An Overview of the International Planning Competition Part 1: AI Planning and the IPC

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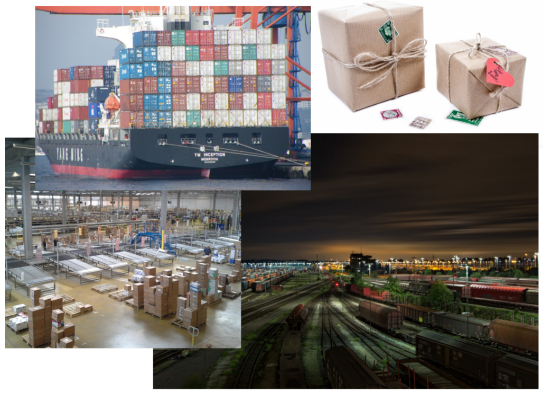
Classical and Temporal Planning in a Nutshell



Classical planning

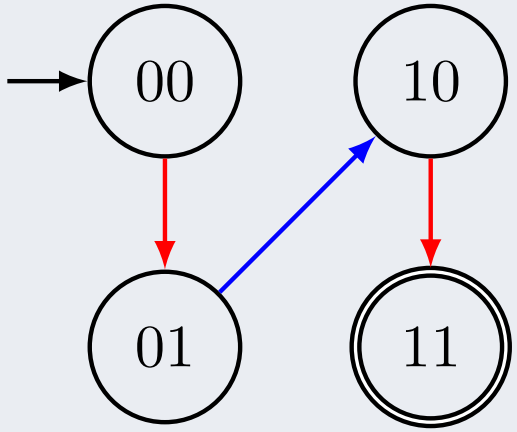
- Find operator sequence to achieve a goal
- Discrete, single-agent, observable, deterministic

Temporal planning

- actions take time and can be executed in parallel
- usually also includes numeric effects

Classical Planning Tasks

Example task: binary counter



State space

- States ○ assign values to variables
- Initial state →○
- Goal states ◎
- Operators ⟹ have conditions and effects on variables

Compact Representation with PDDL

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Evolution of PDDL

- 1998, 2000: PDDL 1.0: STRIPS, ADL (quantified effects and preconditions, conditional effects)
- 2002: PDDL 2.1: temporal + numeric planning
- 2004: PDDL 2.2: derived predicates and timed initial literals
- 2006: PDDL 3.0: soft goals and state trajectory constraints
- 2008: Restricted PDDL Features: STRIPS + action costs
- 2014: Re-introduced conditional effects

Solving Classical Planning Tasks

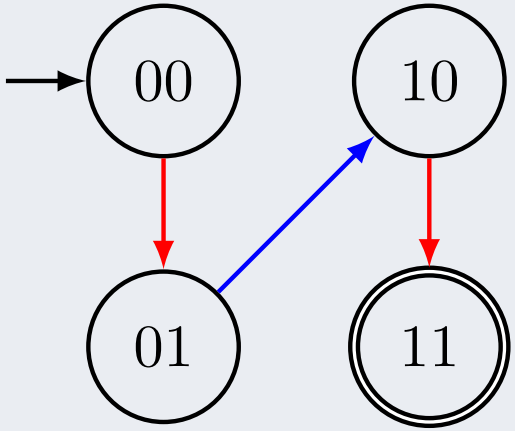
Search

Two important approaches

- explicit state search (A*, GBFS, ...)
  - every search node represents a state
  - expansion: generating successors for applicable operators
  - search guided by heuristic
- symbolic seach
  - every search node represents a set of states
  - expansion: generating all states reachable in one step
  - sets of states compactly represented (BDD, ...)
  - can also be guided by heuristic

Abstractions

Abstractions of Planning Tasks



- full state space too big
  - example: plan for 10 trucks in 10 cities
- map to smaller space
- extract lower bound from abstractions

