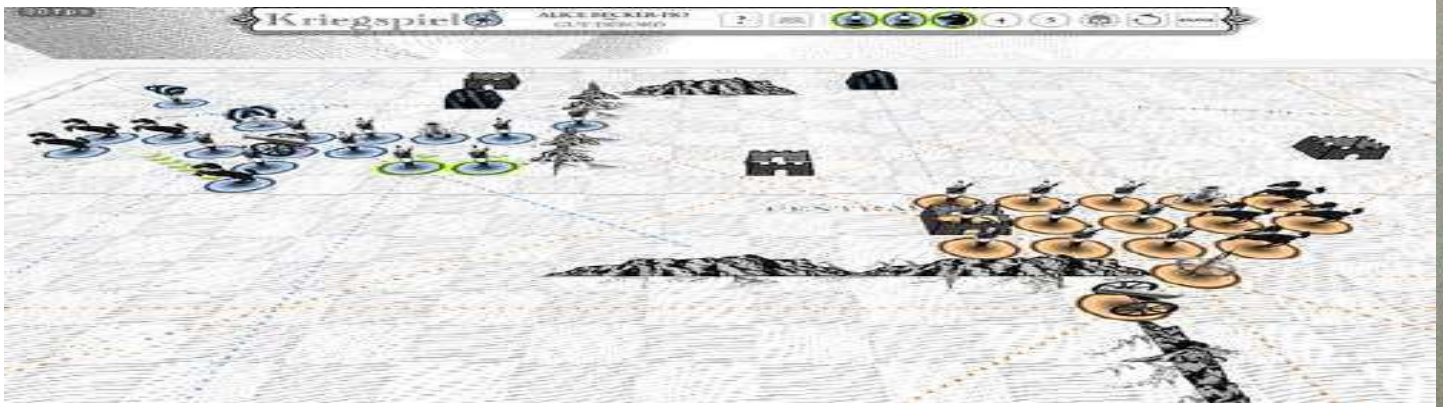
Task Environments

- **Single agent / Multiple agents**
  - The environment may contain other agents which may be of the same or different kind as that of the agent.
- **Accessible / Inaccessible**
  - If the agent's sensory apparatus can have access to the complete state of the environment, then the environment is accessible to that agent.
- **Deterministic / Non-deterministic**
  - If the next state of the environment is completely determined by the current state and the actions of the agent, then the environment is deterministic; otherwise it is non-deterministic.
- **Episodic / Non-episodic**
  - In an episodic environment, each episode consists of the agent perceiving and then acting. The quality of its action depends just on the episode itself. Subsequent episodes do not depend on the actions in the previous episodes. Episodic environments are much simpler because the agent does not need to think ahead.

Task Environment:
Fully Observable vs Partially Observable

- If we can capture the complete state of the environment *relevant to the choice of action* of the agent using the its sensors, then the environment is **fully observable**. If the environment is not fully observable, then it needs to maintain an internal state to keep track of the world.
- The environment could be partially observable not just because of the noise or the inaccuracy of the sensors, but could be due to the framework of the task itself.
- For example, the classic game of **Chess** is fully observable as one agent can perceive the positions and the moves of the other agent. But in the **Kriegspiel** version of chess, the game environment is partially observable (it is unobservable except for the invalid moves).



