

Planning and Optimization

C1. Overview of Classical Planning Algorithms (Part 1)

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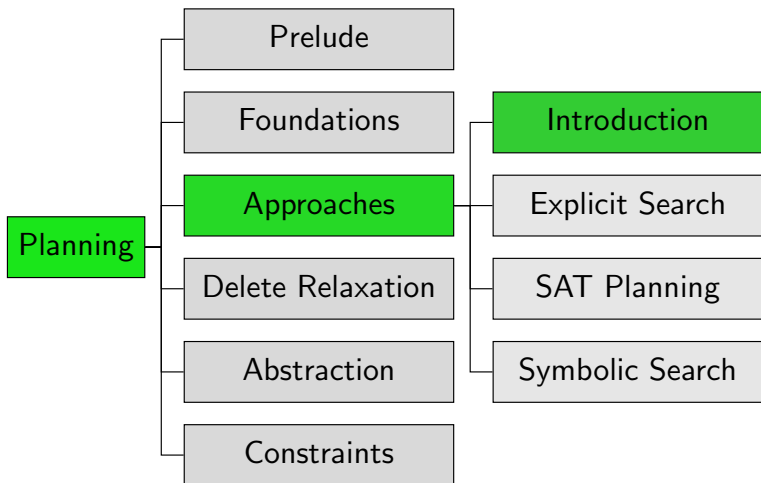
October 6, 2025 — C1. Overview of Classical Planning Algorithms (Part 1)

C1.1 The Big Three

C1.2 Explicit Search

C1.3 Summary

Content of the Course



C1.1 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

C1.2 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? $\rightsquigarrow$ many design choices!

Design Choice: Search Direction

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

$\rightsquigarrow$ 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

C1.3 Summary

Summary

(Joint summary follows after next chapter.)