

Princess Nora University
Faculty of Computer & Information Systems



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ARTIFICIAL INTELLIGENCE
(CS 370D)



Computer Science
Department



CHAPTER OUTLINE

- ✓ What is an Agent?
- ✓ What is a rational agent?
- ✓ Agent Task environments
- ✓ Different classes of agents





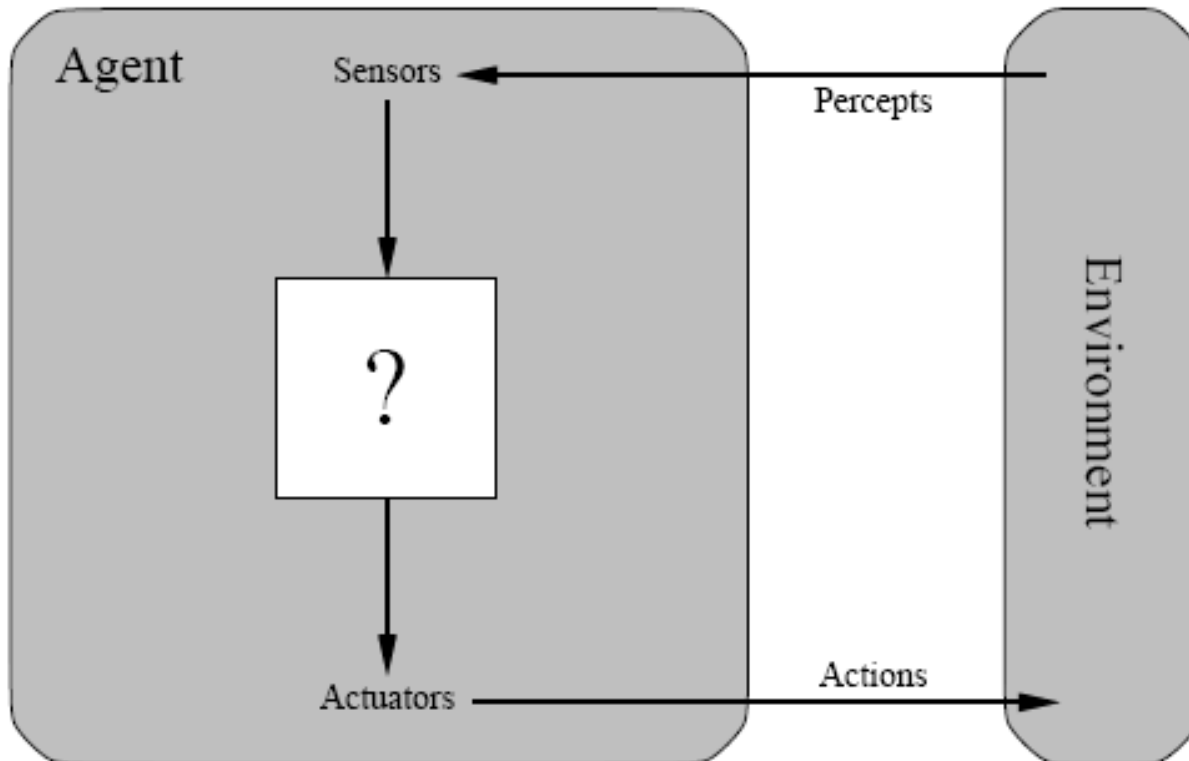
What is an Agent?





1. What is an Agent?

- Perceive the environment through sensors (→Percepts)
- Act upon the environment through actuators (→Actions)





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

- An agent percept sequence is the complete history of every thing the agent has ever perceived.

