Planning and Optimization

C1. Overview of Classical Planning Algorithms (Part 1)

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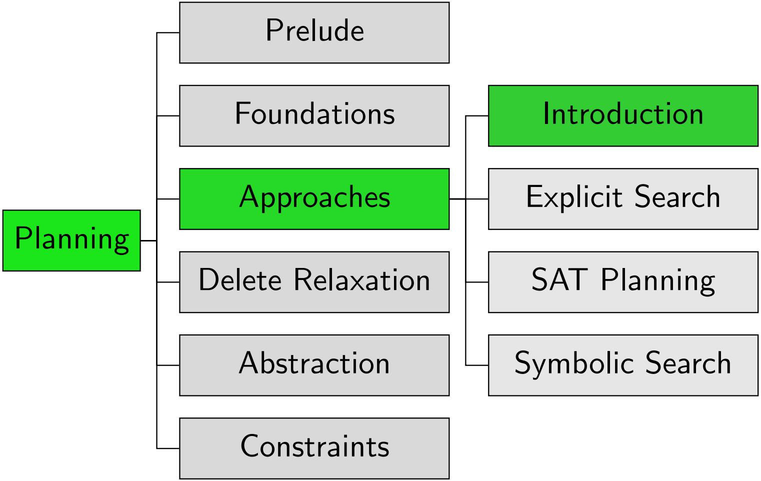
Content of the Course



The Big Three

Classical Planning Algorithms

Let's start solving planning tasks!

This Chapter and the Next

very high-level overview of classical planning algorithms

- bird's eye view: no details, just some very brief ideas

The Big Three

Of the many planning approaches, three techniques stand out:

- explicit search $\rightsquigarrow$ Chapters C3–C4, Parts D–F
- SAT planning $\rightsquigarrow$ Chapters C5–C6
- symbolic search $\rightsquigarrow$ Chapters C7–C8

also: many algorithm portfolios

Satisficing or Optimal Planning?

must carefully distinguish:

- satisficing planning: any plan is OK (cheaper ones preferred)
- optimal planning: plans must have minimum cost

solved by similar techniques, but:

- details very different
- almost no overlap between best techniques for satisficing planning and best techniques for optimal planning
- many tasks that are trivial for satisficing planners are impossibly hard for optimal planners

Explicit Search

Explicit Search

You know this one already! (Hopefully.)

Reminder: State-Space Search

Need to Catch Up?

- We assume prior knowledge of basic search algorithms:
  - uninformed vs. informed (heuristic)
  - satisficing vs. optimal
  - heuristics and their properties
  - specific algorithms: e.g., breadth-first search, greedy best-first search, A^*
- If you are not familiar with them, we recommend Part B of the Foundations of Artificial Intelligence course: `https://dmi.unibas.ch/en/studium/computer-science-informatik/lehrangebot-fs25/13548-lecture-foundations-of-artificial-intelligence/`

Reminder: Interface for Heuristic Search Algorithms

Abstract Interface Needed for Heuristic Search Algorithms

- init() $\rightsquigarrow$ returns initial state
- is_goal(s) $\rightsquigarrow$ tests if s is a goal state
- succ(s) $\rightsquigarrow$ returns all pairs $\langle a, s' \rangle$ with $s \xrightarrow{a} s'$
- cost(a) $\rightsquigarrow$ returns cost of action a
- h(s) $\rightsquigarrow$ returns heuristic value for state s

$\rightsquigarrow$ Foundations of Artificial Intelligence course, Chap. B2 and B9

State Space vs. Search Space

- Planning tasks induce transition systems (a.k.a. state spaces) with an initial state, labeled transitions and goal states.
- State-space search searches state spaces with an initial state, a successor function and goal states.

⇝ looks like an obvious correspondence

- However, in planning as search, the state space being searched can be different from the state space of the planning task.
- When we need to make a distinction, we speak of
  - the state space of the planning task whose states are called world states vs.
  - the search space of the search algorithm whose states are called search states.

Design Choice: Search Direction

How to apply explicit search to planning? ⇝ many design choices!

Design Choice: Search Direction

- progression: forward from initial state to goal
- regression: backward from goal states to initial state
- bidirectional search

⇝ Chapters C3–C4

Design Choice: Search Algorithm

How to apply explicit search to planning? $\rightsquigarrow$ many design choices!

Design Choice: Search Algorithm

- uninformed search:
  depth-first, breadth-first, iterative depth-first, ...
- heuristic search (systematic):
  greedy best-first, A^*, weighted A^*, IDA^*, ...
- heuristic search (local):
  hill-climbing, simulated annealing, beam search, ...

Design Choice: Search Control

How to apply explicit search to planning? $\rightsquigarrow$ many design choices!

Design Choice: Search Control

- heuristics for informed search algorithms
- pruning techniques: invariants, symmetry elimination, partial-order reduction, helpful actions pruning, ...

How do we find good heuristics in a domain-independent way?

$\rightsquigarrow$ one of the main focus areas of classical planning research

$\rightsquigarrow$ Parts D–F

Summary

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(Joint summary follows after next chapter.)