Introduction to Artificial Intelligence

DA 221

Jan - May 2023

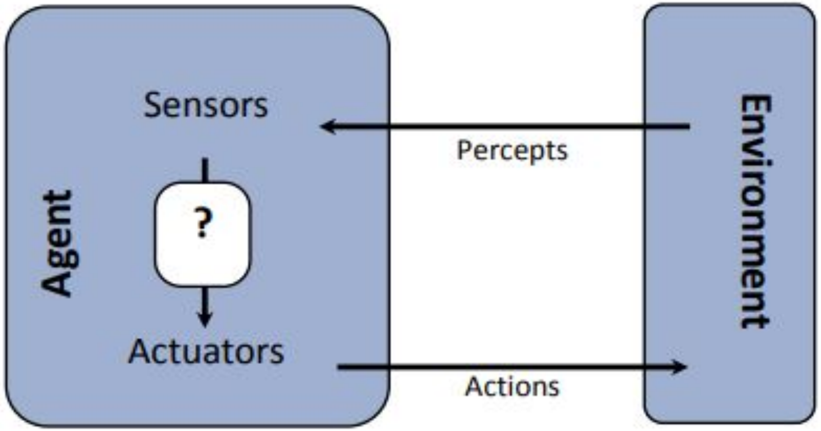
IIT Guwahati

Instructors: Neeraj Sharma & Arghyadip Roy

Lecture 3

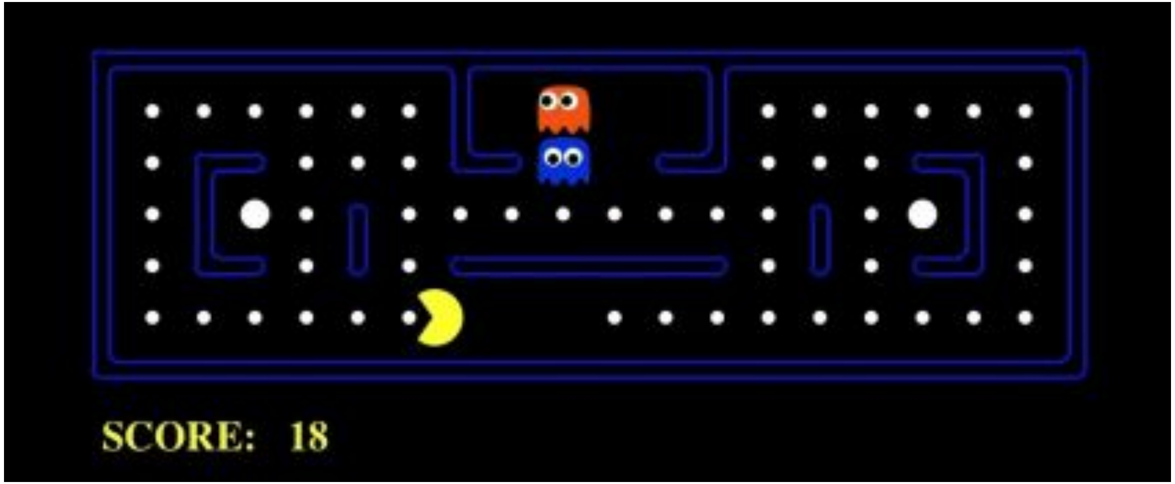
Agents

An agent is an entity that perceives its environment through sensors and take actions through actuators.

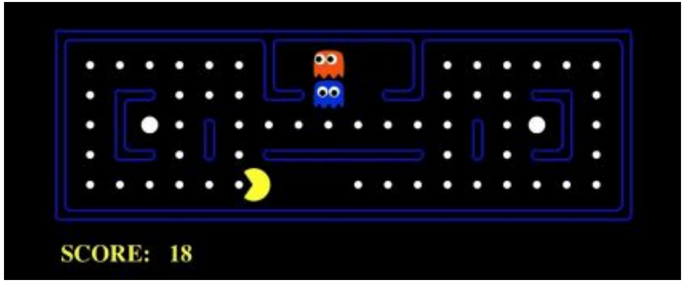


Pacman

Percept sequence	Action
(left cell, no food)	go right
(left cell, food)	eat
(right cell, no food)	go left
(left cell, food)	eat
(left cell, no food), (left cell, no food)	go right
(left cell, no food), (left cell, food)	eat
(...)	(...)



Pacman



- The optimal Pacman?
- What is the right agent function?
- How to formulate the goal of Pacman?
  - 1 point per food dot collected up to time ?
  - 1 point per food dot collected up to time , minus one per move?
  - Penalize when too many food dots are left not collected?
- Can it be implemented in a small and efficient agent program?

