Foundations of Artificial Intelligence

4. Introduction: Environments and Problem Solving Methods

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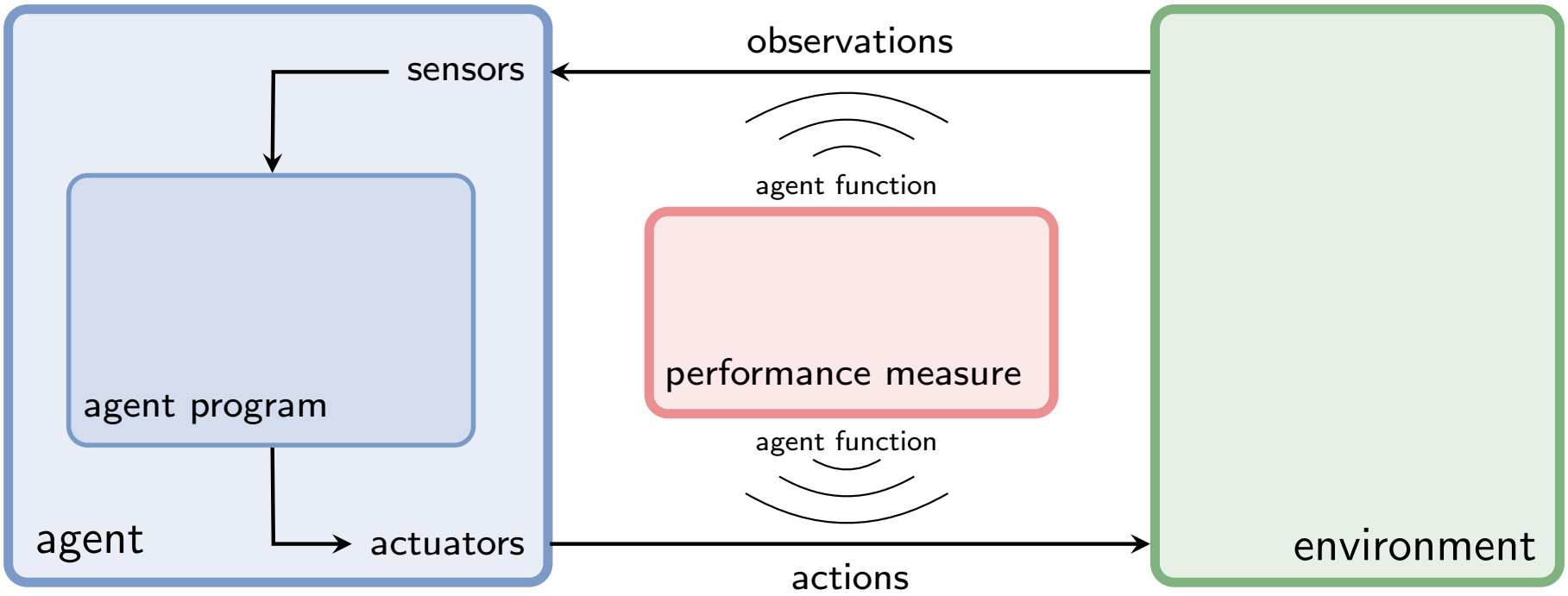
Introduction: Overview