- The agent function maps from percept histories to actions:

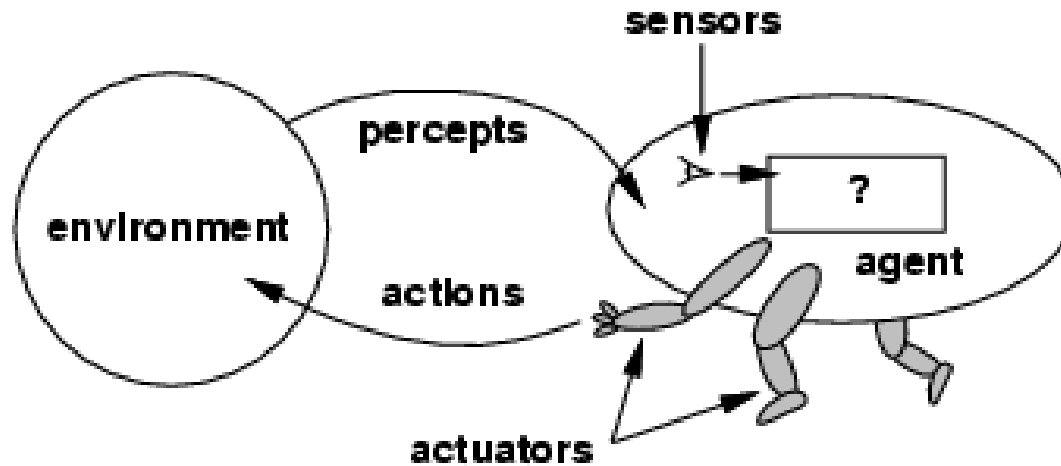
$$[f: P^* \rightarrow \mathcal{A}]$$

Is there a difference between agent function and agent program?





AGENTS



Human agent:

sensors = eyes, ears,

actuators = hands, legs, mouth,

Robotic agent:

sensors = cameras and infrared range finders for

actuators = various motors for actuators





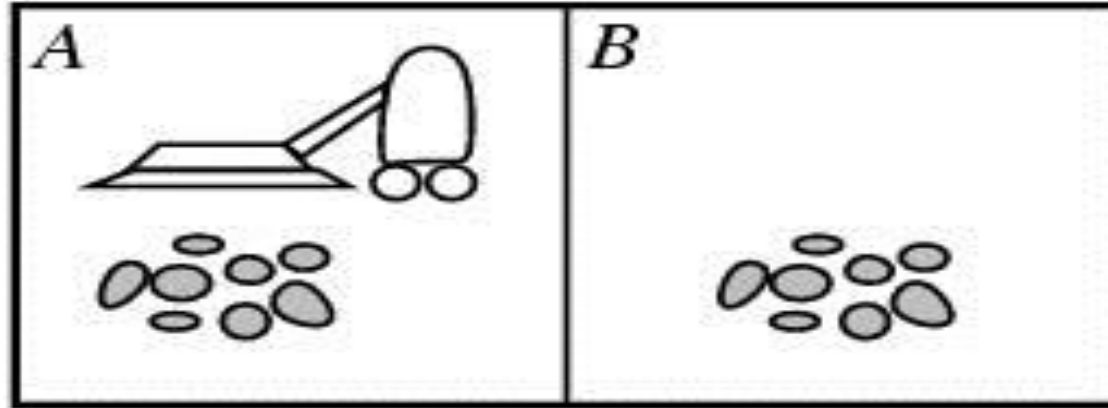
AUTONOMOUS AGENT

- One whose actions are based on both built-in knowledge and own experience
- Initial knowledge provides an ability to learn
- A truly autonomous agent can adapt to a wide variety of environments





The vacuum-cleaner world (1)

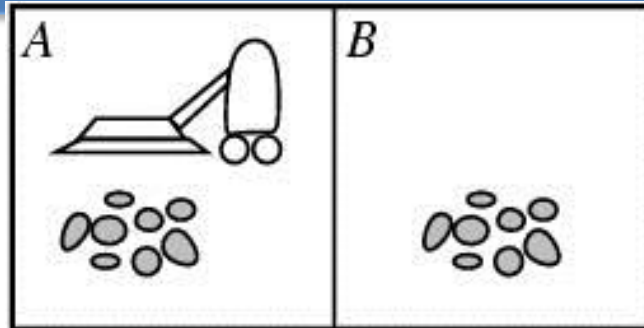


- Environment: square A and B
- Percepts: [location and content] e.g. *[A, Dirty]*
- Actions: left, right, suck, and no-op
- Agent's function → look-up table





The Vacuum-cleaner World (2)