Rational Agent

- Informally, a rational agent is an agent that does the "right thing".
- A performance measure evaluates a sequence of environment states caused by the agent's behavior.
- A rational agent is an agent that chooses whichever action that maximizes the expected value of the performance measure, given the percept sequence to date.

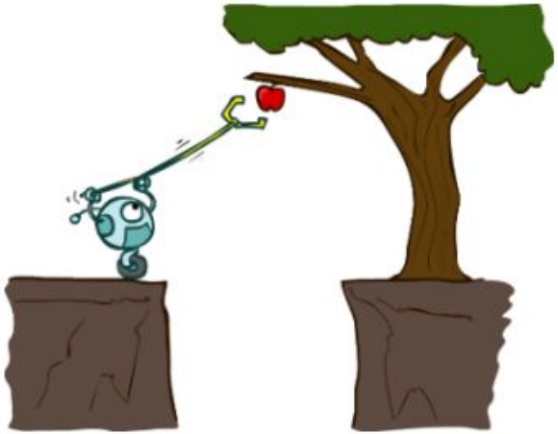


Image credits: CS188, UC Berkeley

Rational Agent

- Rationality is not equal to omniscience
  - percepts may not supply all relevant information
- Rationality is not equal to clairvoyance action
  - outcomes may not be as expected
- Rational is not equal to successful

Rationality leads to exploration, learning and autonomy.

Some tasks

Example 1: a self-driving car

- performance measure: safety, destination, legality, comfort, ...
- environment: streets, highways, traffic, pedestrians, weather, ...
- actuators: steering, accelerator, brake, horn, speaker, display, ...
- sensors: video, accelerometers, gauges, engine sensors, GPS, ...

Adapted: Introduction to Artificial Intelligence, ULiege

Some tasks

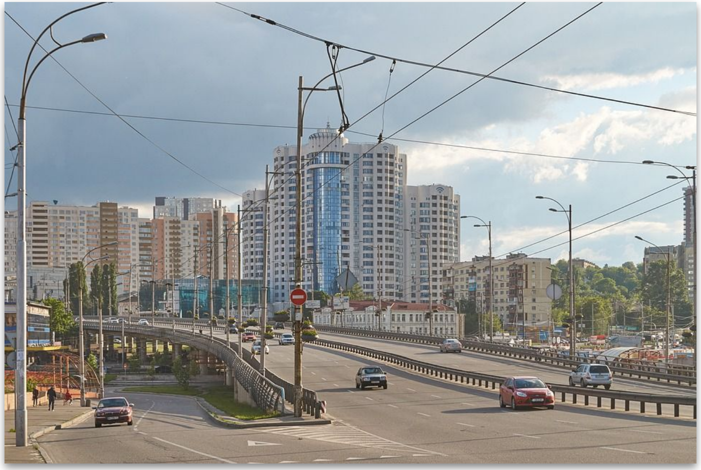
Example 2: an Internet shopping agent

- performance measure: price, quality, appropriateness, efficiency
- environment: current and future WWW sites, vendors, shippers
- actuators: display to user, follow URL, fill in form, ...
- sensors: web pages (text, graphics, scripts)

