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FIT5047 – Intelligent Systems

Intelligent Agents
Chapter 2

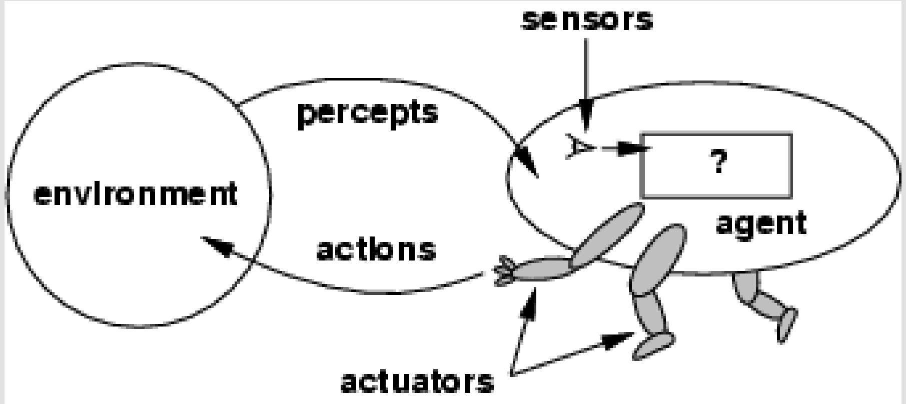
Outline

- **Agents and environments**
- **Rationality**
- **PEAS (Performance measure, Environment, Actuators, Sensors)**
- **Environment types**
- **Agent types**

Agents

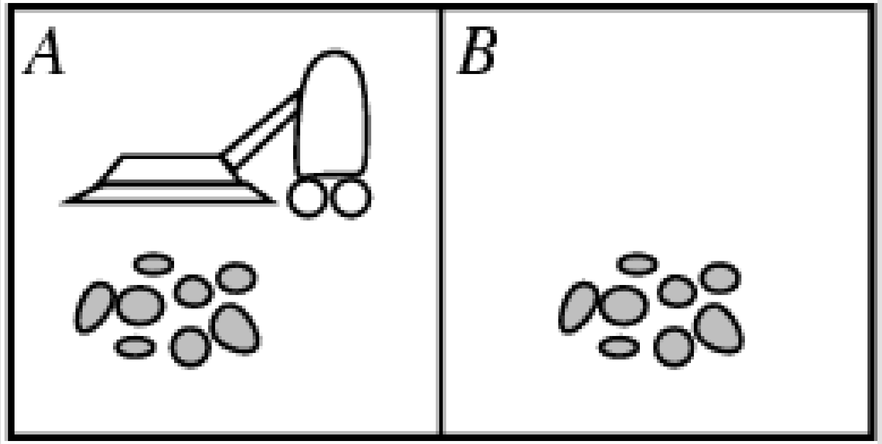
- **An agent is anything that can be viewed as perceiving its environment through sensors, and acting upon that environment through actuators**
- **Human agent:**
  - eyes, ears and other organs for sensors
  - hands, legs, mouth and other body parts for actuators
- **Robotic agent:**
  - cameras and infrared range finders for sensors
  - various motors for actuators

Agents and Environments



- **The agent function maps from percept histories to actions:** $f: \mathcal{P}^* \rightarrow \mathcal{A}$
- **The agent program runs on the physical architecture to produce** f
- **agent = architecture + program**

Example: Vacuum-cleaner World and Agent



- **Percepts: location and contents, e.g., [A,Dirty]**
- **Actions: *Left*, *Right*, *Suck***
- **Program:**

  If *status=Dirty* **return** Suck

  ElseIf *Location=A* **return** Right

  ElseIf *Location=B* **return** Left

Is this a rational agent?

