
ARTIFICIAL INTELLIGENCE
الذكاء الإصطناعي

AI: Subject matter

- Coefficient : 3 Credit : 6
- Mandatory attendance – All classes(cours, TD)
- Evaluation :
  - Attendance/5,
  - Participation/3,
  - Interrogation/7,
  - Oral report/5
- Links:
  - Blog: http://intelligencedz.blogspot.com
  - E-mail: mistudents14@gmail.com
  - Course: elearning.univ-km.dz

References

- Artificial intelligence: a modern approach. Stuart Russel and Peter Norvig (1151 p)
  - 2010. 3rd PEARSON ed. https://github.com/AzatAI/cs_books/blob/master/Artificial Intelligence A Modern Approach.pdf
  - 2022. 4th US ed. https://aima.cs.berkeley.edu/

- Intelligence artificielle pour les développeurs. Concepts et implémentations en C# Virginie Mathivet (512 p)
  - 2014. 3rd ENI ed. http://livre21.com/LIVREF/F1/F001110.pdf

DeepLearning.AI https://www.deeplearning.ai/

towards data science https://towardsdatascience.com/

PLAN

- Chapter 1 : AI & intelligent agents
- Chapter 2 : Search algorithms & problem solving
  - A*, Local search, MiniMax, $\alpha - \beta$ pruning
- Chapter 3 : Constraint satisfaction problems (CSP)
  - Backtracking search, Forward checking
- Chapitre 4 : Machine learning & classification
  - KNN, ANN
- Chapter 5 : Probabilistic reasoning
  - Bayes method, HMM
- Chapter 6 : Natural language processing

CHAPTER I

AI & INTELLIGENT AGENTS

AI: Definition

Artificial intelligence leverages computers and machines to mimic the problem-solving and decision-making capabilities of the human mind

"It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable." *[John McCarthy, 2004]**

** What is Artificial intelligence, John McCarthy, 2004. https://www-formal.stanford.edu/jmc/whatisai.pdf*

AI: Two approaches

- Human approach :
  - Systems that think like humans
  - Systems that act like humans

Computational neuroscience: developing mathematical models of how the brain functions at the neuronal level

- Ideal approach :
  - Systems that think rationally
  - Systems that act rationally

Cognitive science, psychology: understanding human reasoning and predicting human performance on a task

AI: History

1950

Alan Turing

Computing machinery and intelligence.

Can machines think ?

Turing Test

1956

J. McCarthy

Artificial Intelligence (AI)

Lisp language

1967

Frank Rosenblatt

Mark1 Perceptron

First neural net

1980

Backpropagation algorithm

Neural nets widely used in AI apps

1997

Deep Blue

IBM's Deep Blue beats the world chess champion Garry Kasparov

2015

Deep neural networks

Convolutional neural networks

2017

Transformer-based models

Attention is all you need

2023

Generative AI

Large Language Models (LLMs)

T5, GPT, BARD

Types of AI

- Narrow AI : Artificial Narrow Intelligence (ANI)
  - Trained and focused to perform specific tasks
  - Apps : Dialog systems, Chatbots, Data generator, Pattern recognition, …

- General AI : Artificial General Intelligence (AGI)
  - Machine would have an intelligence equaled to humans

    (Consciousness, Solve problems, learn and plan for the future,…)

  - **Future :** Artificial Super Intelligence (ASI) : to surpass the human brain ability..

AI Applications

- NLP : Natural Language Processing

  - Text analysis, Text generation, Speech recognition, Speech synthesis, …

- Computer vision :

  - Image and video processing, Pattern recognition, Radiology imaging, Self-driving cars,…

- Customer service and recommendation engines

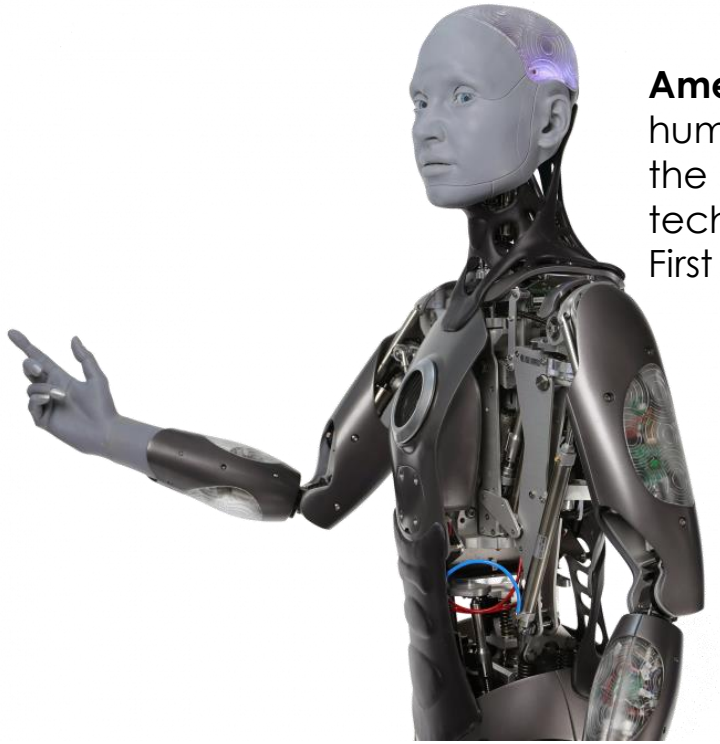
  - Virtual **agents** replace the human agent along the customer journey

