Artificial Intelligence 1
Winter Semester 2024/25

– Lecture Notes –
Conclusion of AI-1

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This document contains the conclusions of the course "Artificial Intelligence 1" held at FAU Erlangen-Nürnberg in the Winter Semesters 2016/17 ff. Other parts of the lecture notes can be found at `http://kwarc.info/teaching/AI/notes-*.pdf`.

Contents

21.1 What did we learn in AI 1?

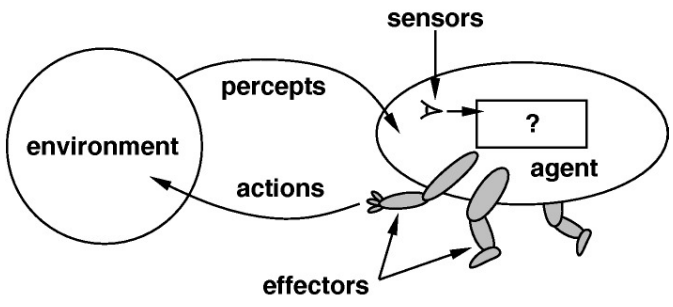
A Video Nugget covering this section can be found at `https://fau.tv/clip/id/26916`.

Topics of AI-1 (Winter Semester)

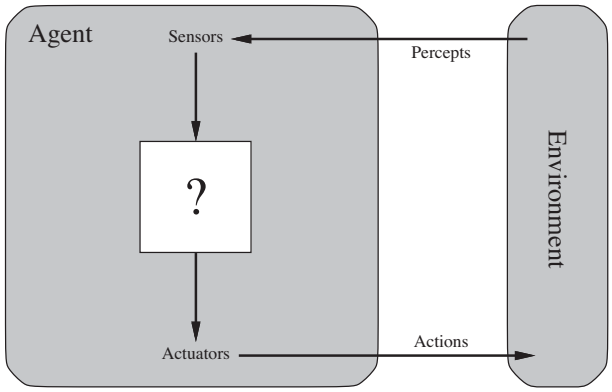
- ▷ Getting Started
  - ▹ What is Artificial Intelligence? (situating ourselves)
  - ▹ Logic programming in Prolog (An influential paradigm)
  - ▹ Intelligent Agents (a unifying framework)
- ▷ Problem Solving
  - ▹ Problem Solving and search (Black Box World States and Actions)
  - ▹ Adversarial search (Game playing) (A nice application of search)
  - ▹ constraint satisfaction problems (Factored World States)
- ▷ Knowledge and Reasoning
  - ▹ Formal Logic as the mathematics of Meaning
  - ▹ Propositional logic and satisfiability (Atomic Propositions)
  - ▹ First-order logic and theorem proving (Quantification)
  - ▹ Logic programming (Logic + Search$\rightsquigarrow$ Programming)
  - ▹ Description logics and semantic web
- ▷ Planning
  - ▹ Planning Frameworks
  - ▹ Planning Algorithms
  - ▹ Planning and Acting in the real world

Rational Agents as an Evaluation Framework for AI

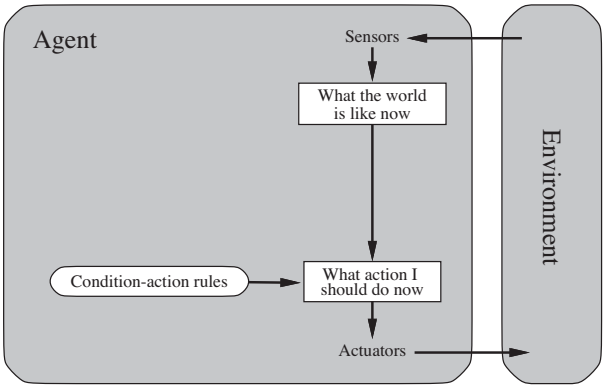
- ▷ Agents interact with the environment