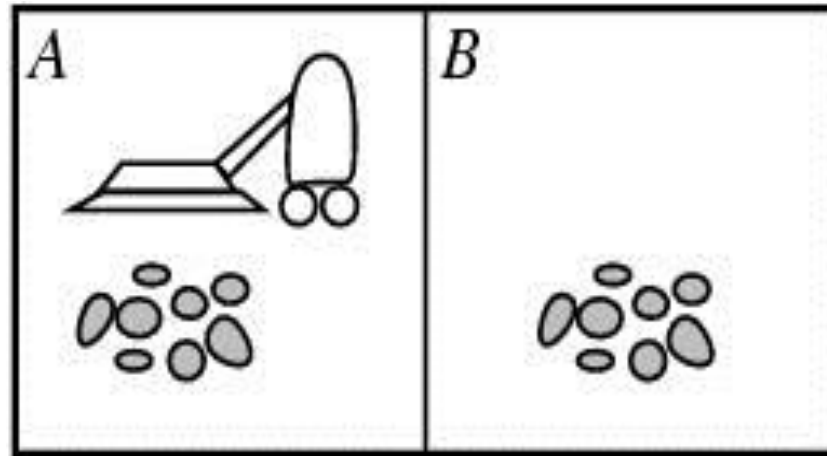


Percept sequence	Action
[A,Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck





The vacuum-cleaner world (3)



function REFLEX-VACUUM-AGENT ($[location, status]$) return an action

if $status == Dirty$ then return *Suck*

else if $location == A$ then return *Right*

else if $location == B$ then return *Left*





Rational agent?





2. Rational agent?

. . . do the \right thing"!

The right action is the one that will cause the agent to be most successful.

how and when to evaluate the agent's success.??

In order to evaluate their performance, we have to define a performance measure.

example : Autonomous vacuum cleaner

- m² per hour
- Level of cleanliness
- Energy usage
- Noise level
- Safety (behavior towards hamsters/small children)





Ideal 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

Rational behavior is dependent on

1. Performance measures (goals)
2. Percept sequences up to date
3. The agent prior Knowledge of the environment
4. Possible actions





Optimal behavior is often unattainable (not totally achieved)

- Not all relevant information is **perceivable**
 - Complexity of the problem is too high
-
- Active perception is necessary to avoid trivialization.
 - The ideal rational agent acts according to the function

Percept Sequence \times World Knowledge \rightarrow Action





Structure of Rational Agents

- **Agent program**, executed on an
- **Architecture** which also provides an interface to the environment (percepts, actions)

→ Agent = Architecture + Program





Rationality vs. Omniscience

- An **omniscient agent** knows the **actual effects** of its **actions** and it is impossible in real world
- In comparison, **a rational agent** behaves according to its percepts and knowledge and attempts to maximize the expected performance
- **Example**: If I look both ways before crossing the street, and then as I cross I am hit by a car, I can hardly be accused of lacking rationality.



Omniscient =have all the knowledge





Agent Task environments





Task Environment

- Before we design an intelligent agent, we must specify its “task environment”:

PEAS:

Performance measure

Environment

Actuators

Sensors





Task Environment (cont..)

- **Example:** Agent = robot driver in DARPA Challenge
 - Performance measure:
 - Time to complete course
 - Environment:
 - Roads, other traffic, obstacles
 - Actuators:
 - Steering wheel, accelerator, brake, signal, horn
 - Sensors:
 - Optical cameras, lasers, sonar, accelerometer, speedometer, GPS, odometer, engine sensors,





Examples of Rational Agents

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	healthy patient, costs, lawsuits(court cases)	patient, hospital, stuff	display questions, tests, diagnoses, treatments,	keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	correct image categorization	downlink from orbiting satellite	display categorization of scene	color pixel arrays
Part-picking robot	percentage of parts in correct bins(books)	conveyor belt with parts, bins	jointed arm and hand	camera, joint angle sensors





Examples of Rational Agents

Agent Type	Performance Measure	Environment	Actuators	Sensors
Refinery controller معمل تكرير	purity, 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 exercises, suggestions, corrections	keyboard entry
web crawling agent	did you get only pages you wanted	User, internet	Display related info	keyboard entry





Properties of Task Environment or Types

- Fully observable vs. partially observable
- Deterministic vs. stochastic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single agent vs. multi agent





Fully observable vs. partially observable

- **fully observable** : if an agent's sensors give it access to the **complete** state of the environment at each point in time.
- agent need not maintain any internal state to keep track of the world.