  - Use past consumption behavior data to discover data trends

➢ Technologies : Classification algorithms, Machine learning, Deep learning, Generative AI,..

AI Agent

An intelligent agent (IA) is an autonomous computer program that **perceives** (using sensors) its environment and **acts** (using actuators) on it in order to reach a specific goal. It is based on AI technologies, and takes various forms, from computer software to autonomous connected object.



Ameca is the world's most advanced human shaped robot representing the forefront of human-robotics technology.
First public demo: Jan. 2022

Human agent vs AI agent

- **Humain agent :**
  - Eyes, Ears and other sensors
  - Hands, legs and other actuators
- **Robot :**
  - Cameras, infra-red sensor and other sensors
  - Wheels, legs, articulated arms and other actuators
- **Software agent :**
  - Keyboard, hard disk access reader and other sensors
  - Screen, hard disk access writer and other actuators

Tesla Optimus

September 30, 2022

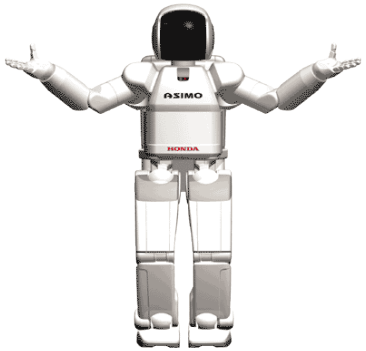
AI agent creation

- Create an agent with the fundamental capabilities:
  - Perception
  - Knowledge representation (modeling)
  - Machine learning
  - Reasoning
  - Decision making

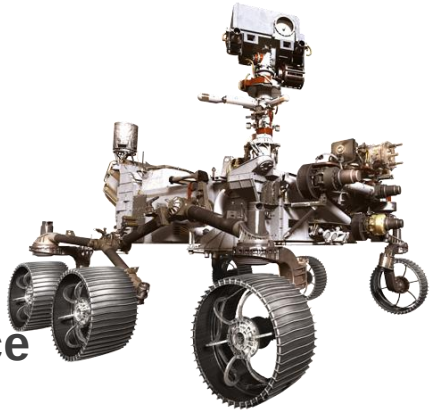
AI agent (Examples)

Kiva system

ANYmal



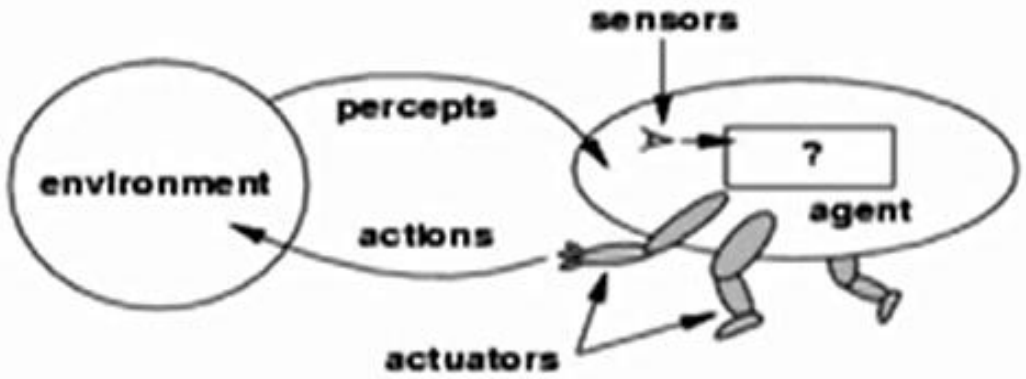
ASIMO



Perseverance

Ingenuity

Agent et environnement



- An AI agent process f takes as input a sequence of **observations** (percepts) and returns an **action**