Adapted: Introduction to Artificial Intelligence, ULiege

Let’s define a problem

Let’s define a problem



A cab driver driving through traffic

A problem

- Define a problem space
  - Are there sub-problems?
- Task

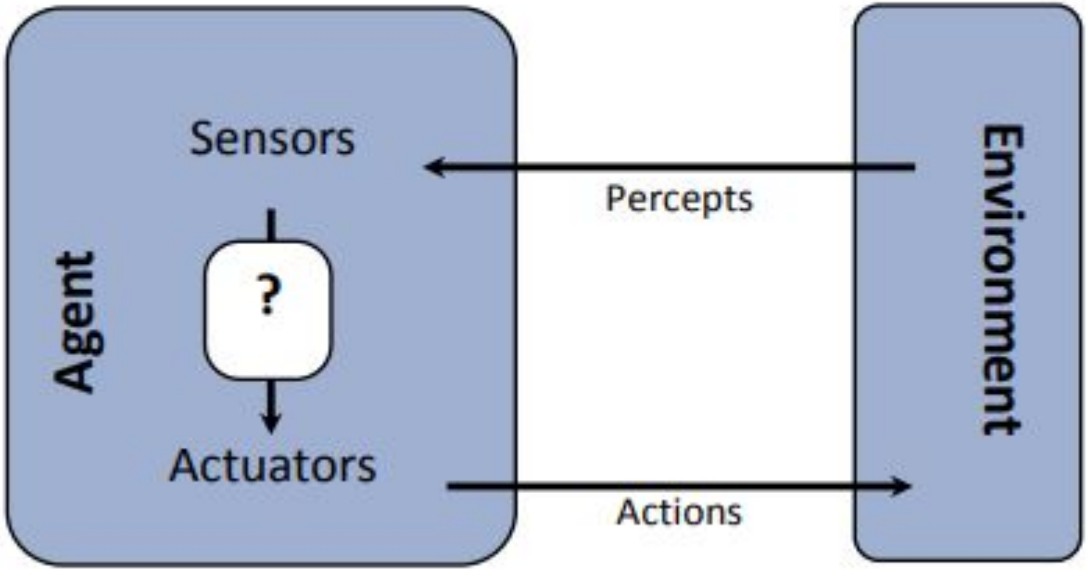
A problem

- Goal
- Constraints
- Task

A problem

- Goal
- Constraints
- Task

PEAS: Performance, Environment, Actuators, and Sensors



Types of Environment

- Fully observable vs. partially observable
  - whether the agent’s sensors give access to complete state of the environment, at each point in time
- Single agent vs. multi-agent
  - whether the environment include several agents that may interact with each other
- Deterministic vs. stochastic
  - whether the next state of the environment is completely determined by the current state and action executed by the agent

Types of Environment

- Episodic vs. sequential
  - whether agent has a memory
- Static vs. dynamic
  - environment or performance measure can change with time
- Discrete vs. continuous
  - environment, percepts and actions are continuous
- Known vs unknown
  - Reflects the agent’s state of knowledge about the environment

Types of Environment

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

- Crossword puzzle
- Chess, with a clock
- Poker
- Backgammon
- Taxi driving
- Medical diagnosis
- Image analysis
- Part-picking robot
- Refinery controller
- The real world

Agent programs

- tables
- rules
- search algorithms
- learning algorithms

Agent Types

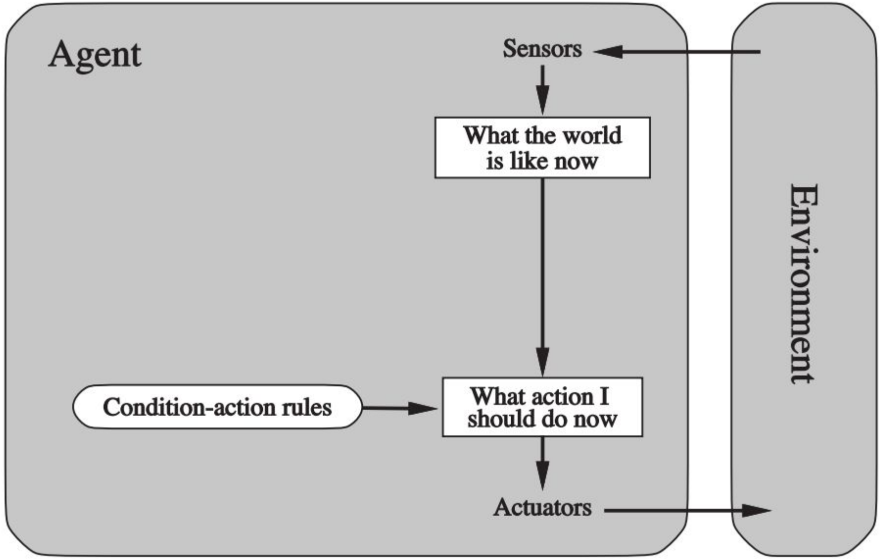
- Simple reflex agents
- Model-based reflex agents
- Goal based agents
- Utility based agents
- Learning agents

Simple reflex agents

- They implement condition-action rules that match the current percept to an action
- Rules provide a way to compress the function table

Example (autonomous car): If a car in front of you slow down, you should break. The color and model of the car, the music on the radio or the weather are all irrelevant.

