ARTIFICIAL INTELLIGENCE

Lecture 02

1

Thinking Humanly	Thinking Rationally
"The exciting new effort to make computers think ... *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	Acting Rationally
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI ... is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 1.1 Some definitions of artificial intelligence, organized into four categories.

Focus of this course

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AGENTS AND ENVIRONMENT

An **agent** is anything that can be viewed as perceiving its **environment** through **sensors** and acting upon that environment through **actuators.**

Agent	Sensor	Actuator
Human	Eyes	Arms/Legs
Robot	Camera	Motors
Software	Keystokes File Receiving Receive Packets	Screen Display File Writing Sending Packets

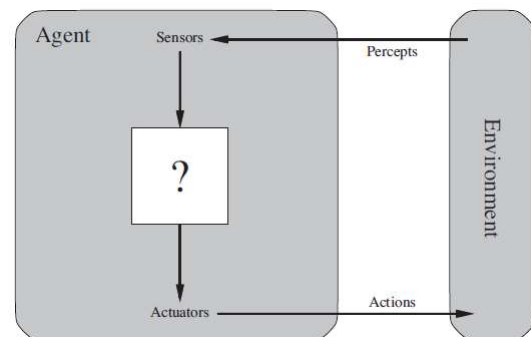Agent — Sensors — Percepts — Environment — Actuators — Actions — ?
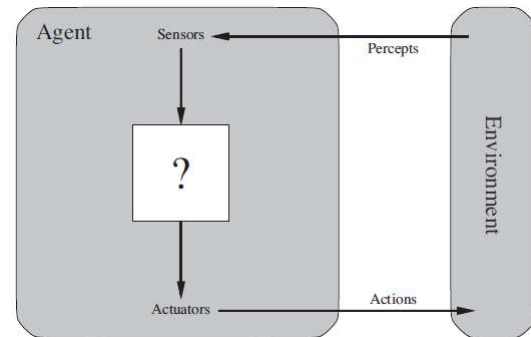
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AGENTS AND ENVIRONMENT

We use the term **percept** to refer to the agent's perceptual inputs at any given instant.

Agent's **percept sequence** is the complete history of everything the agent has ever perceived.

Agent — Sensors — Percepts — Environment — Actuators — Actions — ?

percept

Percepts/ Percept Sequence

Agent Function

Action

Actions/ Action Sequence

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RATIONAL AGENT

A **rational agent** is one that does the right thing.

When an agent is plunked down in an environment, it generates a sequence of actions according to the percepts it receives.

This sequence of actions causes the environment to go through a sequence of states. If the sequence of states is desirable, then the agent has performed well.

This notion of desirability is captured by a **performance measure** that evaluates any given sequence of environment states.

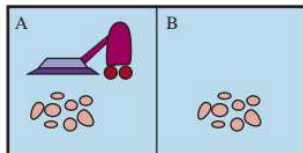Notice that we said *environment* states, not *agent* states.

Figure 2.2 A vacuum-cleaner world with just two locations. Each location can be clean or dirty, and the agent can move left or right and can clean the square that it occupies. Different versions of the vacuum world allow for different rules about what the agent can perceive, whether its actions always succeed, and so on.

Percept sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck
[A, Clean], [A, Clean]	Right
[A, Clean], [A, Dirty]	Suck
⋮	⋮
[A, Clean], [A, Clean], [A, Clean]	Right
[A, Clean], [A, Clean], [A, Dirty]	Suck
⋮	⋮

Figure 2.3 Partial tabulation of a simple agent function for the vacuum-cleaner world shown in Figure 2.2. The agent cleans the current square if it is dirty, otherwise it moves to the other square. Note that the table is of unbounded size unless there is a restriction on the length of possible percept sequences.

ENVIRONMENT VS AGENT STATE

We might propose to measure performance by the amount of dirt cleaned up in a single eight-hour shift.

A rational agent can maximize this performance measure by cleaning up the dirt, then dumping it all on the floor, then cleaning it up again, and so on.

A more suitable performance measure would reward the agent for having a clean floor. For example, one point could be awarded for each clean square at each time step.

As a general rule, *it is better to design performance measures according to what one actually wants in the environment, rather than according to how one thinks the agent should behave.*

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RATIONALITY

What is rational at any given time depends on four things:
- The performance measure that defines the criterion of success.
- The agent's prior knowledge of the environment.
- The actions that the agent can perform.
- The agent's percept sequence to date

This leads to a **definition of a rational agent:**
- *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 whatever built-in knowledge the agent has.*

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PEAS (PERFORMANCE, ENVIRONMENT, ACTUATORS, SENSORS)

Agent: Taxi Driver

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

Figure 2.4   PEAS description of the task environment for an automated taxi.

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PEAS (PERFORMANCE, ENVIRONMENT, ACTUATORS, SENSORS)

Agent: Medical Diagnostic System

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers

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Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

Figure 2.5 Examples of agent types and their PEAS descriptions.

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