Artificial Intelligence 1
Winter Semester 2024/25

– Lecture Notes –
Conclusion of AI-1

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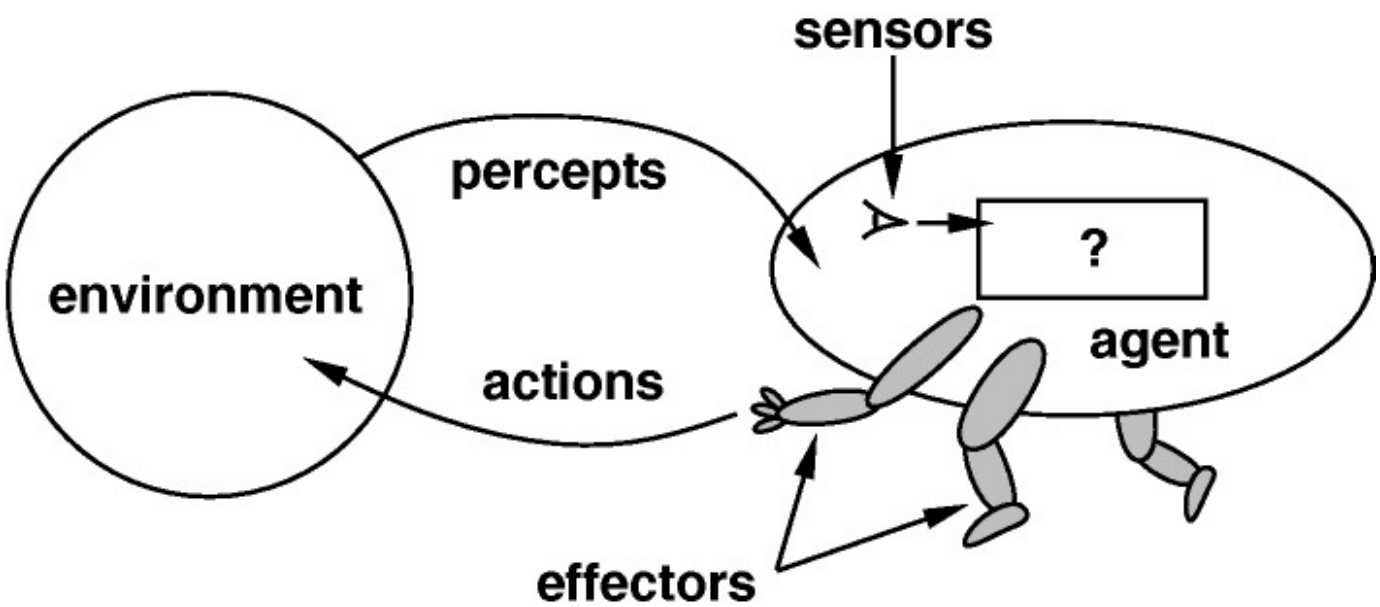
21.1 What did we learn in AI 1?

