GHENT UNIVERSITY

FACULTY OF ENGINEERING AND ARCHITECTURE

E016350 - Artificial Intelligence

Lecture 13
Part 1

Problem-solving agents

Intelligent agents

Aleksandra Pizurica

Ghent University
Fall 2024

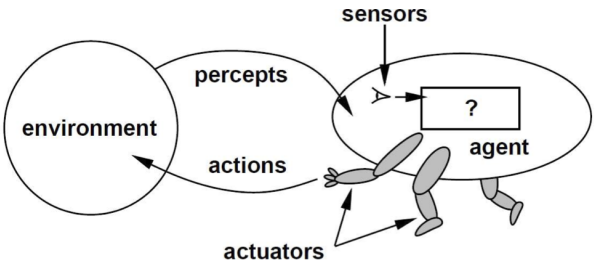
Overview

- Agents and environments
- Agent types

[R&N], Chapter 2

This presentation is based on: S. Russel and P. Norvig: *Artificial Intelligence: A Modern Approach*, (Fourth Ed.), denoted as [R&N] and the resource page http://aima.cs.berkeley.edu/

Intelligent agents



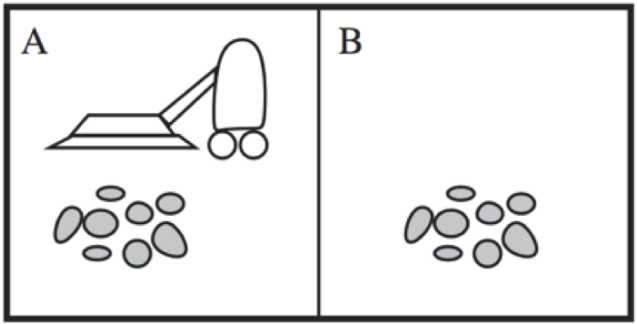
Agents include humans, robots, softbots, thermostats, etc.

The agent function maps from percept histories to actions:

$$f : \mathcal{P}^* \to \mathcal{A}$$

The agent program runs on a physical architecture to produce f.

Example: Vacuum cleaner world



Percepts: location and contents, e.g., $[A, Dirty]$
Actions: $Left$, $Right$, $Suck$, $NoOp$

Example: Vacuum cleaner world

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

function REFLEX-VACUUM-AGENT([*location*,*status*]) **returns** an action

if *status* = *Dirty* **then return** *Suck*
else if *location* = *A* **then return** *Right*
else if *location* = *B* **then return** *Left*

What is the **right** function?
Can it be implemented in a small program?

Rationality

Fixed **performance measure** evaluates the **environment sequence**

- one point per square cleaned up in time T?
- one point per clean square per time step, minus one per move?
- penalize for $> k$ dirty squares?

Definition (Rational action)

Rational action is the action that maximizes the expected value of the performance measure given the percept sequence to date.

- Rational $\neq$ omniscient – percepts may not supply all relevant information
- Rational $\neq$ clairvoyant – action outcomes may not be as expected
- Hence, rational $\neq$ successful

Rational $\Rightarrow$ **exploration**, **learning**, **autonomy**

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .
Environment??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .
Environment?? Belgian streets, traffic, pedestrians, weather, . . .

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .
Environment?? Belgian streets, traffic, pedestrians, weather, . . .
Actuators??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .
Environment?? Belgian streets, traffic, pedestrians, weather, . . .
Actuators?? steering, accelerator, brake, horn, speaker/display, . . .
Sensors??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an automated taxi:

Performance measure?? safety, destination, profits, legality, comfort, . . .
Environment?? Belgian streets, traffic, pedestrians, weather, . . .
Actuators?? steering, accelerator, brake, horn, speaker/display, . . .
Sensors?? video, accelerometers, gauges, engine sensors, keyboard, GPS, . . .

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure?? price, quality, appropriateness, efficiency . . .

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure?? price, quality, appropriateness, efficiency . . .
Environment??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure?? price, quality, appropriateness, efficiency . . .
Environment?? current and future WWW sites, vendors, shippers . . .

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure?? price, quality, appropriateness, efficiency . . .
Environment?? current and future WWW sites, vendors, shippers . . .
Actuators??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure?? price, quality, appropriateness, efficiency . . .
Environment?? current and future WWW sites, vendors, shippers . . .
Actuators?? display to user, follow URL, fill in form . . .
Sensors??

Specifying the task environment

To design a rational agent, we must specify the **task environment**.

Consider, e.g., the task of designing an internet shopping:

Performance measure?? price, quality, appropriateness, efficiency . . .
Environment?? current and future WWW sites, vendors, shippers . . .
Actuators?? display to user, follow URL, fill in form . . .
Sensors?? HTML pages (text, graphics, scripts) . . .

Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable?? Deterministic?? Episodic?? Static?? Discrete?? Single-agent??				

Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??				
Episodic??				
Static??				
Discrete??				
Single-agent??				




Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??	Yes	No	Partly	No
Episodic??				
Static??				
Discrete??				
Single-agent??				




Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??	Yes	No	Partly	No
Episodic??	No	No	No	No
Static??				
Discrete??				
Single-agent??				




Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??	Yes	No	Partly	No
Episodic??	No	No	No	No
Static??	Yes	Semi	Semi	No
Discrete??				
Single-agent??				




Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??	Yes	No	Partly	No
Episodic??	No	No	No	No
Static??	Yes	Semi	Semi	No
Discrete??	Yes	Yes	Yes	No
Single-agent??				




Specifying the task environment

	Solitaire	Backgammon	Internet shopping	Taxi
Observable??	Yes	Yes	No	No
Deterministic??	Yes	No	Partly	No
Episodic??	No	No	No	No
Static??	Yes	Semi	Semi	No
Discrete??	Yes	Yes	Yes	No
Single-agent??	Yes	No	Yes (except auctions)	No



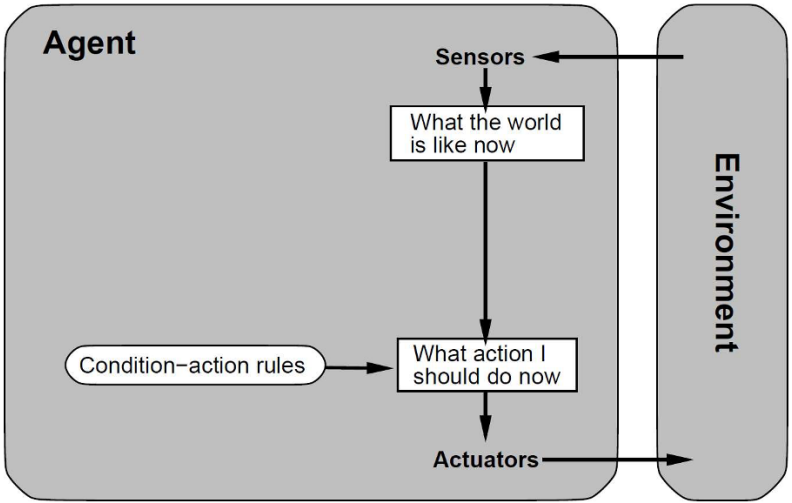

Agent types

Four basic types in order of increasing generality:

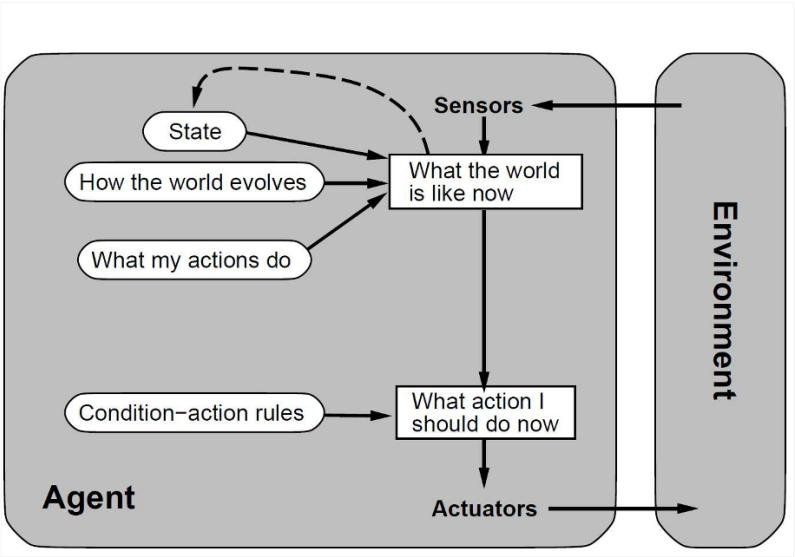
- simple reflex agents
- reflex agents with state
- goal-based agents
- utility-based agents