Chapter overview: introduction

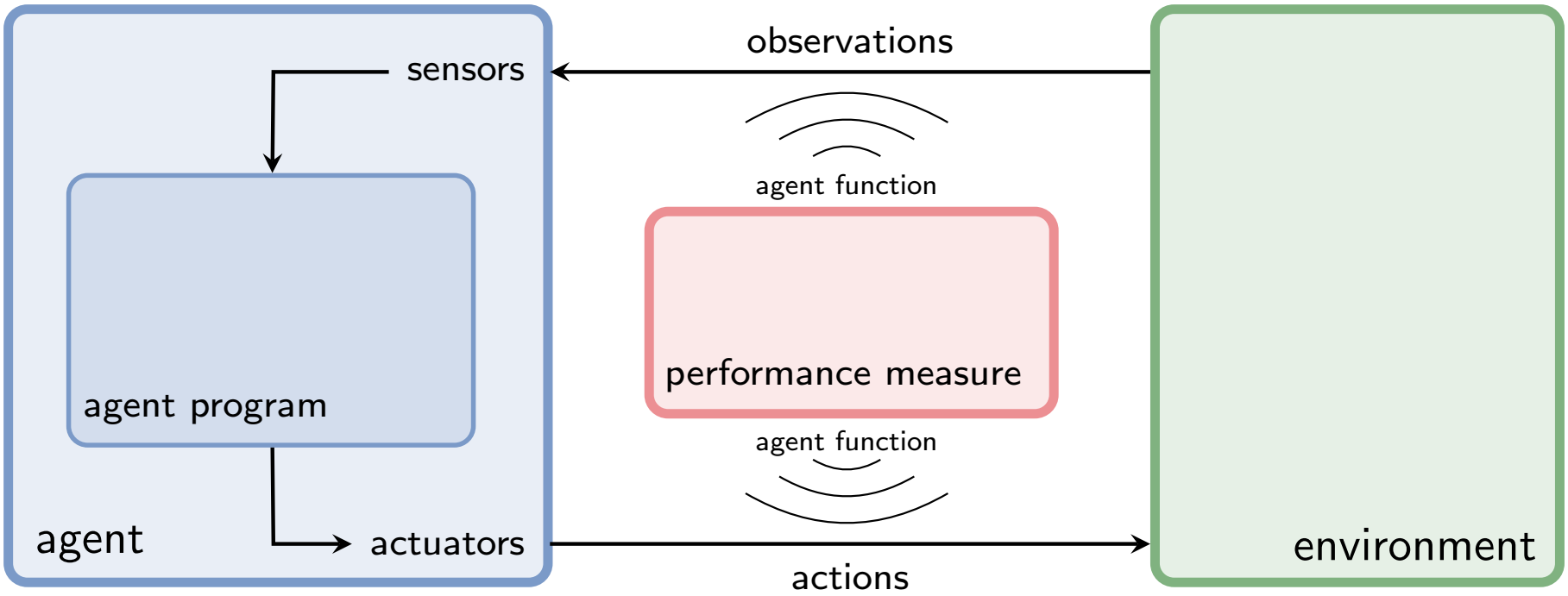
- 1. What is Artificial Intelligence?
- 2. AI Past and Present
- 3. Rational Agents
- 4. Environments and Problem Solving Methods

Environments of Rational Agents

Environments of Rational Agents



Environments of Rational Agents

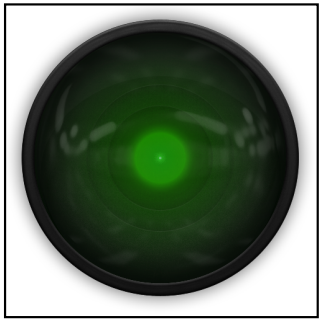


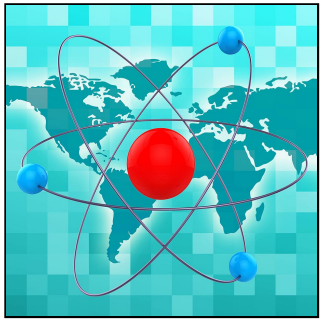
- Which environment aspects are relevant for the agent?
- How do the agent's actions change the environment?
- What does the agent observe?

