MONASH University
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FIT5047: Fundamentals of AI

Intelligent Agents
Chapter 2

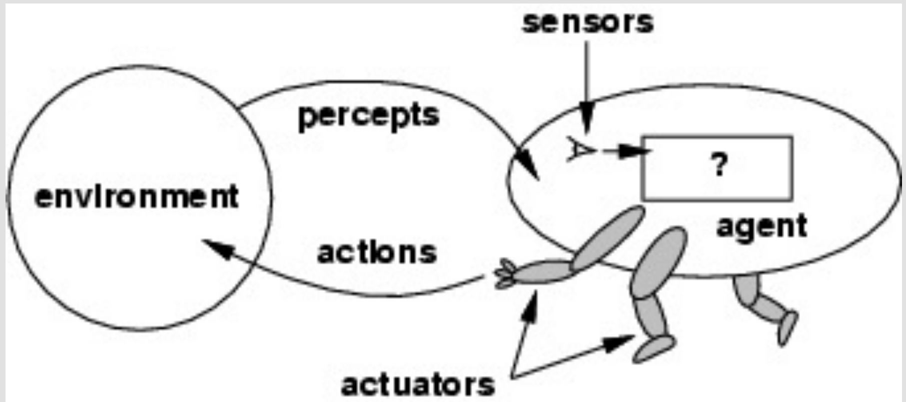
Outline

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

Agents

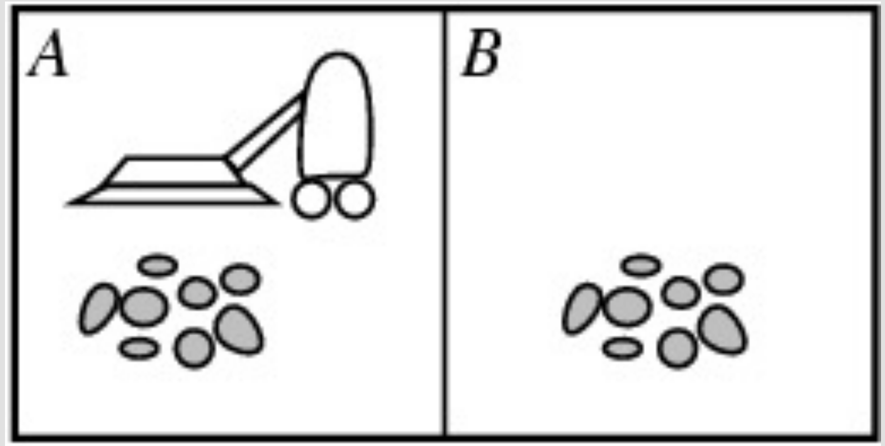
- **An agent is anything that can be viewed as perceiving its environment using sensors, and acting upon that environment via actuators**
- **Human agent:**
  - eyes, ears and other organs for sensors
  - hands, legs, mouth and other body parts for actuators
- **Robotic agent:**
  - cameras and infrared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

Agents and environments



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

Example: Agent in a vacuum-cleaner world



- **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 internet sites, vendors
- **Actuators**
  - Packages that display to user, follow URL, fill in forms
- **Sensors**
  - Packages that read 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

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., states may be continuous, but actions 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 specified by its *agent function* which 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 critic + perf agent knowledge might suggest some driving exercises

How components of agent programs work?

Depends on the representation of states:

- **Atomic – each state is indivisible (Search, Game playing, Markov Decision Processes)**
- **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)**

A more expressive representation can capture everything a less expressive representation can capture, but reasoning and learning is harder

Reading

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

Next topic

- **Lecture Topic 3 (LN3)**
  - Problem solving as search