All these can be turned into learning agents

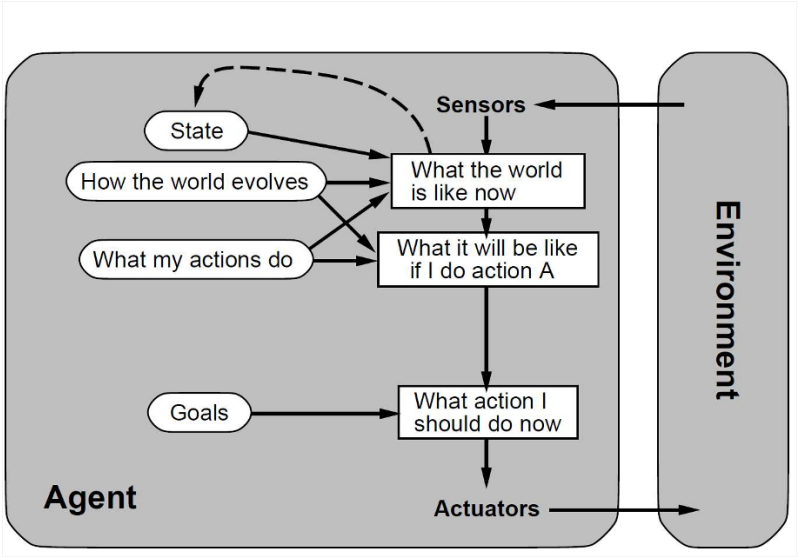
Simple reflex agents



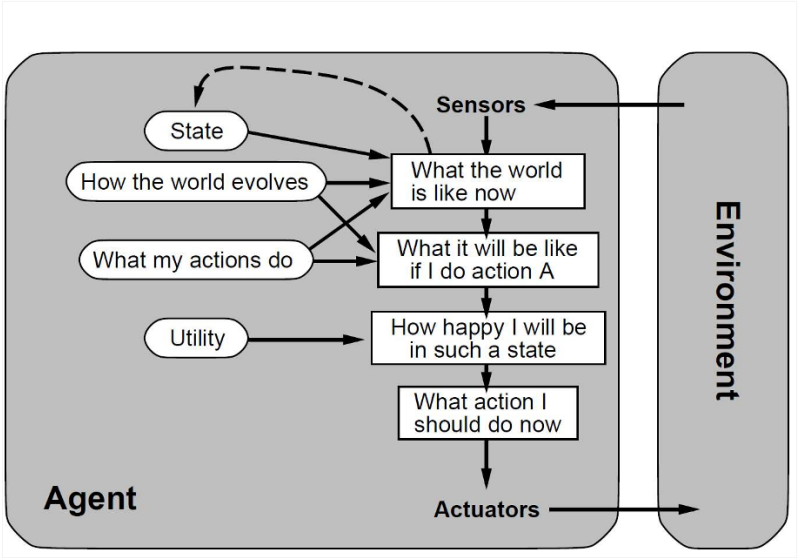
Reflex agents with state



Goal-based agents



Utility-based agents



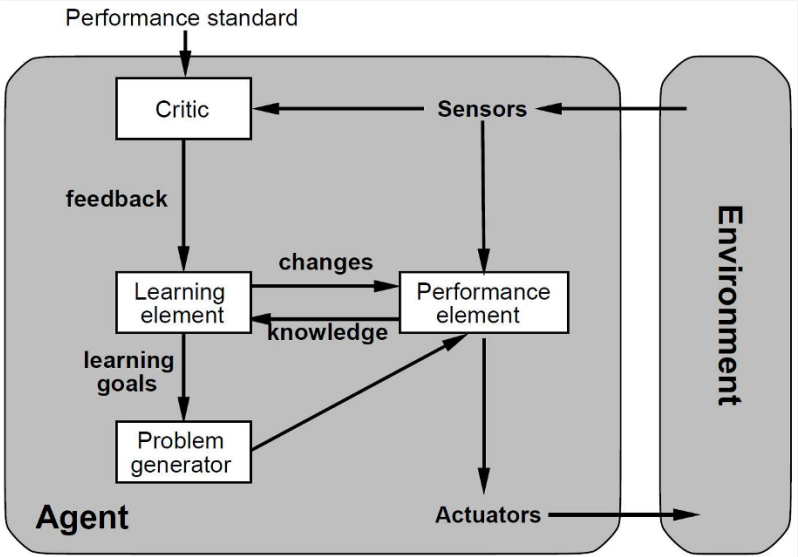
Advantages of utility-based agents

Can act rationally in two important cases where the others fail:

- Having conflicting goals
- Having several goals, none of which can be achieved with certainty

In reality, partial observability – maximizing the expected utility

Learning agents



Summary

- An agent is an entity that perceives and acts in an environment
- The agent function specifies the action taken in response to any percept sequence
- The performance measure evaluates the environment sequence
- A rational agent maximizes expected performance
- The agent program implements the agent function (designs vary in efficiency)
- In designing an agent a first step must be to specify the task environment: Performance measure, Environment, Actuators and Sensors (PEAS)
- Environments are categorized along several dimensions: observable? deterministic? episodic? static? discrete? single-agent?
- Basic agent types: reflex, reflex with state, goal-based, utility-based