$$f : P^* \rightarrow A$$

Agent skeleton code

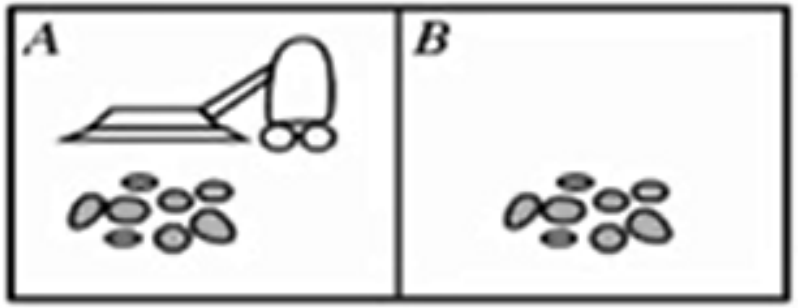
function SKELETON-AGENT(*percepts*) **{**

Static: *memory, the agent's memory of the world*

memory ← UPDATE-MEMORY(*memory,percept*)
action ← CHOOSE-BEST-ACTION(*memory*)
memory ← UPDATE-MEMORY(*memory,action*)

return *action*
}

Example : Vacuum cleaner



- Percepts : Position and room cleanliness
  - For example : [A, Clean], [A, Dirty], [B, Clean], [B, Dirty]
- Actions : *Left*, *Right*, *Suck*, *NoOp*
  - *f* :

    [A,Clean] → *Right*
    [A,Dirty] → *Suck*
    ...
    [A,Clean] [A,Clean] [A,Dirty] → *Suck*
    [A,Clean] [A,Clean] [A,Clean] → *Right*
    ...

Ideal Agent

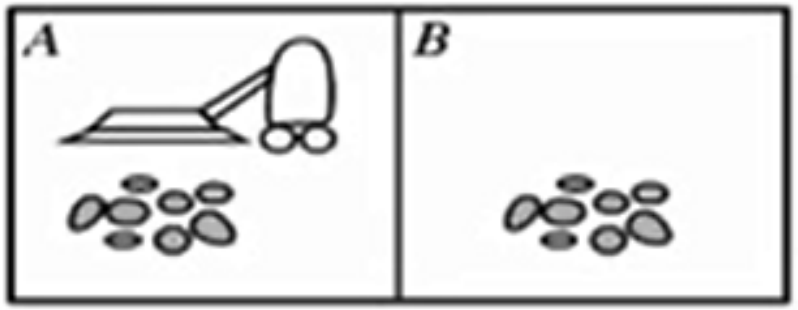
- **An ideal AI agent has to act correctly depending to what it percepts and its action ability**

  A correct action is the act that permits to the Agent to achieve better its goal

- **Performance measure :** an objective function that measures the behavior quality of an AI agent

Example : Vacuum robot

- Quantity of vacuumed waste
- Cleanliness
- Task duration
- Generated noise



- **An ideal agent :**
  - **must choose the action that maximises the performance measure**
  - **Be autonomous**

Agents Designing : PEAS Model

PEAS = *Performance, Environment, Actuators, Sensors*

- They help define the task environment for an intelligent agent by defining the following main components :
  - **P**erformance measure
  - **E**nvironment elements
  - Agent actions (**A**ctuators)
  - Agent percepts (**S**ensors)

PEAS of Automated Taxi Driver

- **Agent : Robot Taxi Driver**
  - **Performance measure :** Security, Speed, Respect of traffic Laws, Benefits maximization, Comfortable travel
  - **Environement :** Road, Traffic, Pedestrians, Passengers
  - **Actuators :** Steering wheel, Gear changer, Accelerator, Brake, Honk, Blinkers
  - **Sensors :** Cameras, Sonar, GPS, Engine light, Speedometer, Odometer,

PEAS of Automated Sales manger

- **Agent : Virtual sales manager**
  - **Performance measure :** Increase sales, maximize return
  - **Environement :** Sales, Customers, Salesmen
  - **Actuators :** Output files
  - **Sensors :** Input files

PEAS of Tomato classification agent

- **Agent : Tomato classification system**
  - **Performance measure :** How successful the agent is classifying the tomatoes (Accuracy)
  - **Environement :** A moving walkway through which the tomates are passed on for segregation
  - **Actuators :** Segregation machanism
  - **Sensors :** Cameras, Weighing sensors, Color sensing

Environnement characteristics

- **Each problem has an environment with specific characteristics:**
  - Fully observable vs Partially observable
  - Deterministic vs Stochastic
  - Episodic vs Sequential
  - Static vs Dynamic
  - Discrete vs Continuous
  - Single-agent vs Multi-agent

