

# Introduction to Artificial Intelligence

## A Brief Introduction about AI and intelligence agent

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# What is AI?

## AI history and foundation

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# What is AI?

- AI is a broad field encompassing many subfields.
- It is relevant to any intellectual task.
- Historically, definitions of AI have varied.
  - Some focus on human *performance*.
  - Others on *rationality*.
  - Some consider about internal *thought* processes and reasoning.
  - While others focus on intelligent *behavior*, an external characterization.



# Four approaches - **Acting humanly**

- *The Turing test approach* - The computer would need the following capabilities:
- ***Natural language processing*** to communicate successfully in a human language.
- ***Knowledge representation***: to store what it knows or hears.
- ***Automated reasoning***: to answer questions and to draw new conclusions.
- ***Machine learning***: to adapt to new circumstances and to detect and extrapolate patterns.
- ***Computer vision and speech recognition*** to perceive the world.
- ***Robotics*** to manipulate objects and move about

# Four approaches - Thinking humanly

- The cognitive modeling approach
- **Introspection:** trying to catch our own thoughts as they go by.
- **Psychological experiments:** observing a person in action.
- **Brain imaging:** observing the brain in action.

# Four approaches - Thinking rationally

- The “laws of thought” approach
- Logic as conventionally understood requires knowledge of the world.
- Correct inferences.

# Four approaches - **Acting rationally**

- The rational agent approach
- An **agent** is just something that acts.
- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.
- In a nutshell, *AI has focused on the study Do the right thing and construction of agents that do the right thing.*

# Foundation of AI - Philosophy

- Can formal rules lead to valid conclusions?
- How does the mind arise from the brain?
- Where does knowledge come from?
- How does knowledge lead to action?
- The final element in the philosophical picture of the mind is the connection between knowledge and action. This element is vital to AI because intelligence requires action as well as reasoning.
- Methods based on logical planning to achieve definite goals dominated the first few decades of theoretical research in AI.



# Foundation of AI - Mathematics

- Mathematization of logic: mathematics provides the formal rules to draw valid conclusions.
- Computability: Mathematics helps explore what can be computed.
- Reasoning with Uncertainty: Mathematics, through the theory of probability, provides the tools to reason with uncertain information.
- Algorithms: The concept of an algorithm has its roots in mathematics.

# Foundation of AI - Neuroscience

- Key Question: How do brains process information?
- To understand how brains process information, how the nervous system, particularly the brain, enables thought.
- Brain vs. Computers: computers have faster cycle times, but the brain makes up for that with more storage and interconnection.
- Neurophysiological evidence: This type of evidence is incorporated into computational models, especially in computer vision.

# Foundation of AI - Computer Engineering

- Key Question: How can we build an efficient computer for AI?
- Hardware: Computer engineers create the physical components that make computation possible, including CPUs, memory, and storage, GPUs, TPUs, ...
- Parallelism: computing power has been increased rapidly with parallel computation.
- Software: Computer science has provided the operating systems, programming languages, and tools needed to write AI models.

# History of AI - Key Milestones

- The Dartmouth Workshop in **1956** is considered the birthplace of AI.
- Alan Turing's influential work on the Turing Test, machine learning, genetic algorithms, and reinforcement learning.
- Turing Award winners who defined foundations of the field:
  - *Marvin Minsky and John McCarthy (1969, 1971) for representation and reasoning.*
  - *Allen Newell and Herbert Simon (1975) for symbolic models of problem-solving.*
  - *Ed Feigenbaum and Raj Reddy (1994) for developing expert systems.*
  - *Judea Pearl (2011) for probabilistic reasoning techniques.*
  - *Yoshua Bengio, Geoffrey Hinton, and Yann LeCun (2019) for making deep learning.*

# History of AI - Challenges and Resurgence

- 1956 - 1968: Early AI faced issues like "combinatorial explosion", limitations in basic structures, General Problem Solver, machine evolution, ...
- 1969 - 1986: Expert systems emerged with programs like DENDRAL and MYCIN, focusing on encoding human knowledge.
- 1980s: There was a debate on symbolic vs. connectionist models, with connectionist models having the capability to learn from examples.
- 1986 - present: AI saw a resurgence with increased data, computing resources, and new algorithms, focusing on machine learning, deep learning, reinforcement learning.
- The rise of Transformers (2017) to LLM, typically ChatGPT (by OpenAI, 2022).

