

## WHAT IS ARTIFICIAL INTELLIGENCE?

- Cognitive simulation  
(⇐ Thinking rationally / human-like)<sup>a</sup>
- Construction of “intelligent” systems  
(⇐ Acting rationally / human-like)

⇒ Investigation of principles of “information” processing

- Strict formalization
- Exemplary implementations

Thinking is **also / only** computation.

(“also” = weak vs. “only” = strong AI hypothesis)

Interdisciplinary character of AI: Computer science, neuroscience, psychology, philosophy, linguistics, control theory, economics, . . .

<sup>a</sup>cf. Russell/Norvig

## Prehistory of AI

The idea of artificial man (“second creation”): automata and androids

- Antiquity and Middle Ages
- Modern Age: Empirism, Rationalism, Materialism; Robots

The idea of the universal computing engine

- Leibniz, Pascal, . . . , Babbage
- Turing, Zuse, v. Neumann

The universal language idea

“Thinking as computation” — Logic and functional simulation

- Calculation procedures: Al-Chorezmi (Al-Khwarizmi), Fibonacci, Riese
- Hobbes, Leibniz
- Frege, Boole, Peirce, Hilbert, Gödel, . . .
- Wittgenstein I: Tractatus and the “Linguistic Turn”; “ideal language” program

## The Origin of AI in the 20th Century

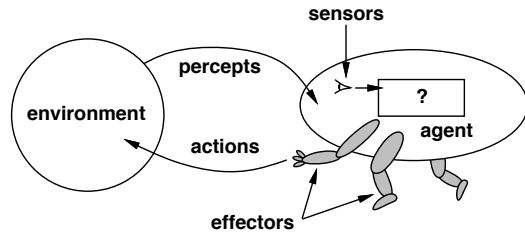
- Modern formal logic
- Turing and the Turing Machine
- McCulloch and Pitts — Neural Networks: analog, topological computation
- Dartmouth conference 1956 — “GOFAI” McCarthy, Minsky, Newell, Simon, et al.: discrete, algebraic computation
- Vannevar Bush — MEMEX: hypermedia

## Phases of the Development of AI

- Dartmouth conference 1956
- Foundational phase: “power-based approach” — heuristic search
- Knowledge representation: “knowledge-based approach”
- Knowledge-based systems, broad applications, “fifth generation”
- Neuronal networks connectionism
- Multi-agent systems
- “Nouvelle AI”: robotics without central representation, subsumption architecture

### Rational "AGENTS"

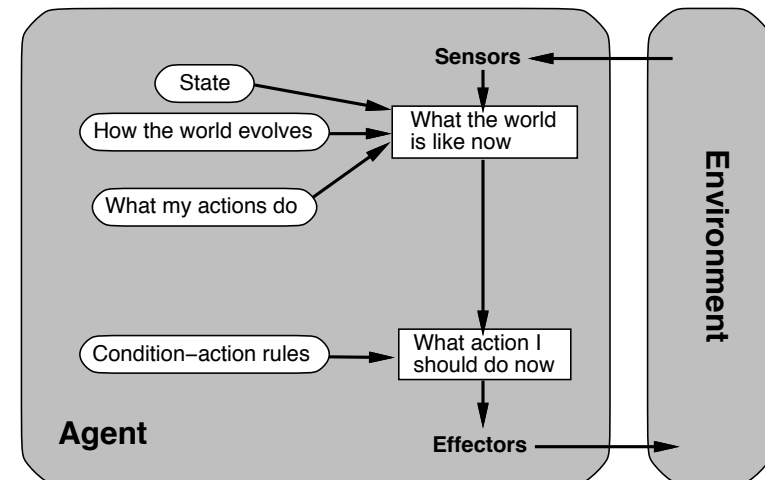
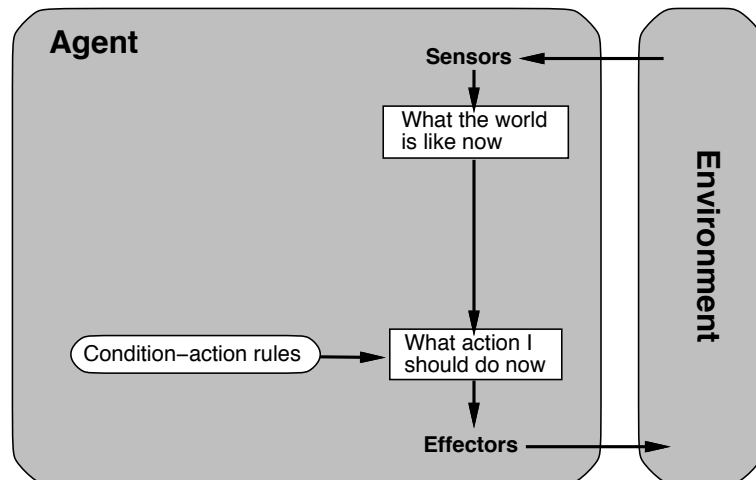
"For each possible percept sequence, an ideal rational agent should do whatever action is expected to maximize its performance measure, on the basis of the evidence provided by the percept sequence and whatever built-in knowledge the agent has." (Russell/Norvig)