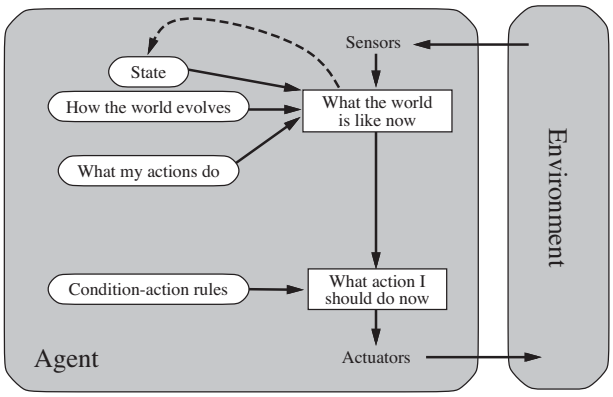
General agent schema



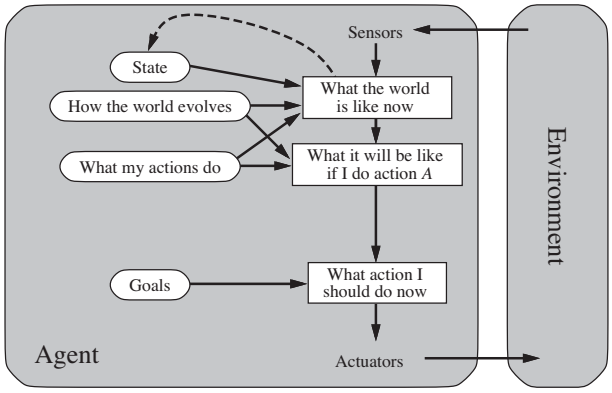
Simple Reflex Agents



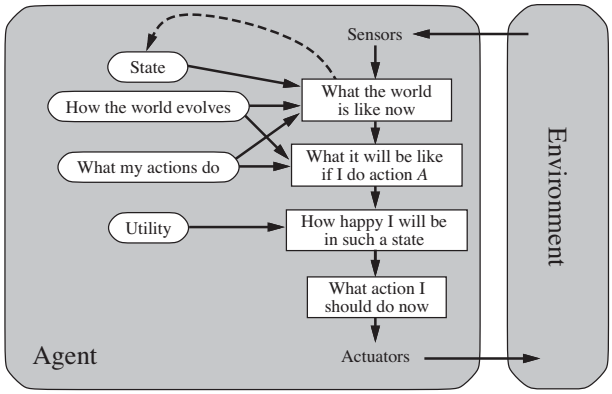
Reflex Agents with State



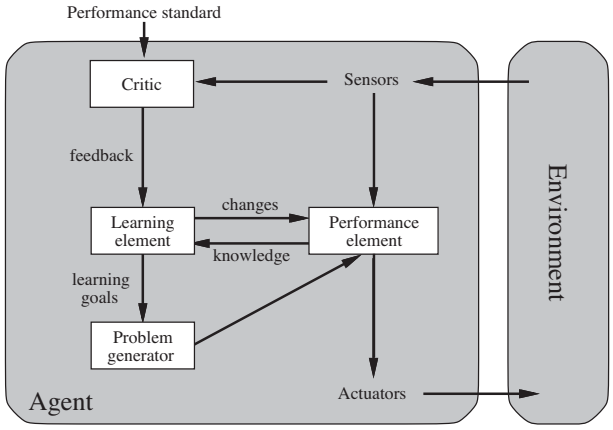
Goal-Based Agents



Utility-Based Agent



Learning Agents



Rational Agent

▷ **Idea:** Try to design agents that are successful (do the right thing)

▷ **Definition 21.1.1.** An agent is called rational, if it chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date. This is called the MEU principle.

▷ **Note:** A rational agent need not be perfect

- ▷ only needs to maximize expected value (rational $\neq$ omniscient)
  - ▷ need not predict e.g. very unlikely but catastrophic events in the future
- ▷ percepts may not supply all relevant information (Rational $\neq$ clairvoyant)
  - ▷ if we cannot perceive things we do not need to react to them.
  - ▷ but we may need to try to find out about hidden dangers (exploration)
- ▷ action outcomes may not be as expected (rational $\neq$ successful)
  - ▷ but we may need to take action to ensure that they do (more often) (learning)

▷ Rational $\rightsquigarrow$ exploration, learning, autonomy

Symbolic AI: Adding Knowledge to Algorithms

▷ Problem Solving (Black Box States, Transitions, Heuristics)

- ▷ **Framework**: Problem Solving and Search (basic tree/graph walking)
- ▷ **Variant**: Game playing (Adversarial search) (minimax + $\alpha\beta$-Pruning)

▷ Constraint Satisfaction Problems (heuristic search over partial assignments)

- ▷ States as partial variable assignments, transitions as assignment
- ▷ Heuristics informed by current restrictions, constraint graph
- ▷ Inference as constraint propagation (transferring possible values across arcs)

▷ Describing world states by formal language (and drawing inferences)

- ▷ Propositional logic and DPLL (deciding entailment efficiently)
- ▷ First-order logic and ATP (reasoning about infinite domains)
- ▷ **Digression**: Logic programming (logic + search)
- ▷ Description logics as moderately expressive, but decidable logics

▷ Planning: Problem Solving using white-box world/action descriptions

- ▷ **Framework**: describing world states in logic as sets of propositions and actions by preconditions and add/delete lists
- ▷ **Algorithms**: e.g heuristic search by problem relaxations

Topics of AI-2 (Summer Semester)

- ▷ Uncertain Knowledge and Reasoning
  - ▷ Uncertainty
  - ▷ Probabilistic reasoning
  - ▷ Making Decisions in Episodic Environments
  - ▷ Problem Solving in Sequential Environments
- ▷ Foundations of machine learning
  - ▷ Learning from Observations
  - ▷ Knowledge in Learning
  - ▷ Statistical Learning Methods
- ▷ Communication (If there is time)
  - ▷ Natural Language Processing
  - ▷ Natural Language for Communication