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

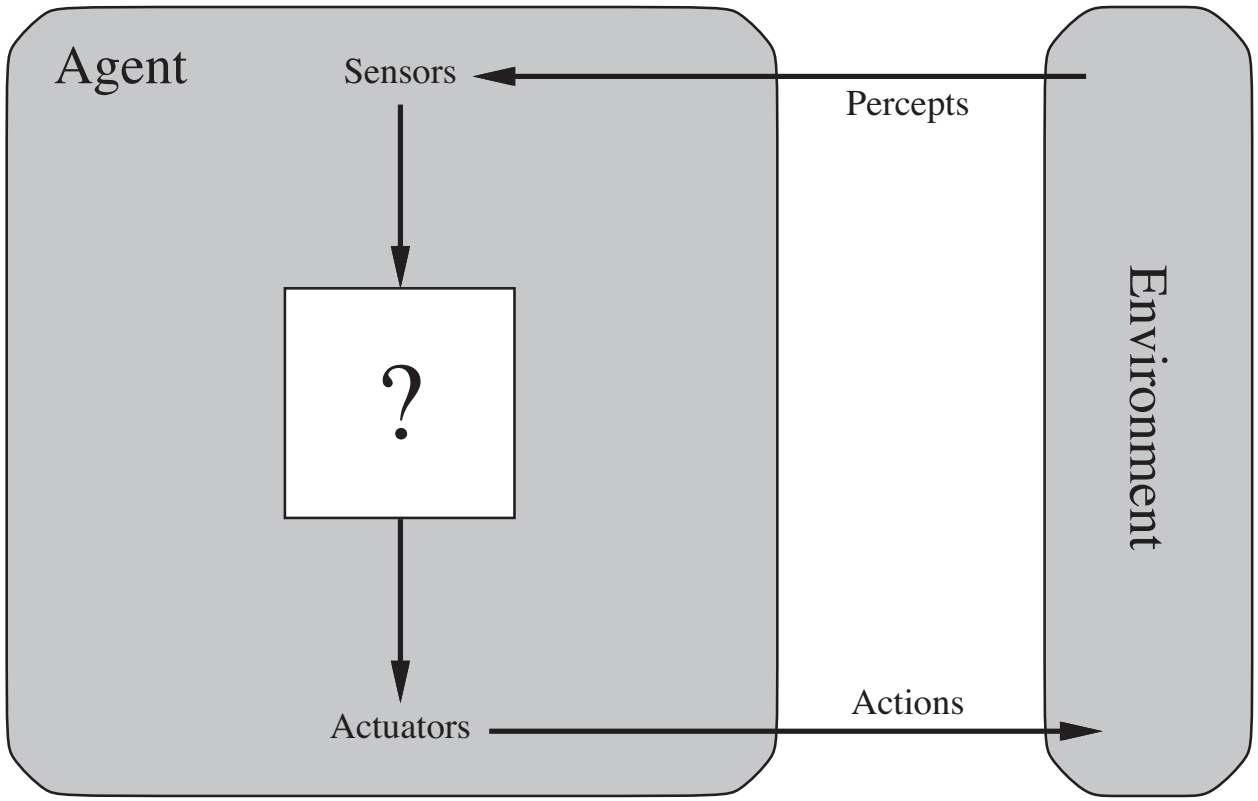
Rational Agents as an Evaluation Framework for AI