Environnement characteristics

- **Fully observable :** Thanks to its sensors, the agent has a complete access to the environment in each time (**vs Partially observable**)
  - Chess game (Fully observable): We can see the position of each piece
  - Pocker game (Partially observable): We can't see the cards in the hands of the other players
- **Deterministic :** The next state of the environment is completly determined by the current one (**vs Stochastic**)
  - Chess game (Deterministic): Move a piece gives always the same result in a specific situation
  - Pocker game (Stochastic): Random Card distribution

Environnement characteristics

- **Episodic :** Actions are divided into episodes (**vs Sequential**)

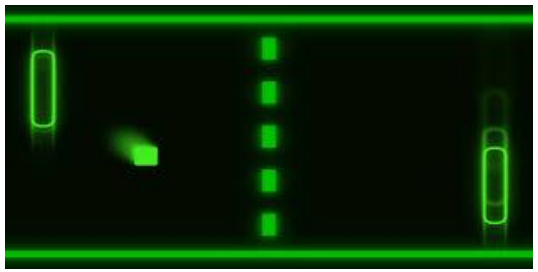
- Each episode consists of observing the environment and execute one action

- This action has no influence on the environment in the next state

  - Character recognition (Episodic): Each character is recognised independently
  - Pocker game (Sequential): Decide if I put or not the card has a direct impact on the next state of the game

- **Static :** No one acts, no change in the environment (**vs Dynamic**)

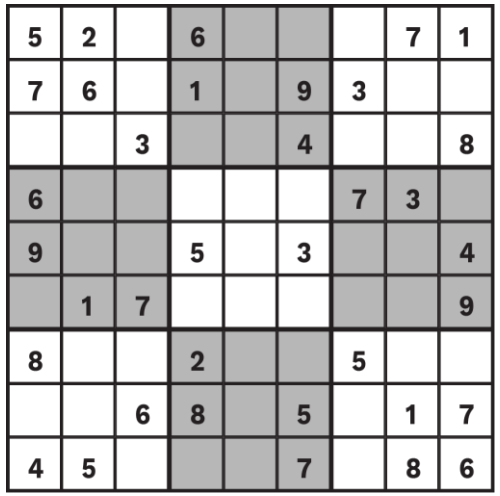
  - Chess game (Static): No one plays, no change in the game
  - Pong game (Dynamic): The ball continue moving even no one is playing



Environnement characteristics

- **Discete :** Limited number of actions and sensing data (**vs Conitnuous**)
  - Chess game (Discrete): All the states and actions can be enumerated
  - Autonomous driving (Conitnuous): Vision angle is a real number

- **Single-agent :** An agent acts alone on its environment (**vs Multi-agent**)
  - Chess game (Multi-agent): There is always another player
  - Sudoku (Single-agent): No opponent



Communication between agents

Multi-agent System

- AI agents communicate with each other to coordinate, cooperate and negotiate their activities, and they generally need to communicate their intentions, goals, results and states :

  - *Syntax :* How the symbols are structured
  - *Pragmatic :* Symbols interpretation;
  - *Ontology :* in order to use the same vocabulary.

Agents Communication language

- There are two main communication languages :
  - **KQML** (Knowledge Query and Manipulation Language)
  - **FIPA-ACL** (Foundation for Intelligent Physical Agents – Agent Communication Language)

Communication language

- Each **KQML** or **FIPA-ACL** message is mainly composed of :

  - ***Performative*** : Type of communicative act (passing information, recquisite information,…)
  - ***Sender*** : Message sender.
  - ***Receiver*** : Message reveiver.
  - ***Content*** : Message content (transported information by the performative).

Communication language

KQML message :

```
(tell
: receiver A
: sender B
: ontology e-book
: language PROLOG
: content  "price(ISBN 973-31-1096-5)")
```

ACL message :