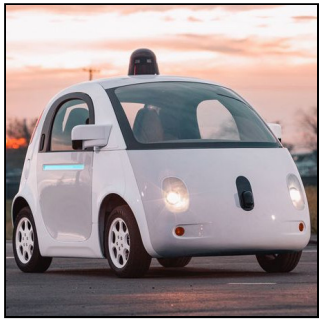
Properties of Environments

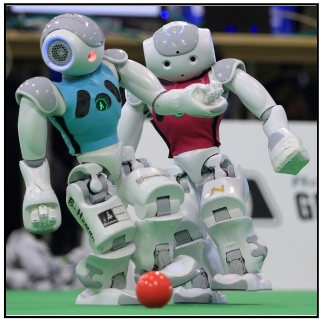
- fully vs. partially vs. not observable
- single-agent vs. multi-agent (competitive and/or cooperative)
- deterministic vs. non-deterministic vs. stochastic
- static vs. dynamic
- discrete vs. continuous

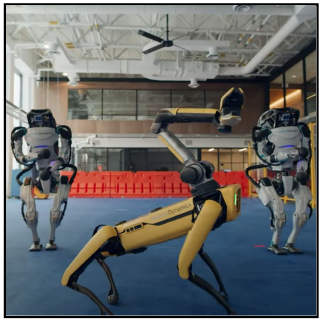
Properties of Environments



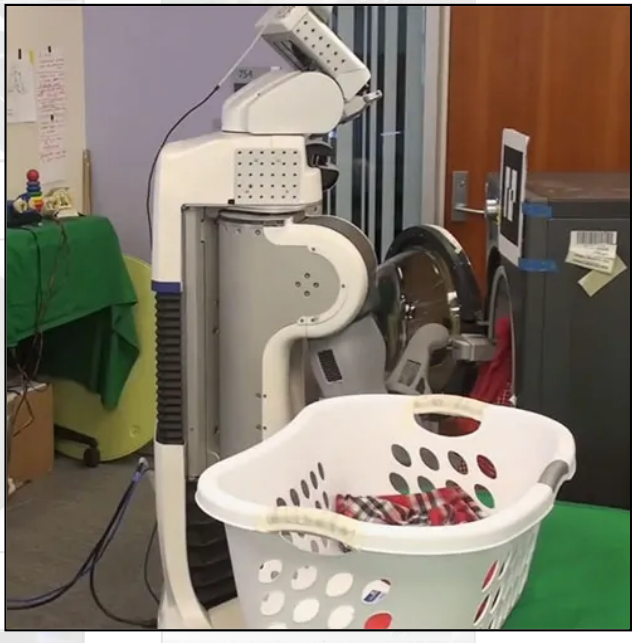








Properties of Environments



fully vs. partially vs. not observable

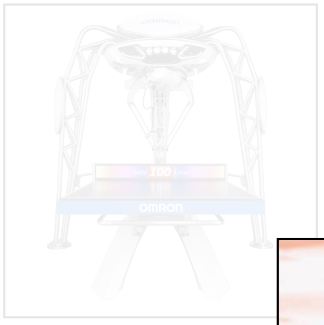
To what extent do observations determine the state of the environment?

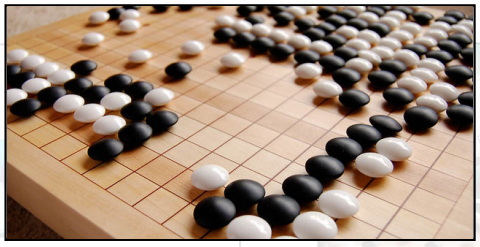
Properties of Environments

single-agent vs. multi-agent (competitive and/or cooperative)

Are other agents relevant for own performance? How?

Properties of Environments

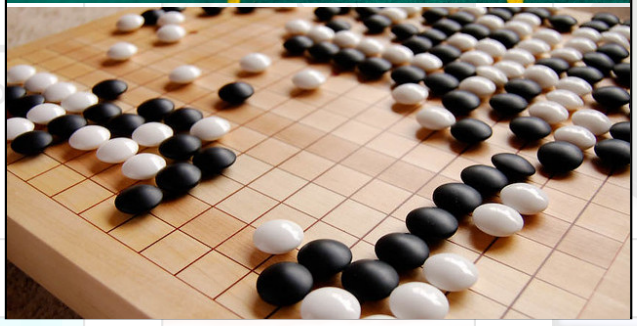


deterministic vs. non-deterministic vs. stochastic

Is the next state of the environment fully determined by the current state and the next action? Are probabilities involved?