Rationality and Rational Agents

- **Rationality depends on**
  - Performance measure
  - The agent's prior knowledge of the environment
  - The actions that the agent can perform
  - The percept sequence to date
- **Definition:**
  For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and the agent's built-in knowledge

Rational, Autonomous Agents

- **Rationality is NOT omniscience**
- **Agents can perform actions to modify future percepts in order to obtain useful information → exploration, learning**
- **An agent is autonomous if its behavior is determined by its own experience**

Task Environment – PEAS

To design a rational agent, we must specify the *Task Environment*

- **PEAS**
  - Performance measure
  - Environment
  - Actuators
  - Sensors

PEAS – Example (I)

Automated taxi driver:

- **Performance measure**
  - Safe, fast, legal, comfortable trip, minimize fuel consumption, maximize profit
- **Environment**
  - Road types, road contents, customers, operating conditions
- **Actuators**
  - Control over the car, interfaces for informing other vehicles and informing passengers
- **Sensors**
  - Cameras, sonar, speedometer, GPS, odometer, engine sensors, interface for receiving information from other vehicles and passengers (e.g., speech recognizer)

PEAS – Example (II)

Internet shopping agent:

- **Performance measure**
  - cheap, good quality, appropriate product
- **Environment**
  - current WWW sites, vendors
- **Actuators**
  - display to user, follow URL, fill in form
- **Sensors**
  - HTML pages (text, graphics, scripts)

Environment Types (I)

The environment type largely determines the agent design

- **Fully (partially) observable** – An agent's sensors give it access to the complete state of the environment at all times
- **Known (unknown)** – An agent knows the “laws” of the environment
- **Single (multi) agent** – An agent operating by itself in an environment
- **Deterministic (stochastic)** – The next state is completely determined by the current state and the action executed by the agent

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Environment Types (II)

- **Episodic (sequential)** – **The agent's experience is divided into atomic *episodes*. The next episode does NOT depend on previous actions**
  - In each episode an agent perceives a percept and performs a single action
- **Static (dynamic) – The environment is unchanged while an agent is deliberating**
- **Discrete (continuous) – Pertains to number of states, the way time is handled, and number of percepts and actions**
  - E.g., state may be continuous, but actions may be discrete

Environment Types – Examples

	Sorting laundry	8-puzzle	Back-gammon	Medical diagnosis	Taxi
Observable?					
Known?					
Single agent?					
Deterministic?					
Episodic?					
Static?					
Discrete?					

The real world is partially observable, unknown, multi-agent, stochastic, sequential, dynamic, continuous

Environments and Methodologies

	Search	Logical inference	Bayesian networks	Machine learning
Observable?	✓	✓		
Known?	✓	✓	✓	✗
Single agent?				
Deterministic?	✓	✓	✗	
Episodic?				
Static?	✓	✓	✓	✓
Discrete?	✓	✓		

Agent Functions and Programs

- **An agent is completely specified by the *agent function* that maps percept sequences to actions**
- **Aim: design a program that implements the rational agent function concisely**

Agent Types

Based on the function = how actions are selected

Agent Type	**Action selected based on**
Simple reflex	current percept
Model based	+ internal state (world model)
Goal based	+ goal
Utility based	+ utility function
Learning	performance element = above agent + critic + learning element + problem generator (exploratory)

Agent Types – Taxi Example

Agent Type	Action
Simple reflex	brake when brake-lights of car in front light up
Model based	+ remember the roads travelled, time, state
Goal based	+ make a plan to reach a destination
Utility based	+ quickest with least petrol consumption
Learning performance elem + critic + learning element + problem generator	 above agent observes the world & informs learning elem formulates new driving rules based on the feedback from the critic might suggest some driving exercises

How Components of Agent Programs Work?

Depends on the representations of states:

- **Atomic – each state is indivisible (Search, Game playing)**
- **Factored – splits each state into attributes, each of which has a value (Propositional logic, Bayesian networks, Machine learning)**
- **Structured – represents how things are related to each other (First order logic, First-order probability models)**

Reading

- **Russell, S. and Norvig, P. (2010), *Artificial Intelligence* – Chapter 2**

Next Lecture Topic

- **Lecture Topic 3**
  - Problem Solving as Search