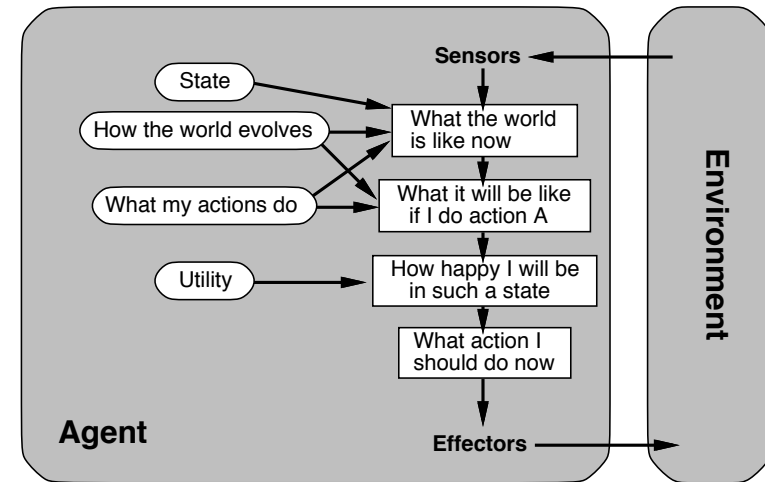
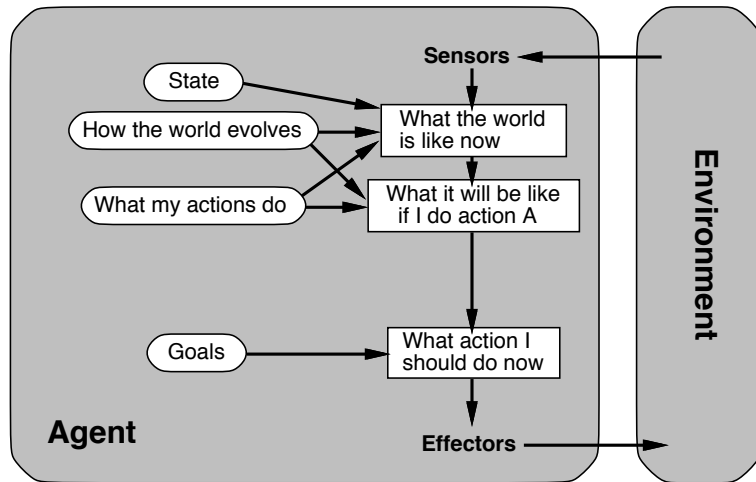


Agent = architecture + program

### Agent Types

- Reflex agent
  - rule-based
  - e.g. factorial agent
- Memory-based agents
  - rule-based plus learned rules
  - e.g., factorial agent that remembers previous solutions
- Goal-based agents
  - planner
  - e.g. route planner
- Utility-based agents
  - maximize continuous-valued goals
  - e.g. planner: tradeoff between time and cost





### Fundamental Subfields of AI

Given the goal to implement rational action in a complex environment, as exemplified by the conception of the rational agent, AI is an interdisciplinary, cross-cutting discipline.

There is nothing like a big unifying theory of AI, but instead an inventory of methods which can be associated with fundamental subfields:

- Problem solving and heuristic search
- Knowledge representation and inference
- Planning
- Learning
- Perception
- Natural language processing and image interpretation
- Agent architectures

### Questions to Ask

in each part ...

- What is the subject?
- Which functionality do we want to achieve?
- Which phenomena do we have to deal with?
- What are typical examples?
- Which subproblems are there?
- What are the underlying theories? Which approach will be chosen?
- Which methods and techniques are used; what are their properties?
- Which extensions and which interactions are there?