- An environment might be **partially observable** because of
 - ❖ **noisy** and inaccurate sensors
 - ❖ or because parts of the state are simply missing from the sensor data
 - ❖ Examples: vacuum cleaner with local dirt sensor.





Deterministic vs. stochastic

- **deterministic** Environment : if the **next state** of the environment is **completely** determined by the **current state** and the action executed by the agent.
 - **EX:** Vacuum cleaner is **Deterministic** why?
 - **Ex:** Taxi driving agent (robot driving agent) is stochastic, why?
 - He doesn't know about traffic, can never predict traffic situation



Stochastic= connected to random events





Episodic vs. sequential:

- **Episodic** An agent's action is divided into atomic episodes. Each episode perceives then takes action (this action depends on this episode) and the next episode does not rely on the previous one in taking the right action.

EX: classification tasks,

- **Sequential:** the current decision could affect all future decisions

EX: chess and taxi driver





Static vs. dynamic:

➤ **Static environment** is **unchanged** while an agent is deliberating

- ❑ it is easy to deal with because the agent need not keep looking at the world while it is deciding on the action or need it worry about the passage of time
- ❑ EX :crossword puzzles are static

➤ **Dynamic environments:** continuously ask the agent what it wants to do

Ex: taxi driving is dynamic





Discrete vs. Continuous:

- **Discrete** : A limited number of distinct, clearly defined states, percepts and actions.
 - ❖ Ex: Chess has finite number of discrete states, and has discrete set of percepts and actions.

- **Continuous** : not limited
 - ❖ Taxi driving has continuous states, and actions





Single agent vs. multi-agent:

- An agent operating by itself in an environment is single agent
 - **EX:** Crossword is a single agent
 - **Ex:** chess is a competitive multi-agent environment





Environment types

- **The simplest environment is**

- ▣ Fully observable, deterministic, episodic, static, discrete and single-agent.

- **Most real situations are:**

- Partially observable, stochastic, sequential, dynamic, continuous and multi-agent.





Different classes of agents

1. Simple Reflex agents
2. Model based Reflex agents
3. Goal Based agents
4. Utility Based agents





1- Simple Reflex Agent

```
function SIMPLE-REFLEX-AGENT(percept) returns an action  
persistent: rules, a set of condition–action rules  
  
state ← INTERPRET-INPUT(percept)  
rule ← RULE-MATCH(state, rules)  
action ← rule.ACTION  
return action
```

• **Reflex agents** respond **immediately** to percepts.

➤ Select actions on the basis of the current percept, ignoring the rest of the percept history

➤ **Ex** vacuum cleaner , why?

Because its decision based only on the current location and whether it contain dirt or not.





2- Model-based Reflex Agents

function MODEL-BASED-REFLEX-AGENT(*percept*) **returns** an action

persistent: *state*, the agent's current conception of the world state

model, a description of how the next state depends on current state and action

rules, a set of condition–action rules

action, the most recent action, initially none

state ← UPDATE-STATE(*state*, *action*, *percept*, *model*)

rule ← RULE-MATCH(*state*, *rules*)

action ← *rule*.ACTION

return *action*

- The most effective way to handle **partial observably**
- In case the **agent's history in perception** in addition to the actual percept is required to **decide on the next action**, it must be represented in a suitable form. [model]





3- Goal-based Agents

- **Goal-based agents** work towards goals.
- Often, **percepts alone are insufficient** to decide what to do.
- This is because the correct action depends on the given **explicit goals** (e.g., go towards X).
- **The goal-based agents** use an explicit representation of goals and consider them for the choice of actions.
- **Ex** : taxi driving destination , vacuum cleaner





4- Utility-based Agents

- Usually, there are **several possible actions** that can be taken in a given situation.
- **Utility-based agents** take action that maximize their reward.
- A **utility function** maps a state (or a sequence of states) onto a real **number**. The agent can also use these **numbers** to **weigh the importance of competing goals**.
- Ex taxi driving , may be many paths lead to goal but some are quicker, cheaper, safer