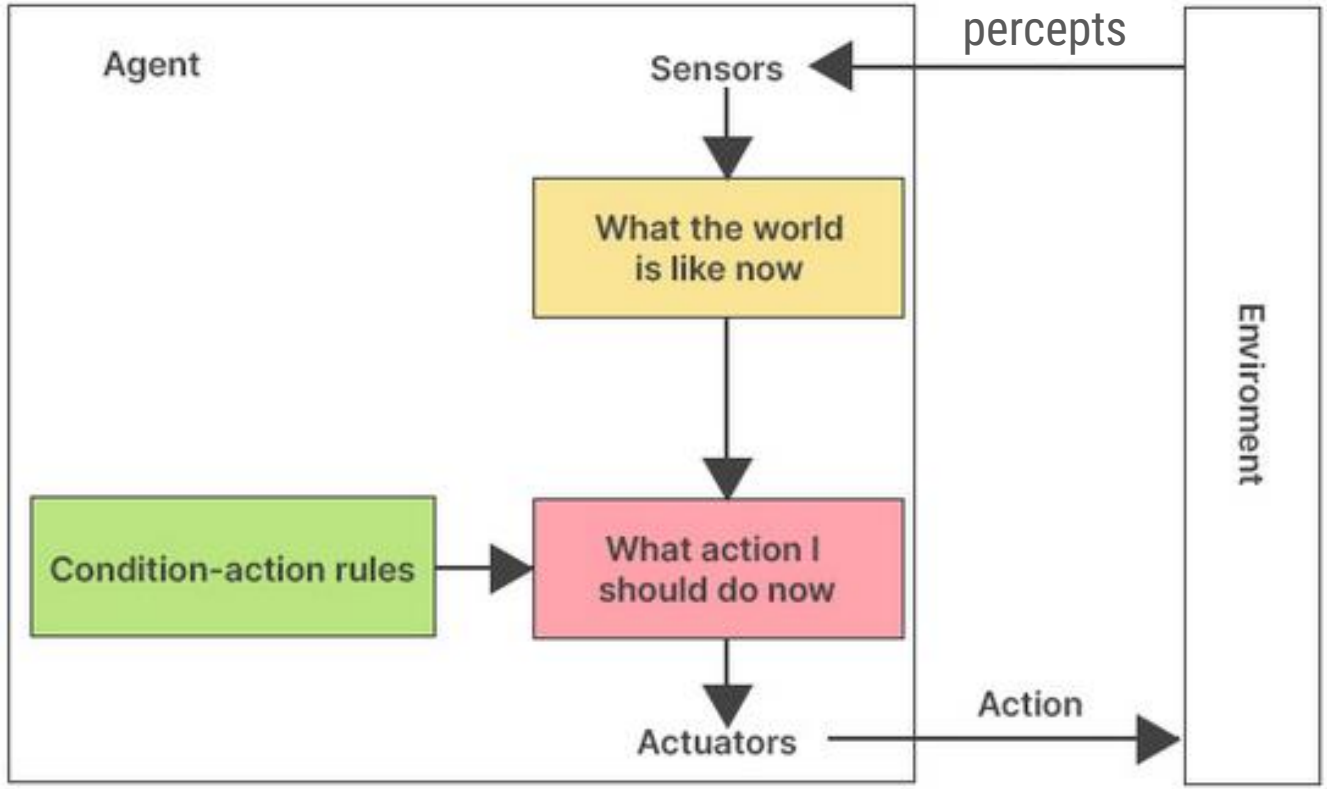
```
ACLMessage msg = new ACLMessage(ACLMessage.INFORM);
msg.setContent("I sell seashells at $10/kg");
AID dest = "ag5452";
msg.addReceiver(dest);
send(msg);
```