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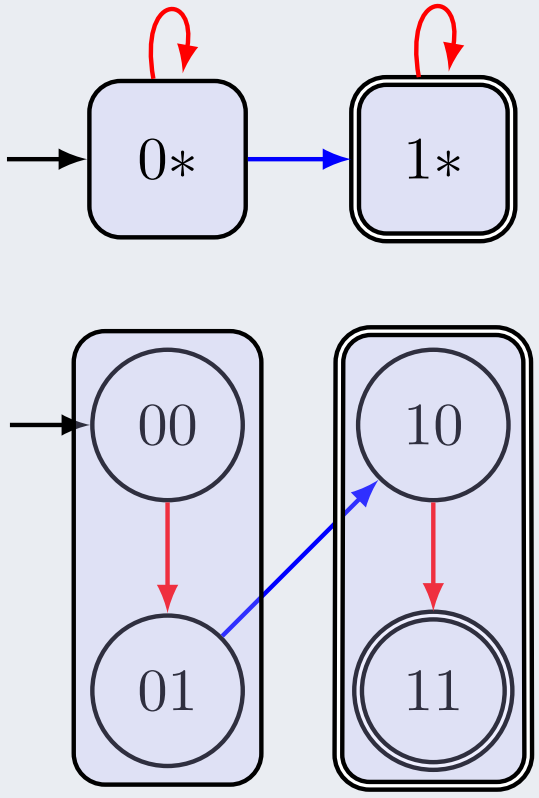

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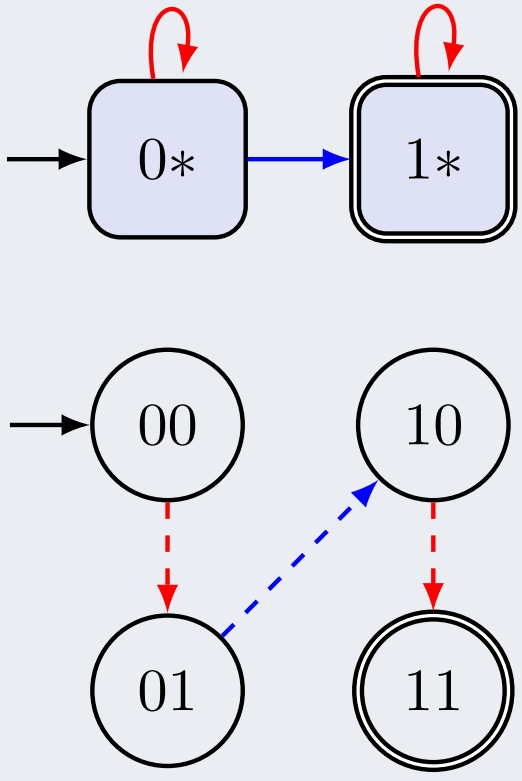

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Delete Relaxations

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Delete Relaxations

- modify domain so deleting a fact never helps
- ignore some or all delete effects
- problem is simpler to solve
- heuristic value: solution cost in the relaxation

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Novelty

Novelty

- when exploring the state space prefer new areas
- a state is novel if we see parts of it for the first time
- the more general the part, the more novel the state
- limit search to only explore novel states
- can be combined with heuristics (best-first width search)

The International Planning Competition

IPC

The International Planning Competition (IPC)

- semi-regular competition
  - 1998, 2000, 2002, 2004, 2006, 2008, 2011, 2014, 2018
- organized in the context of the International Conference on Planning and Scheduling (ICAPS)

Past and Future IPCs

- `icaps-conference.org/index.php/Main/Competitions`
- `icaps-conference@googlegroups.com`

Goals of the IPC

Goals

- evaluate state-of-the-art planning systems
- promote planning research
- highlight challenges
- provide new benchmarks

IPC Organization

Organization

- different tracks for different planning variants
- tracks organized more or less independently
  - initiative of track organizers
  - IPC happens if someone organizes a track

Organizing a Track

Jobs as an organizer

- track rules
- benchmarks
  - create/elicit new domains
  - select instances
  - find reference solutions
- participants
  - elicit participation
  - compile planners
  - assist in testing/bug fixing
- experiments
  - run planners on benchmarks
  - evaluate results

IPC Tracks

Classical Planning Tracks

- satisficing (1998, 2000, 2004, 2006, 2008, 2011, 2014, 2018)
- optimal (2004, 2006, 2008, 2011, 2014, 2018)
- satisficing multi-core (2011, 2014)
- agile (2014, 2018)
- cost-bounded (2018)

Temporal Metric Planning

- satisficing (2002, 2004, 2008, 2011, 2014, 2018)
- optimal (2006, 2008, 2014)
- agile (2018)

...

IPC Tracks (continued)

Probabilistic Planning

- MDP (2004, 2006, 2011, 2018)
- conformant (2006, 2008)
- POMDP (2011)
- FOND, NOND (2008)
- continuous (2014)

Preferences, Constraints, Net-benefit

- satisficing (2006, 2008, 2014)
- optimal (2008, 2014)

Learning (2008, 2011, 2014)
Unsolvability (2016)
Hand-Tailored, Domain-Specific tracks (1998, 2000, 2002)