Situated Planning: Searching a burning tree

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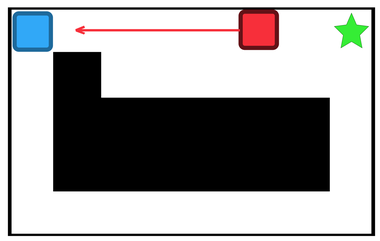
Planning Under Time Pressure

Offline planning find complete plan, then execute
Anytime planning improve complete plan until terminated
Realtime planning return partial plan by fixed deadline
Situated planning relax realtime

- time pressure from agent's objective replaces deadline



Time passes: moving, thinking or waiting

Search nodes: expire

- Must decide when to commit to action(s)

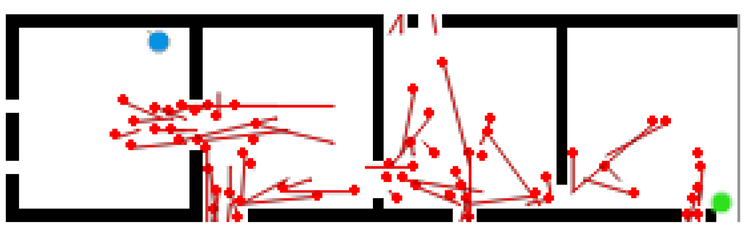
Planning without acting: costs

- Missed opportunities
- Potential danger

Metareasoning: planning how to plan

- Important to provide a net benefit

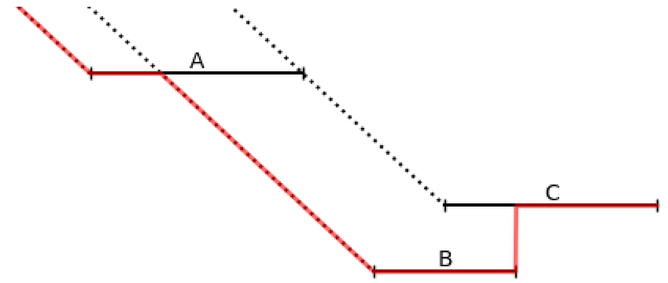
SPAM-O



Given: 2D grid with moving and static obstacles, start and goal location
Find: actions incrementally, minimizing time-to-goal
Subject to: safety
Offline problem: SIPP(Phillips and Likhachev ICRA 2011)
Safe Intervals: consecutive colocated safe states

Subintervals: Safe Interval search for SPAM-O

SIPP searches on intervals because earlier states dominate
Subintervals the time-dependent cost-to-go of interval states



The piecewise linear function is defined by:
subintervals corresponding to it's children.

$$h_{subinterval}(t) = \begin{cases} h - (t - start) & t < start \\ h & start \leq t \leq end \\ \inf & else \end{cases} \quad (1)$$

Situated agents using subintervals can:

- Generate successor states that front load planning
- Generalize the dynamic component of heuristic learning.

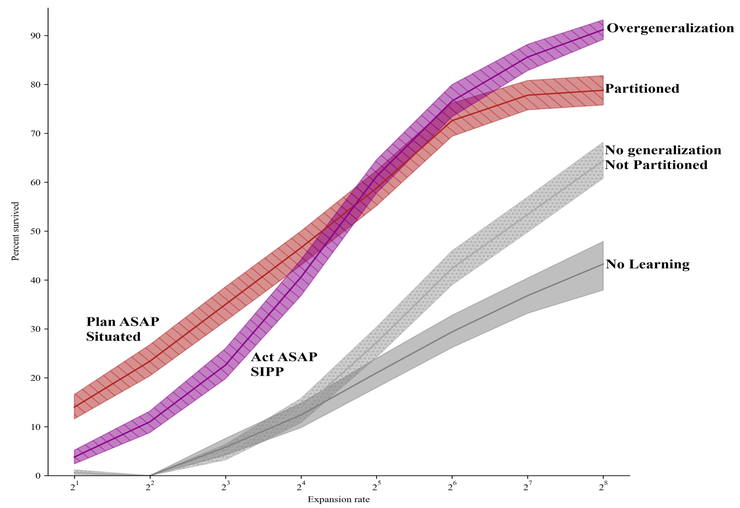
Research Questions

Q1: What makes a successful situated agent?

- Successor generation:
  Act ASAP SIPP style
  Plan ASAP Same end state, but frontload waiting
- Heuristic generalization
  No Generalization learn to states
  Overgeneralization learn to safe intervals
- Heuristic learning
  No Learning don't learn
  LSS-LRTA* learn heuristic from frontier
  Partitioned learn static map separately

Q2: When do the metareasoning methods that have been suggested in theory pay off in practice?

Results



R1: Generalized or partitioned learning is important.
R2: Situated specific methods can help.

Opportunistic Science

Given: opportunity to exchange resources for reward
Find: whether to exploit the opportunity
Subject to: a long term plan

Resource constraint more realistic than time constraint in SPAM-O

Orienteering

Given: graph of locations, start location, set of time bounded rewards at locations
Find: actions incrementally, maximizing sum of rewards.
Subject to: return to start by deadline

Similar to opportunistic science, but all opportunities are known up front

Conclusions

- Applications demand situated planning!
- Situated planning suggests both theoretical and practical research.
- Starting with the simplest: situated pathfinding.