Types of AI agents

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

Types of AI agents

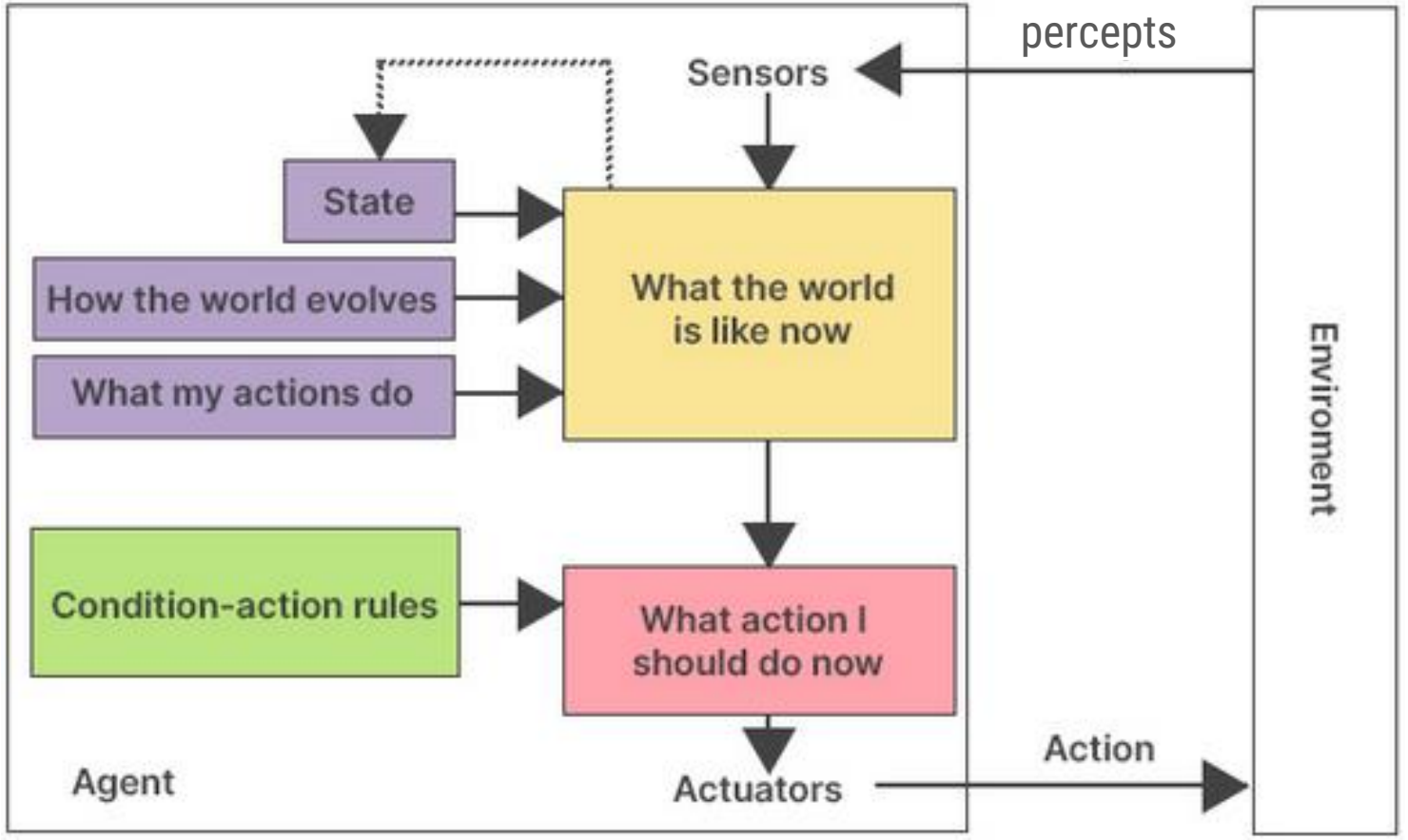
Simple reflex agents



React to the current state of the environment without considering history

Types of AI agents