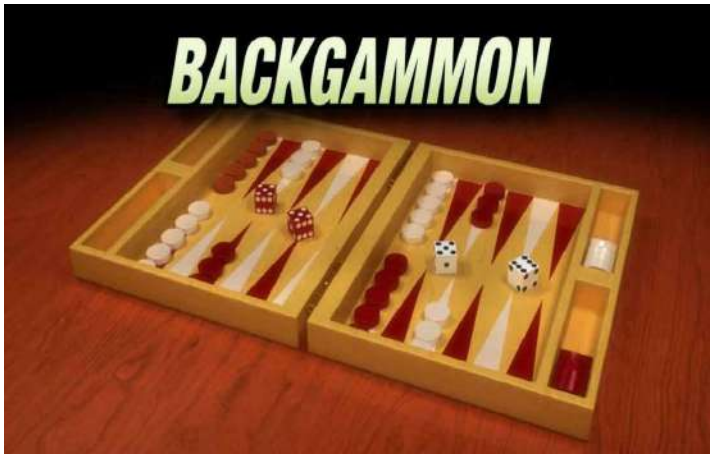


Task Environment:
Single agent vs Multi agent

- Consider two kinds of agents: **a vacuum cleaning agent** and **a chess engine**. The vacuum cleaning environment is single agent while chess is a two agent environment. We need to define what entities must be viewed as agents with respect to a task environment.
- If the performance measure of agent B depends on the action performed by agent A, then the environment is said to have two agents. In chess, the 'optimal' move of one agent, by rule, reduces the performance measure for the other agent, and so it is said to be a **competitive** environment.
- Consider a case of two taxi-driving agents. Here, avoiding collisions maximizes the performance of both the agents, and so it is a **cooperative** environment.

Task Environment: Deterministic vs Stochastic

- If the next state is completely determined by the current action of the agent, then the environment is **deterministic**. The vacuum world described earlier is a deterministic one, while **the game of ludo and backgammon is stochastic** (the dice will generate the uncertainty in the environment).
- We could consider the game of **chess as a deterministic environment** though there can be uncertainty due to the other agent in the game, because we could still determine the state of the game to an extent by estimating the other agent's moves.
- Most real-life situations are so complex that we cannot keep track of all the unobserved aspects, and must be treated as stochastic.



Task Environment: Static vs Dynamic

- If the environment can change while the agent is performing an action, then **the environment is dynamic** for that agent; otherwise **it is static**.
- Agents in static environments does not need to worry about the state of the environment during the action, and so the environments are easy to deal with.
- **Taxi driving is dynamic**, as the other cars keep moving while the agent is deciding for an action**. Chess is static**.

Task Environment: Discrete vs Continuous

- The discrete/continuous distinction applies to the state of the environment, to the way time is handled, and to the percepts and actions of the agent.
- For example, the **chess environment has a finite number of distinct states** and has a discrete set of percepts and actions.
- **Taxi driving is a continuous-state** and continuous-time problem, and the corresponding actions are also continuous.

Task Environment: Episodic vs Non-episodic

- In an episodic environment, the performance of an agent is dependent on a number of discrete episodes, with no link between the performance of an gent in different scenarios.
- episodic environments are simpler from the agent developer's perspective because the agent can decide what action to perform based only on the current episode – it need not reason about the interactions between this and future episodes.
-
- Examples: *Episodic environment:* mail sorting system *Non-episodic environment: chess game*

Task Environment: Accessible vs Inaccessible

- An **accessible environment** is one in which the agent can obtain complete, accurate, up-to-date information about the environment's state.
- Most moderately **complex environments** (for example, the everyday physical world and the Internet) are inaccessible.
- The more accessible an environment is the simpler, to build agents to operate in it.

- Examples:
  - *Inaccessible environment:* physical world: information about any event on earth
  - *Accessible environment*: empty room which state is defined by its temperature and agents can measure it.

Example: VRKitcken Environment…

- **VRKitchen: An interactive virtual environment to train and test AI agents**

- A team of researchers at the University of California Los Angeles (UCLA), under the supervision of Prof. Song-Chun Zhu, has developed an interactive 3-D virtual environment for training and evaluating AI systems. Their platform, called VRKitchen, was recently presented in a paper pre-published on arXiv, 2019.

Example: VRKitcken Environment…

- Compared to other existing virtual environments, VRKitchen has two key advantages.
- First, in VRKitchen, an AI agent can perform a wide range of cooking tasks with rich object state changes and compositional goals. For instance, if an agent is learning to make pizza, the virtual environment simulates visual effects of the cheese being grated, tomatoes being cut and the ingredients being placed onto the dough. The ability to simulate these complex cooking tasks would make VRKitchen stand out from other platforms.

- A second advantage of VRKitchen is that the embodied agent navigating the virtual environment can be controlled by both AI algorithms and human users. This allows humans to give demonstrations to AI agents, so that the latter can acquire knowledge about how to complete a task via observation, rather than having to learn the task independently.

Example: VRKitcken Environment

Video Source: https://youtu.be/bpsoaJe-DAw

Intelligent Agents

THE END