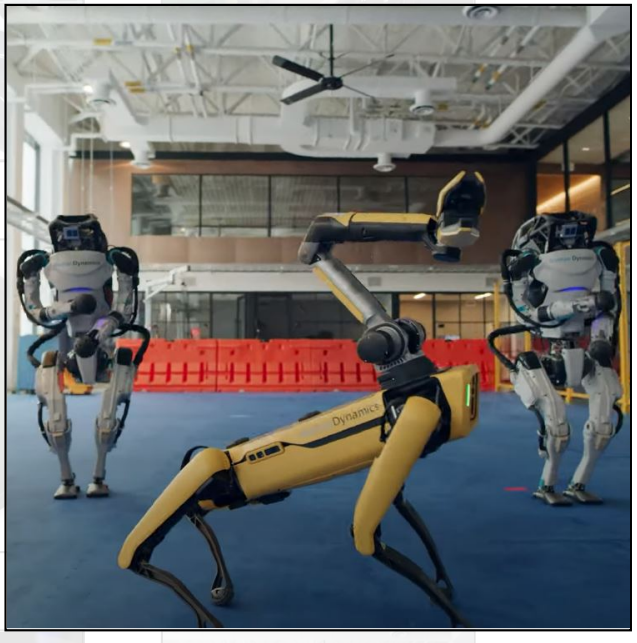
Properties of Environments



static vs. dynamic

Does the state of the environment remain the same while the agent is contemplating its next action?

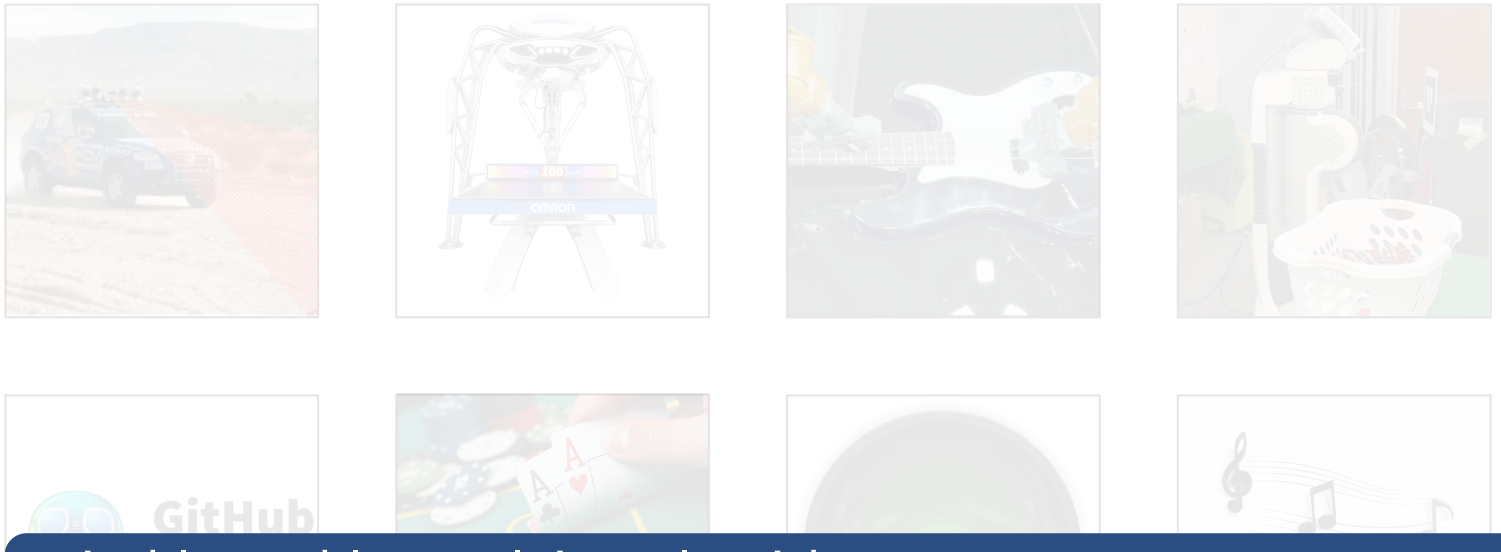
Properties of Environments



discrete vs. continuous

Is the state of the environment (and actions, observations, time) given by discrete or by continuous parameters?