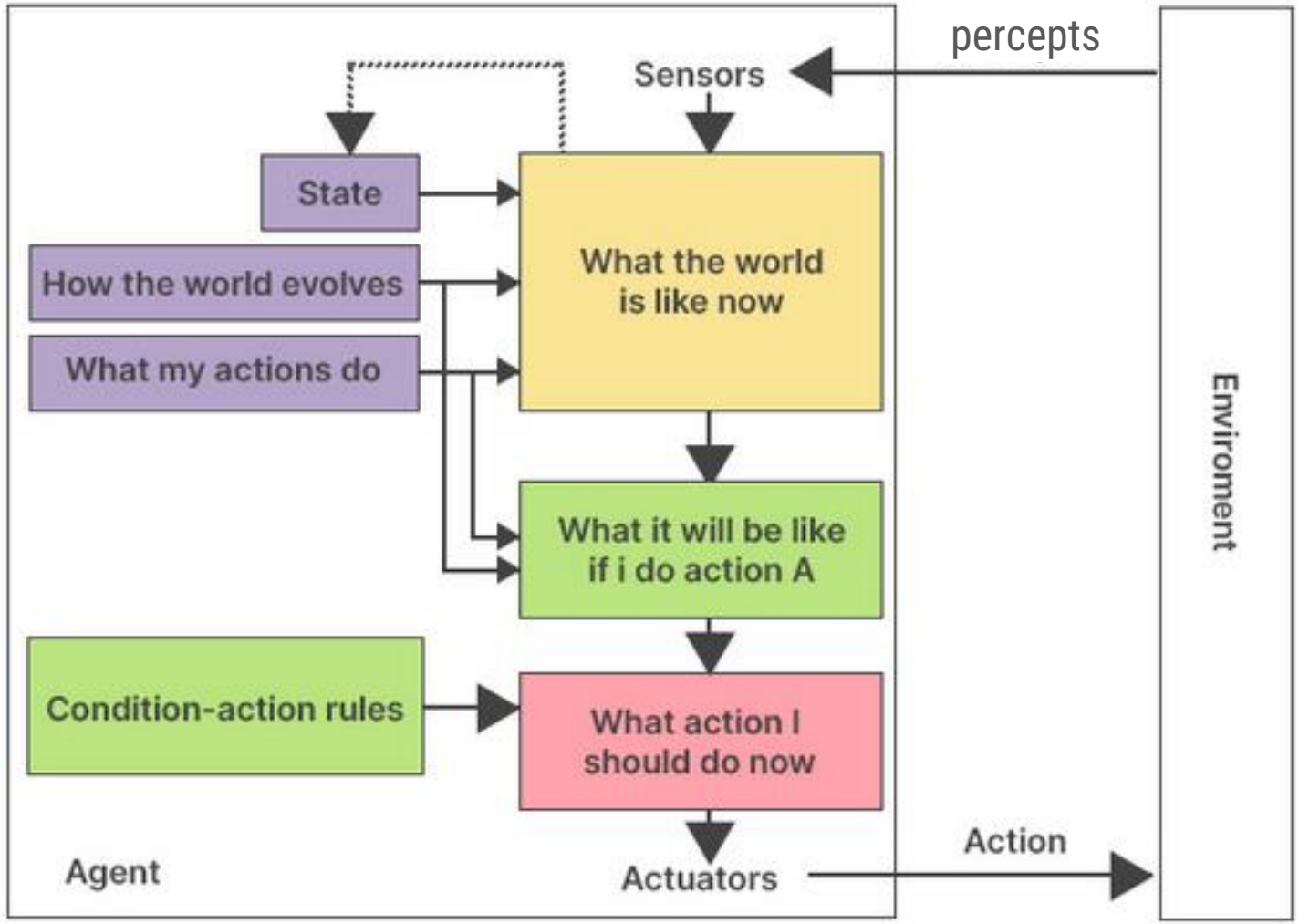
Model-based reflex agents



Utilize internal models to make decisions based on the current state and past history

Types of AI agents

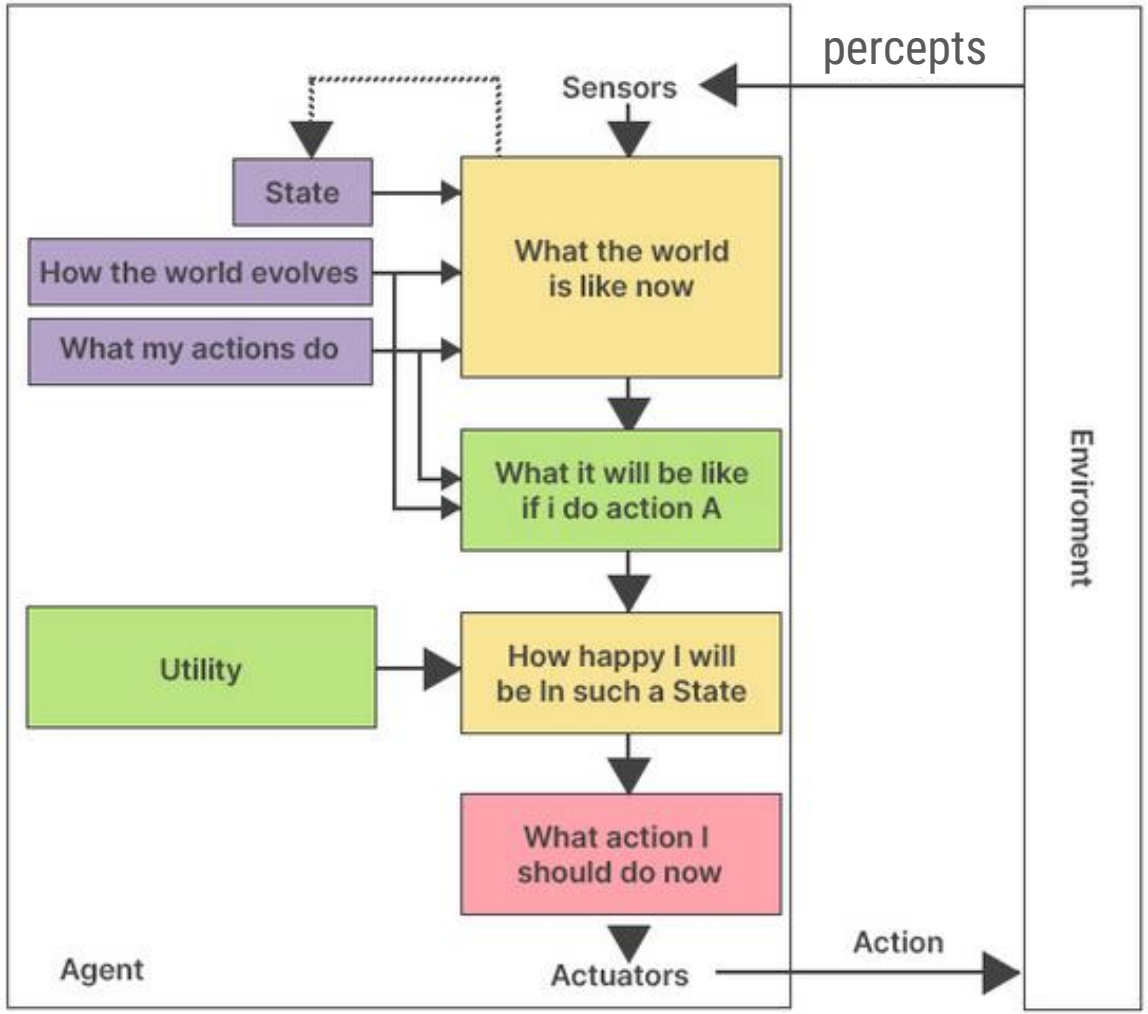
Goal-based agents



Take actions based on achieving specific goals.