- Agents interact with the environment



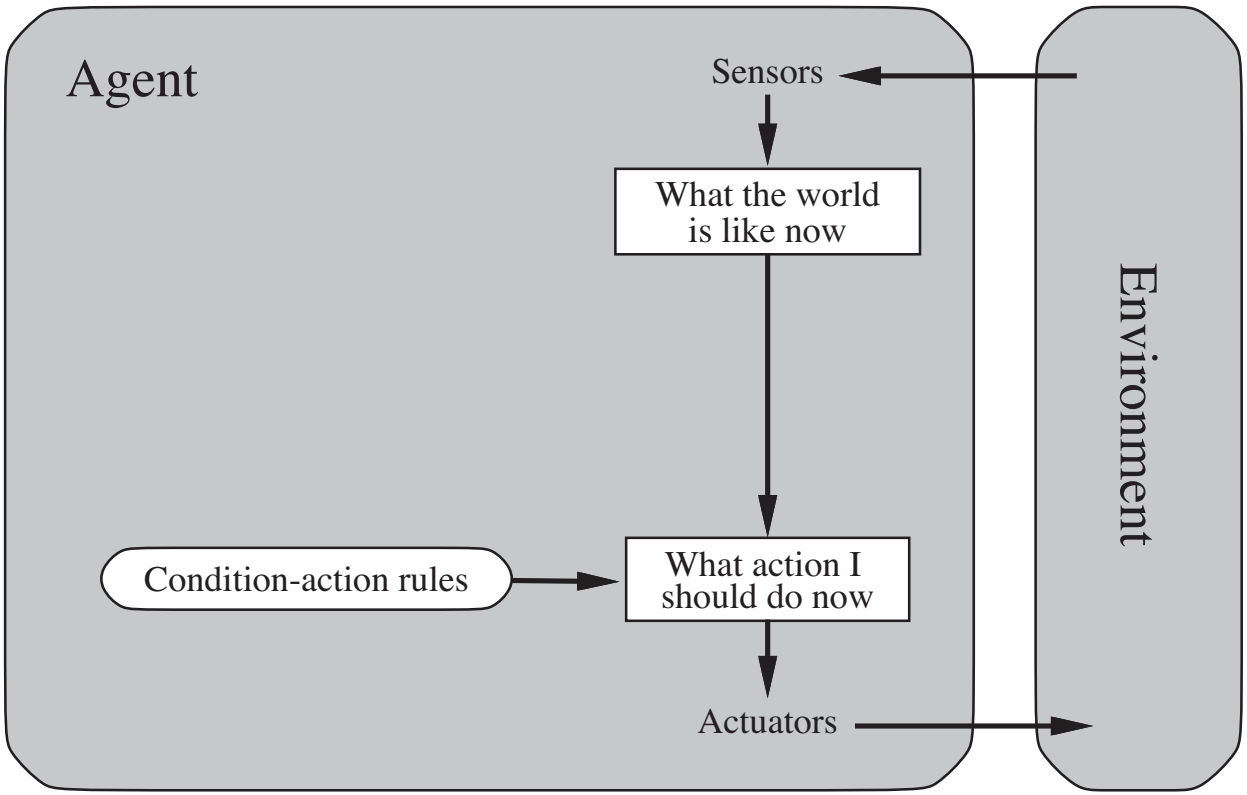
Rational Agents as an Evaluation Framework for AI

- General agent schema



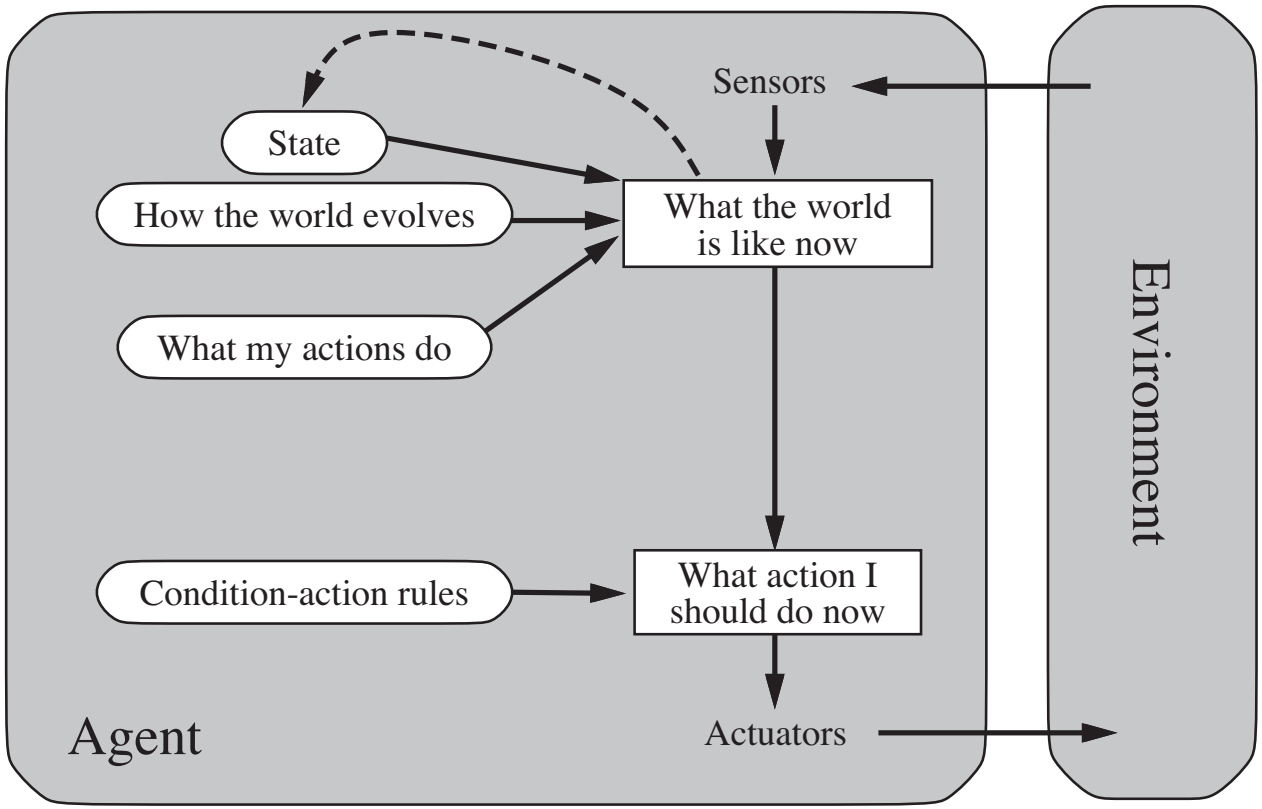
Rational Agents as an Evaluation Framework for AI