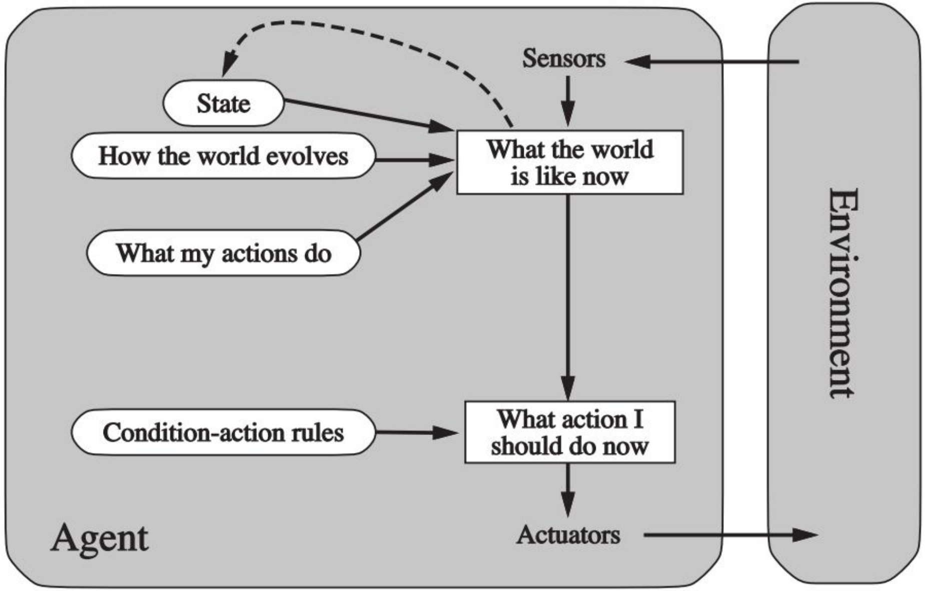
- Works in a Markovian environment, that is if the correct decision can be made on the basis of only the current percept.
- The environment is fully observable



Model based agents

Model-based agents handle partial observability of the environment

- internal state of model-based agents is updated on the basis of a model
- keeps tracks of:
  - how the environment evolves independently of the agent;
  - how the agent actions affect the world.



Can we do better?

Planning agents:

- ask "what if?"
- make decisions based on (hypothesized) consequences of actions
- must have a model of how the world evolves in response to actions
- must formulate a goal

Goal based agents

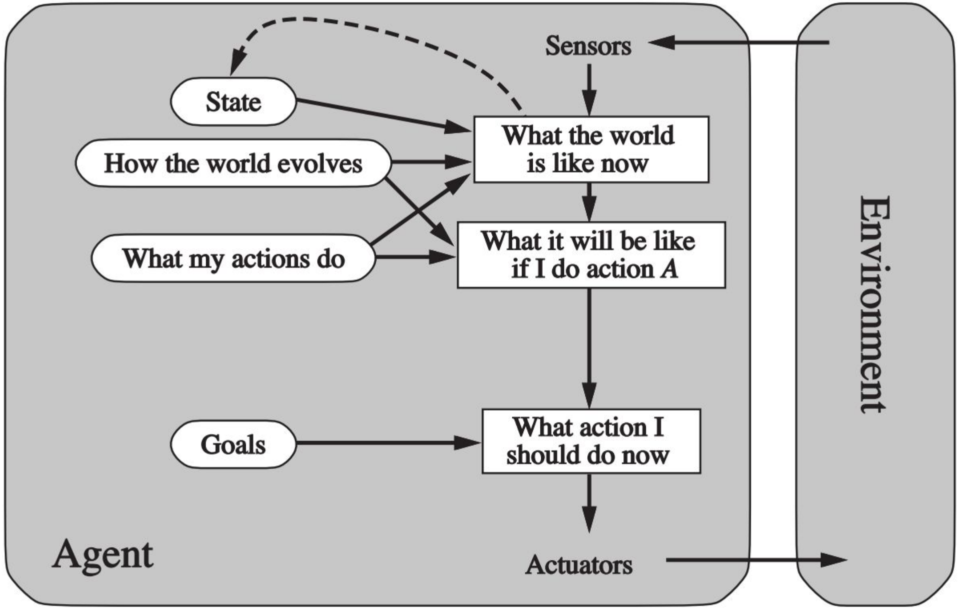
Decision process:

- generate possible sequences of actions
- predict the resulting states
- assess goals in each

A goal-based agent chooses an action that will achieve the goal:

- goals are more general than rules
- finding action sequences that achieve goals is difficult. Search and planning are two strategies.