Types of AI agents

Utility-based agents

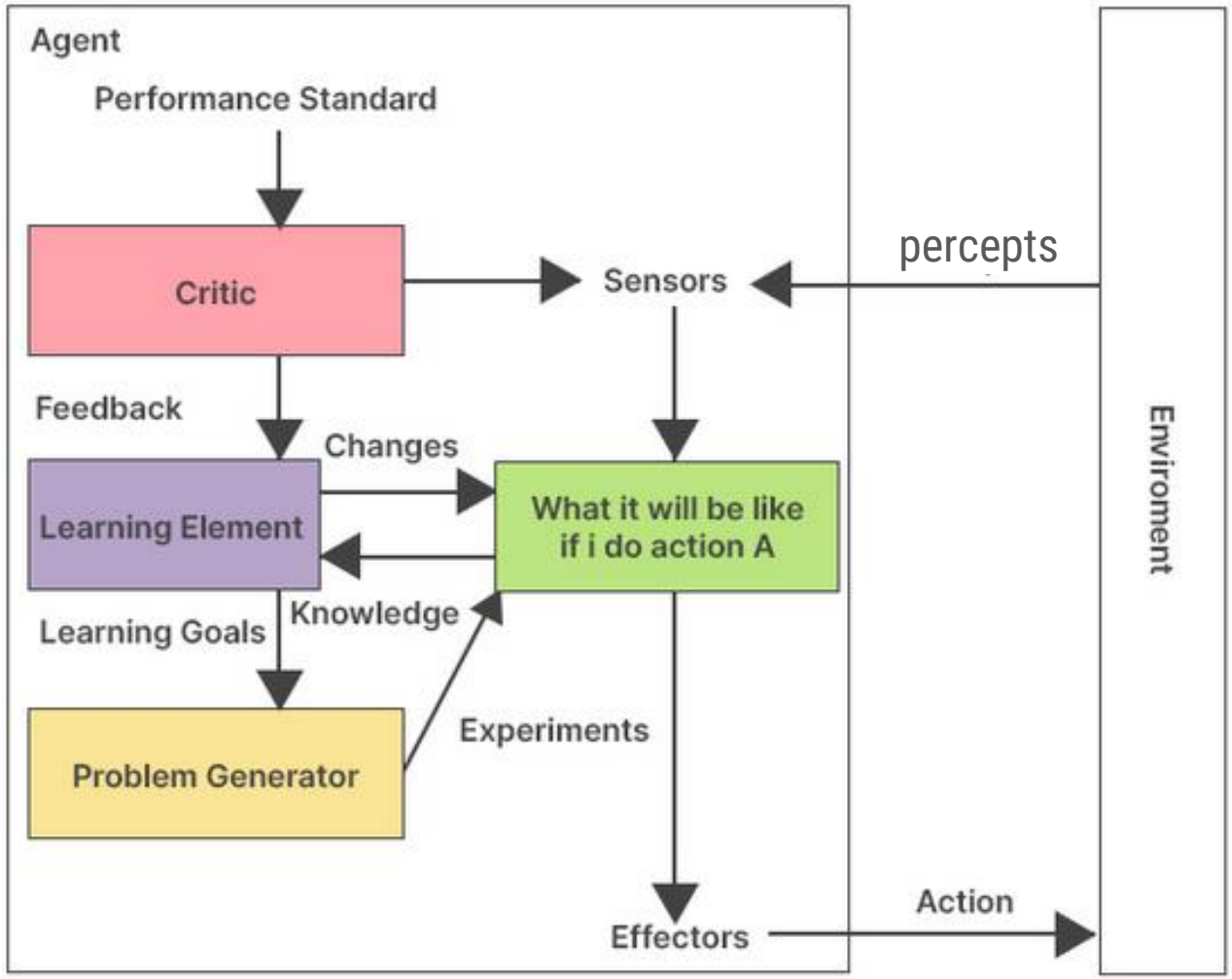


Consider both goals and utility to maximize overall satisfaction

(exp. Choose the action that solves a given task as quickly as possible)

Types of AI agents

Learning-based agents



- Supervised learning
- Unsupervised learning
- Reinforcement learning

Learn from their experiences and improve their performance over time