- Simple Reflex Agents



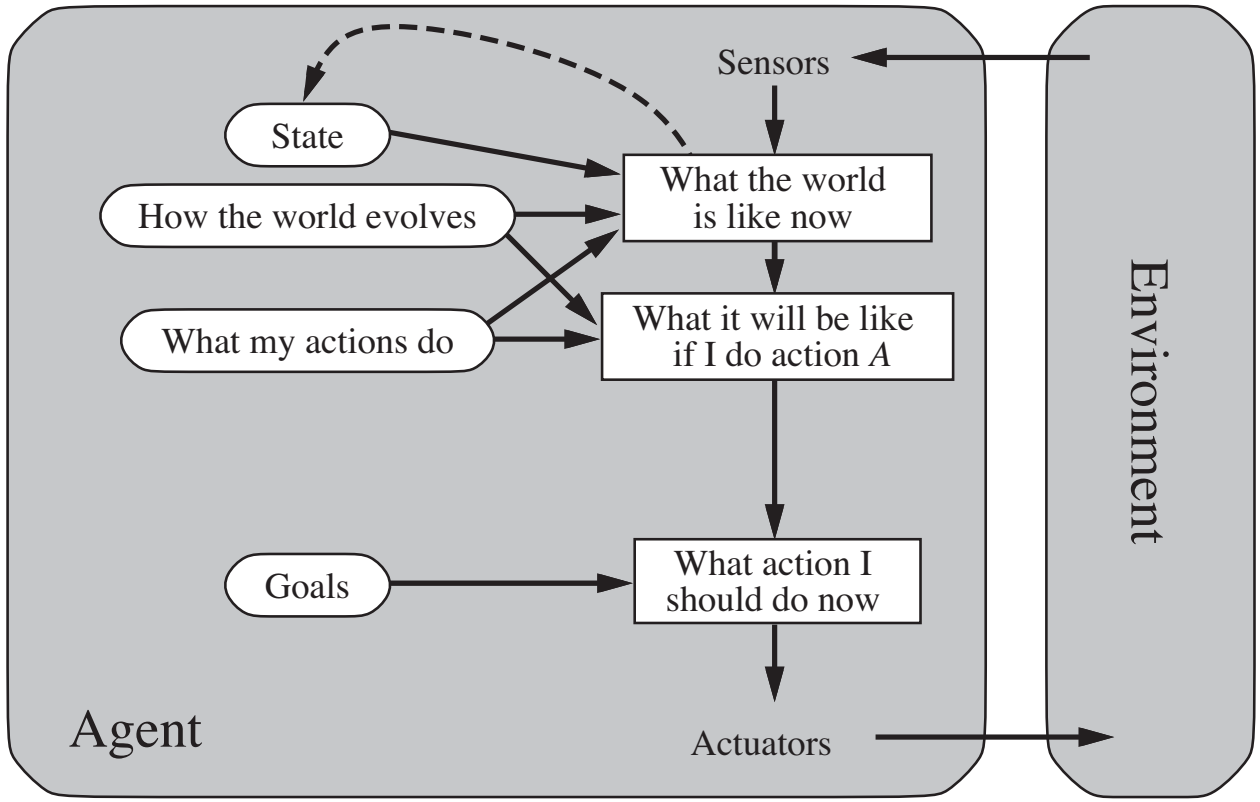
Rational Agents as an Evaluation Framework for AI