- Example (autonomous car): reach destination



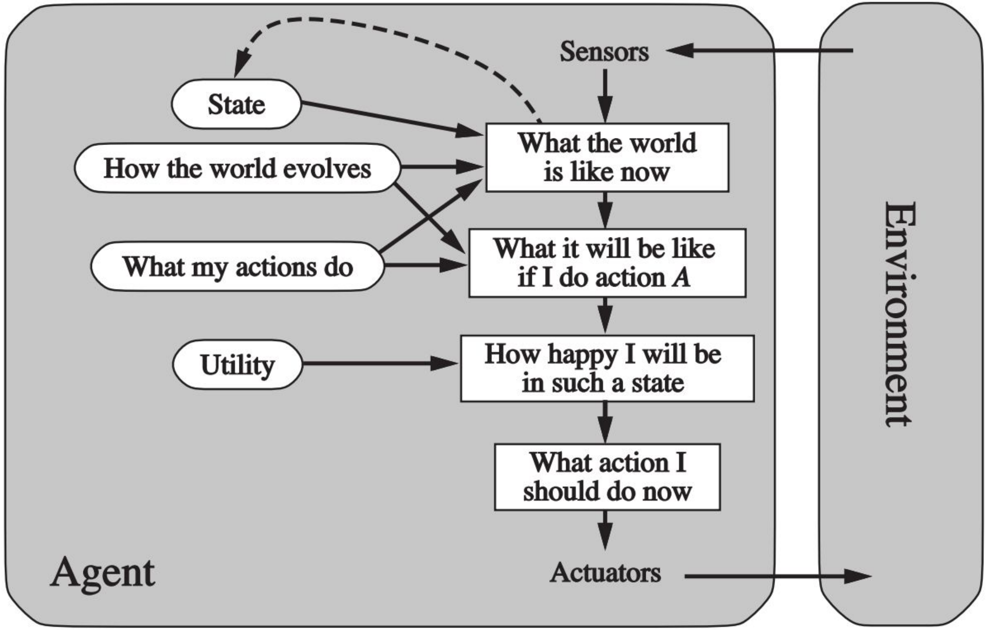
Utility based agents

Goals are often not enough to generate high-quality behavior.

- Example (autonomous car): There are many ways to arrive to destination, but some are quicker or more reliable.
- Goals only provide binary assessment of performance.

A utility function scores any given sequence of environment states.

- internalization of the performance measure.
- a rational utility-based agent chooses an action that maximizes the expected utility of its outcomes

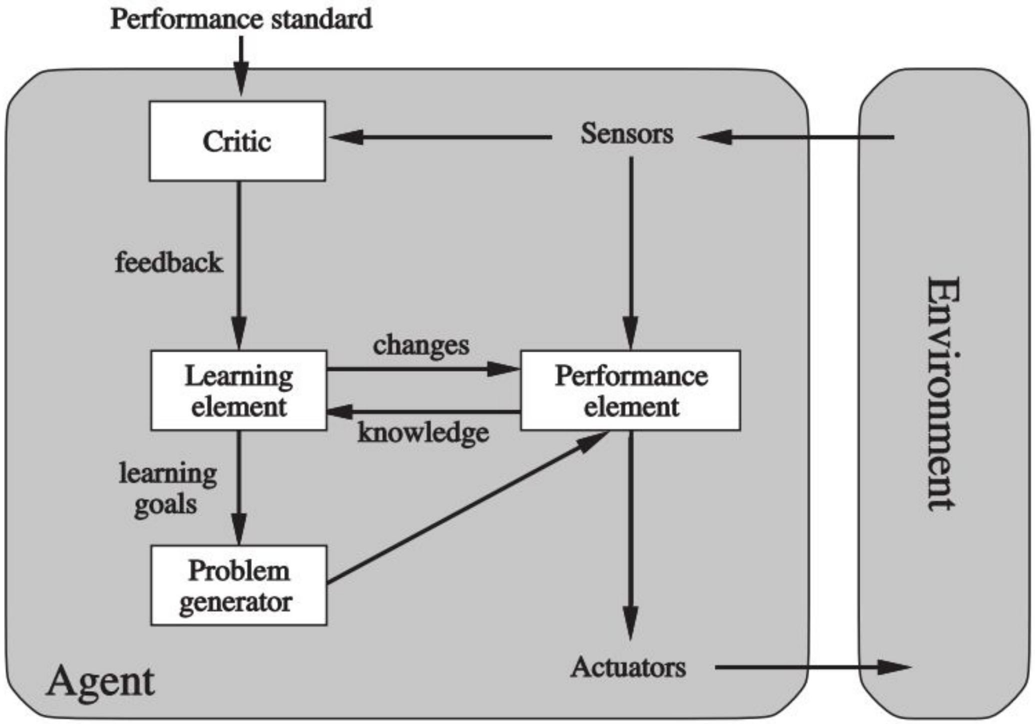


Learning based agents

- Learning agents are capable of self-improvement
- They can become more competent than their initial knowledge alone might allow

They can make changes to any of the knowledge components by:

- learning how the world evolves;
- learning what are the consequences of actions;
- learning the utility of actions through rewards



Summary