Properties of Environments



suitable problem-solving algorithms

Environments of different kinds (according to these criteria) usually require different algorithms.

real world

The "real world" combines all unpleasant (in the sense of: difficult to handle) properties.

Problem Solving Methods

Three Approaches to Solving AI Problems

We can solve a concrete AI problem (e.g., backgammon) in several ways:

Problem Solving Methods

1. problem-specific: implement algorithm tailored to problem

problem-specific algorithms:

- designed to solve a specific problem
- allows to exploit problem-specific knowledge
- solves just one (type of) problem

Three Approaches to Solving AI Problems

We can solve a concrete AI problem (e.g., backgammon) in several ways:

Problem Solving Methods

1. problem-specific: implement algorithm tailored to problem
2. general: create problem description as input for general solver

general problem solvers:

- user creates model of problem instance in general language
- solver takes modeled instance as input
- solver implements general algorithm to compute solution

Three Approaches to Solving AI Problems

We can solve a concrete AI problem (e.g., backgammon) in several ways:

Problem Solving Methods

1. problem-specific: implement algorithm tailored to problem
2. general: create problem description as input for general solver
3. learning: learn (aspects of) algorithm from data

learners:

- general approach that learns to solve specific problem
- adapts via experience instead of via reasoning
- requires data and feedback instead of model of the AI problems

Three Approaches to Solving AI Problems

We can solve a concrete AI problem (e.g., backgammon) in several ways:

Problem Solving Methods

1. problem-specific: implement algorithm tailored to problem
2. general: create problem description as input for general solver
3. learning: learn (aspects of) algorithm from data

- all three approaches have strengths and weaknesses
- combinations are possible (and common in practice)
- we will mostly focus on general algorithms, but also consider other approaches

Classification of AI Topics

Classification of AI Topics

Many areas of AI are essentially characterized by

- the properties of environments they consider and
- which of the three problem solving approaches they use.

We conclude the introduction by giving some examples

- within this course and
- beyond the course ("advanced topics").

Examples: Classification of AI Topics

Course Topic: Informed Search Algorithms

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent

problem solving method:

- problem-specific vs. general vs. learning

Examples: Classification of AI Topics

Course Topic: Constraint Satisfaction Problems

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent

problem solving method:

- problem-specific vs. general vs. learning

Examples: Classification of AI Topics

Course Topic: Board Games

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent (adversarial)

problem solving method:

- problem-specific vs. general vs. learning

Examples: Classification of AI Topics

Advanced Topic: General Game Playing

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. (stochastic)
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent (adversarial)

problem solving method:

- problem-specific vs. general vs. learning

Examples: Classification of AI Topics

Course Topic: Classical Planning

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent

problem solving method:

- problem-specific vs. general vs. learning

Examples: Classification of AI Topics

Course Topic: Acting under Uncertainty

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent

problem solving method:

- problem-specific vs. general vs. learning

Examples: Classification of AI Topics

Advanced Topic: Reinforcement Learning

environment:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent

problem solving method:

- problem-specific vs. general vs. learning

Summary

Summary (1)

AI problem: performance measure + agent model + environment

Properties of environment critical for choice of suitable algorithm:

- static vs. dynamic
- deterministic vs. non-deterministic vs. stochastic
- fully vs. partially vs. not observable
- discrete vs. continuous
- single-agent vs. multi-agent

Summary (2)

Three problem solving methods:

- problem-specific
- general
- learning

general problem solvers:

- models characterize problem instances mathematically
- languages describe models compactly
- algorithms use languages as problem description and to exploit problem structure