- Reflex Agents with State



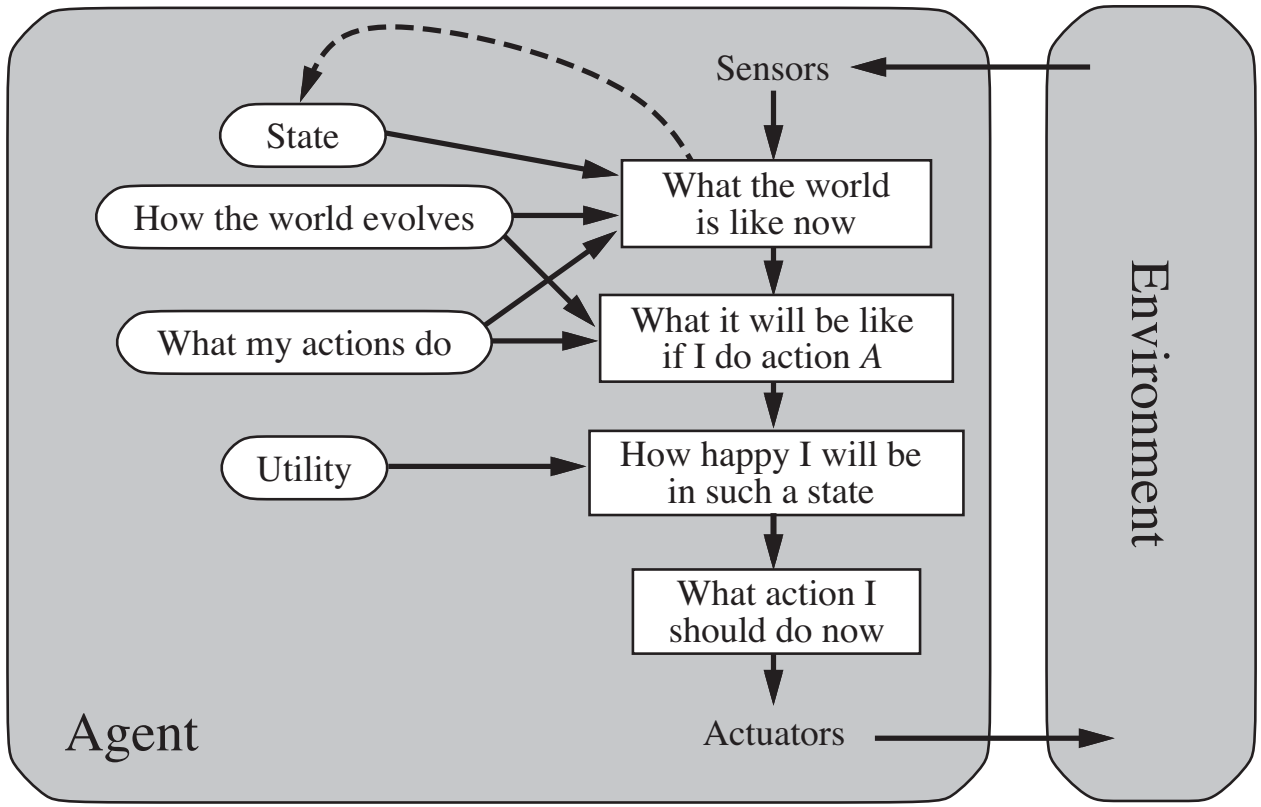
Rational Agents as an Evaluation Framework for AI

