Biological Vision and Applications
Module 06-02: Agents and Environment

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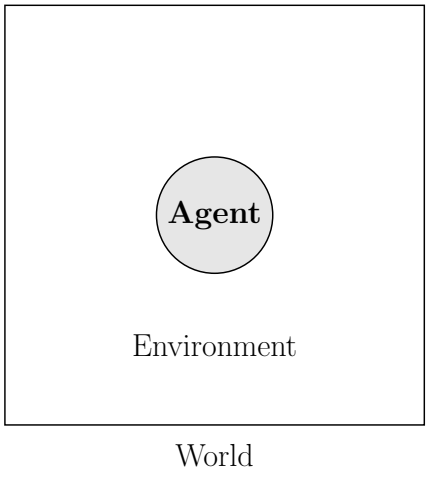
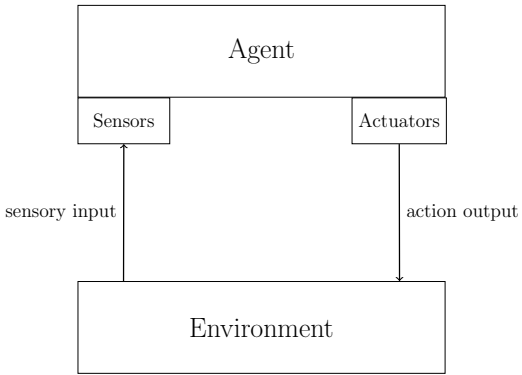
A situated agent

Agent, Environment and the World



An agent interacts with it's environment

Sensing and effecting (or, actuating)



Characterizing the environment

- Accessible vs. Inaccessible
  - Accessible: Agent has complete information about the environment
  - Inaccessible: Agent has partial information about the environment
- Deterministic vs. non-deterministic
  - Deterministic: An action by an agent has a guaranteed effect on the environment
  - Non-deterministic: The change in the environment cannot be guaranteed
- Episodic vs. non-episodic
  - Episodic: Distinct episodes – no link between episodes
  - Non-episodic: No such boundary – all events in an agent's life are linked

Characterizing the environment

Continued

- Static vs. Dynamic
  - Static: Does not change except for that caused by the agent's action
  - Dynamic: Changes with time, even if an agent does not act
  - Semi-static: Can change by action of some other agent
- Discrete vs. Continuous
  - Discrete: The environment states are discrete
  - Continuous: The environment states are continuous

Modeling of Agent and Environment

- An agent can execute a finite set of actions
  - Let the action repertoire of an agent be $A = \{a_1, a_2, \ldots, a_m\}$
- The environment has a finite number of states
  - Let the states of an environment be $S = \{s^1, s^2, \ldots, s^n\}$
- At any given point of time t, the environment is characterized by a sequence of states that it has traversed
  - $S^* = (s_0, s_1, \ldots, s_t)$ where
    1. $s_i (i = 1, \ldots, t) \in S$
    2. s_0 represents the initial state of the environment

Modeling of Agent and Environment

Agent

- In general, an agent translates a sequence of environment states to an action
  - $action(s_0, s_1, \ldots, s_t) \rightarrow a$
- Behavioral model of an agent is defined by the action function
  - $action : S^* \rightarrow A$, where
    - S^* denotes a sequence of environment states
- As a special case, the action of an agent may be determined by the current state alone
  - $action : S \rightarrow A$

Modeling of Agent and Environment

Environment

- An action changes the state of an environment
  - There can be uncertainty in the state that the environment will transit to
- The change in environmental state can be modeled as
  - $env(s, a) \rightarrow \rho(S)$, where
    - $\rho(S)$ denotes an set of states
    - Possible outcomes of the action
    - Often attributed by a probability distribution
- If $\forall s, a : env(s, a)$ is a singleton
  - The environment is deterministic
  - ... Otherwise, it is non-deterministic
- Behavioral model of environment
  - $env : S \times A \rightarrow \rho(S)$

Modeling of Agent and Environment

History and Characteristic Behavior

- A history of a system $(\mathcal{A}, \mathcal{E})$ is defined as the sequence of environment states and agent actions
  - $h(\mathcal{A}, \mathcal{E}) = s_0 \xrightarrow{a_0} s_1 \xrightarrow{a_1} s_2 \xrightarrow{a_2} s_3 \ldots s_i \xrightarrow{a_i} s_{i+1} \ldots$, when
    1. $\forall i : a_i = action(s_0, s_1, \ldots, s_i)$
    2. $s_{i+1} \in env(s_i, a_i)$

- Characteristic behavior of an agent $\mathcal{A}$ in environment $\mathcal{E}$
  - $\mathcal{H}(\mathcal{A}, \mathcal{E}) = \{h(\mathcal{A}, \mathcal{E})\}$
  - ... (set of all possible histories)

Modeling of Agent and Environment

Summary

- Agent: $\mathcal{A} \equiv action : S^* \rightarrow A$
- Environment: $\mathcal{E} \equiv env : S \times A \rightarrow \rho(S)$
- History: $h(\mathcal{A}, \mathcal{E}) \equiv s_0 \xrightarrow{a_0} s_1 \xrightarrow{a_1} s_2 \xrightarrow{a_2} s_3 \ldots s_i \xrightarrow{a_i} s_{i+1} \ldots$
- Characteristic behavior of $\mathcal{A}$ in $\mathcal{E}$: $\mathcal{H}(\mathcal{A}, \mathcal{E})$
  - where, $\mathcal{H}(\mathcal{A}, \mathcal{E}) = \{h(\mathcal{A}, \mathcal{E})\}$
- Two agents $\mathcal{A}_1$ and $\mathcal{A}_2$ are said to be behaviorally identical with respect to environment $\mathcal{E}$, iff
  - $\mathcal{H}(\mathcal{A}_1, \mathcal{E}) = \mathcal{H}(\mathcal{A}_2, \mathcal{E})$

Modeling of Agent and Environment

Invariant property

- A property P is called an invariant property of the characteristic behavior $\mathcal{H}(\mathcal{A}, E)$, iff
  - P holds good for all $h(\mathcal{A}, \mathcal{E}) \in \mathcal{H}(\mathcal{A}, \mathcal{E})$
- Example: a car does not collide with another while driving
- An invariant property in one environment does not necessarily hold good in another environment
  - A car drives on the left side on Indian roads

Abstract architecture and Concrete architecture

- Abstract architecture
  - Deals with internal states, state-transitions of an agent
  - Does not worry about how it is implemented
- Concrete architecture
  - Deals with representations and implementations
  - Logic, Bayesian reasoning, Petrinet, ...

Quiz

Quiz 06-02

End of Module 06-02