# Benefits of AI

- AI has an increasingly important role in various sectors like economic, social, scientific, medical, financial, industry and military.
- Long-term goals of AI: creating intelligence comparable to or more capable than human intelligence:
  - *Human-level AI (HLAI): A machine should be able to do anything a human can do.*
  - *Artificial general intelligence (AGI): The movement with similar goals to HLA.*
  - *Artificial superintelligence (ASI): The concern raised about creating AI that is more capable than humans.*

- Misuse of AI
- Long-Term Control Issues: concern that such AI might not be controllable.
- Unintended Consequences of AI: biased decision making, impact on employment, safety-critical applications, ...
- Other points of concern: Lack of Transparency, Need for Governance and Regulation.
- Discuss more on class: ?

# Intelligent Agents

## Introduction to Agent Architectures

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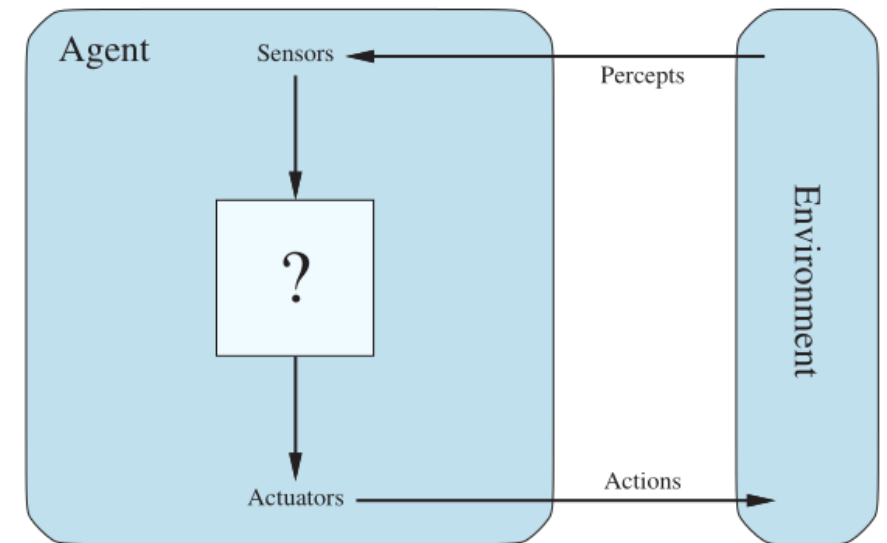
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# What is an Agent?

- An **agent** is anything that can be viewed as **perceiving** its environment through **sensors** and **acting** upon that environment through **actuators**.
- **Key takeaway:** Agents interact with their surroundings.
- Examples:
  - Software agents (e.g., trading bots)
  - Robots (e.g., vacuum cleaners, self-driving cars)
  - Humans can be considered as agents.



# The Concept of Rationality

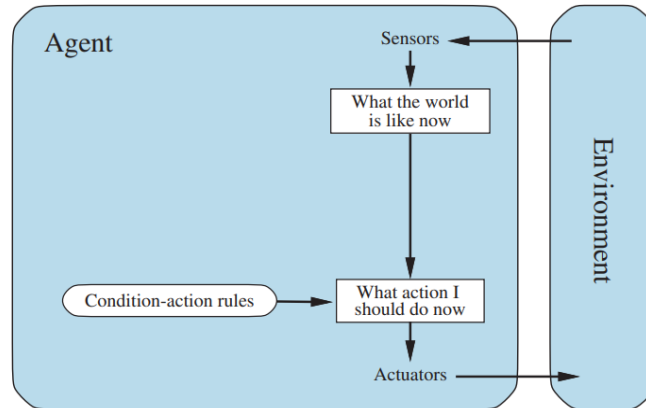
- What makes an agent "good" or "bad," "intelligent" or "stupid?"
- Rationality: An agent should strive to do the "right thing," aiming to maximize its expected utility.
- Ideal rational agent: Takes the best possible action in a given situation.
- *Note: Achieving perfect rationality is often unachievable due to computational complexity.*