- Goal-Based Agents



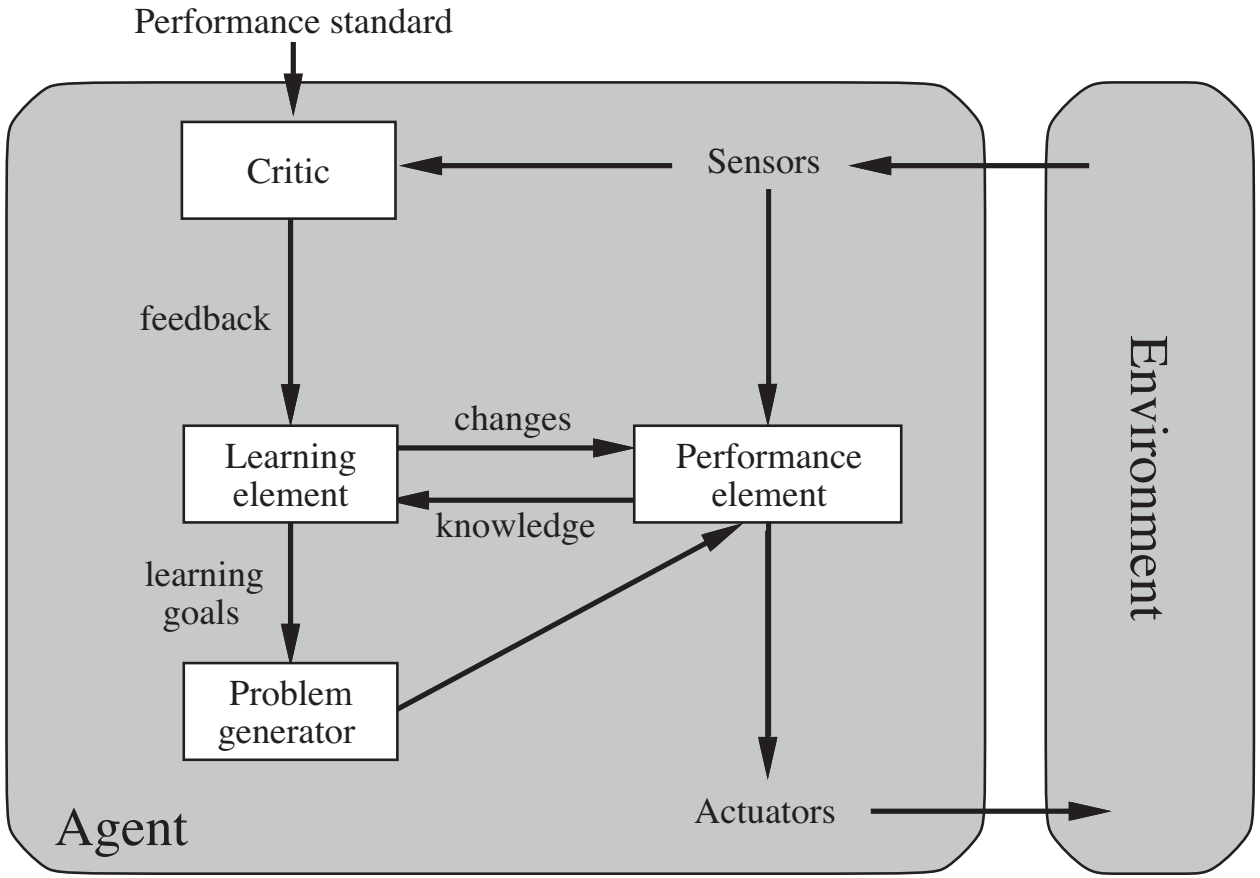
Rational Agents as an Evaluation Framework for AI

- Utility-Based Agent



Rational Agents as an Evaluation Framework for AI

- Learning Agents



Rational Agent

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

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  - States as partial variable assignments, transitions as assignment
  - Heuristics informed by current restrictions, constraint graph
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- 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

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- 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

References I