Learning Agents

- **Learning agents** improve their behavior over time
- Learning agents can become **more competent over time.**
- They can start with an initially **empty knowledge base.**
- They can operate in initially **unknown environments.**

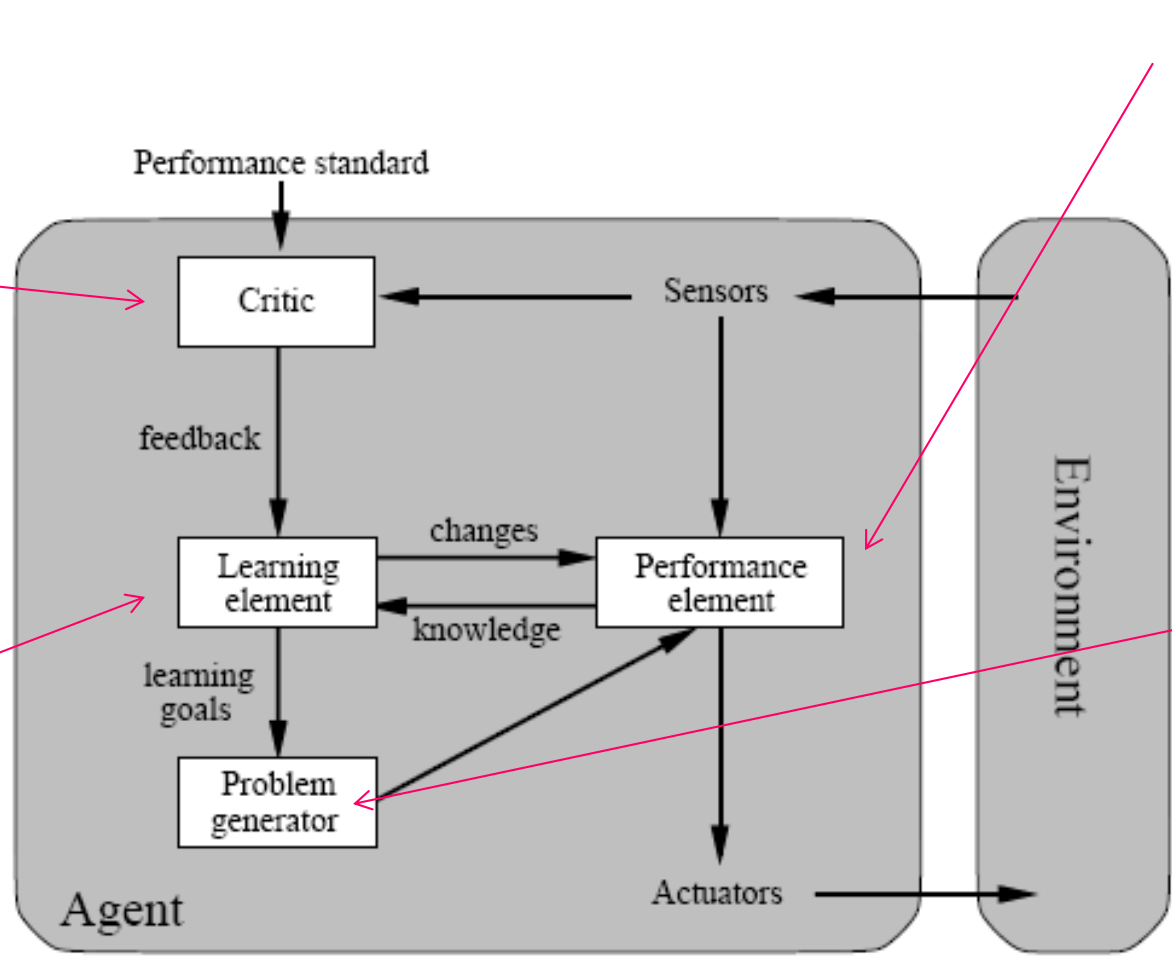




Learning Agents

determines the performance of the agent:
percept only
doesn't provide how much is the agent is successful

responsible for making improvements



take percept and decide an action

suggests exploratory actions that will lead to new informative experiences



Thank you



**End of
Chapter 2**