# Intelligent agent characteristics

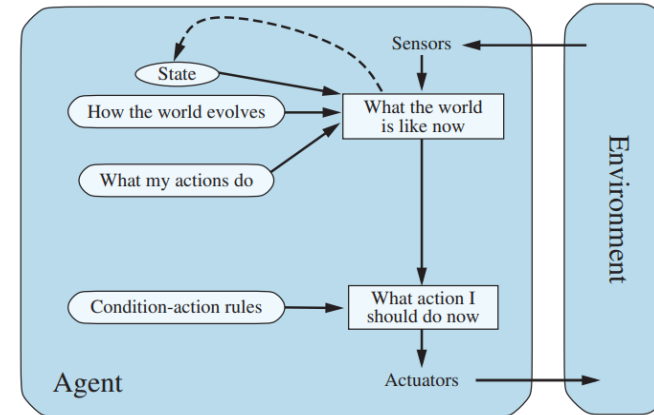
- **Perception:** Agents use sensors to perceive their environment.
- **Action:** Agents act on their environment through actuators.
- **Autonomy:** Agents are expected to operate autonomously.
- **Rationality:** A rational agent acts to achieve the best outcome, or the best expected outcome when there is uncertainty.
- **Learning:** Rational agents can learn from their percepts and experiences and adjust their behavior over time.
- **Functionality:** An agent's behavior is described by the agent function, which maps percept sequences to actions.
- **Performance measure:** An agent's behavior is evaluated by a performance measure that assesses the desirability of the sequence of environment states that result from the agent's actions

# Intelligent Agents - Examples

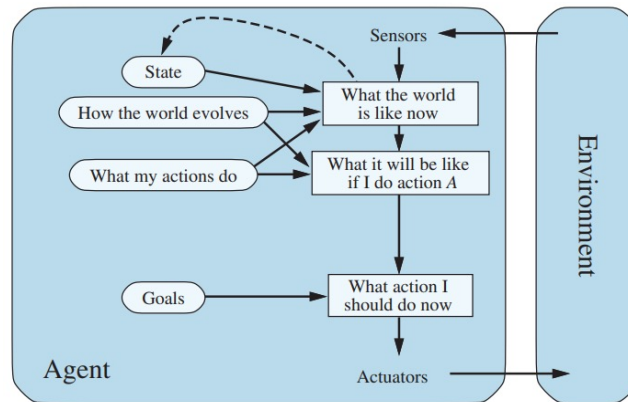
Reflex Agent



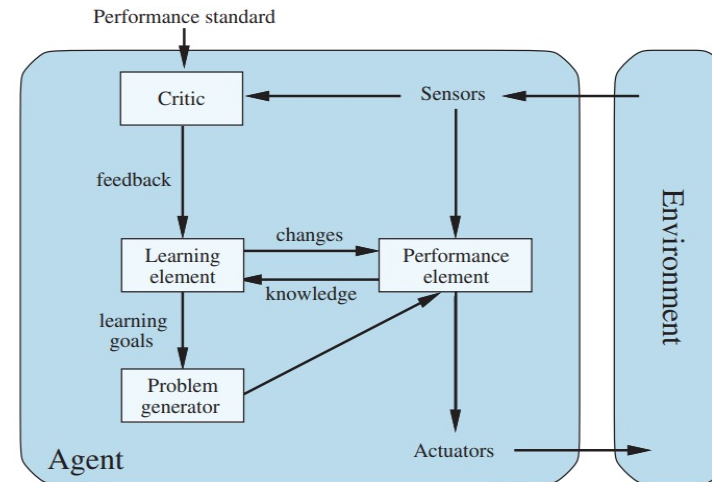
Model-based Agent



Goal-based Agent



General Learning Agent



# Intelligent Agents - Summary

- AI is the science of intelligent agent design.
- Agents interact with environments through sensors and actuators.
- Rational agents strive to maximize their expected utility.
- Agent programs can be of different types based on their components (reflex, model-based, goal-based, utility-based).
- Learning agents improve performance by modifying their components.



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# Question & Answer