Introduction to Artificial Intelligence

Planning and Acting

Chapter 13

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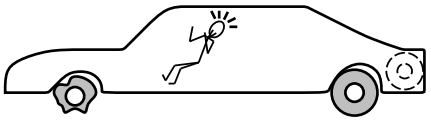
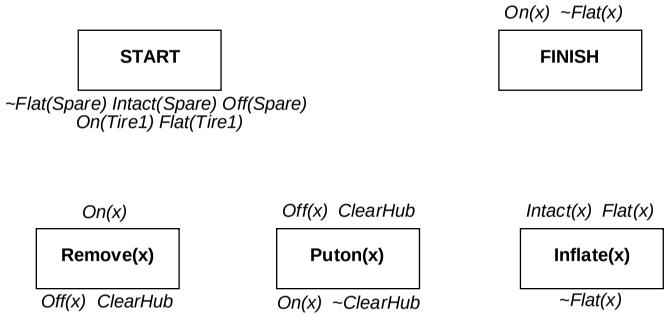
Outline

- ♢ The real world
- ♢ Conditional planning
- ♢ Monitoring and replanning

The real world





Things go wrong

Incomplete information

Unknown preconditions, e.g., $Intact(Spare)$?
Disjunctive effects, e.g., $Inflate(x)$ causes

$$Inflated(x) \vee SlowHiss(x) \vee Burst(x) \vee BrokenPump \vee \ldots$$

Incorrect information

Current state incorrect, e.g., spare NOT intact
Missing/incorrect postconditions in operators

Qualification problem:

can never finish listing all the required preconditions and possible conditional outcomes of actions

Solutions

Conditional planning

Plan to obtain information (**observation actions**)
Subplan for each contingency, e.g.,
$[Check(Tire1), \mathbf{If}(Intact(Tire1), [Inflate(Tire1)], [CallAAA])]$
Expensive because it plans for many unlikely cases

Monitoring/Replanning

Assume normal states, outcomes
Check progress *during execution*, replan if necessary
Unanticipated outcomes may lead to failure (e.g., no AAA card)

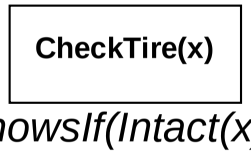
In general, some monitoring is unavoidable

Conditional planning

$[\ldots, \mathbf{If}(p, [then\,plan], [else\,plan]), \ldots]$

Execution: check p against current KB, execute "then" or "else"

Conditional planning: just like POP except
if an open condition can be established by **observation** action
add the action to the plan
complete plan for each possible observation outcome
insert conditional step with these subplans



Conditional planning example

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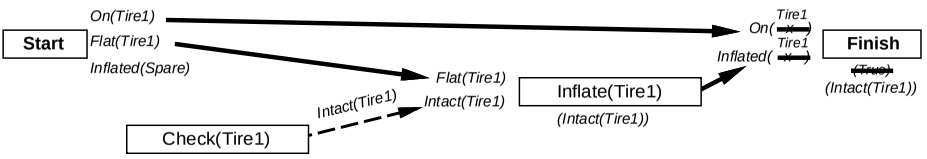
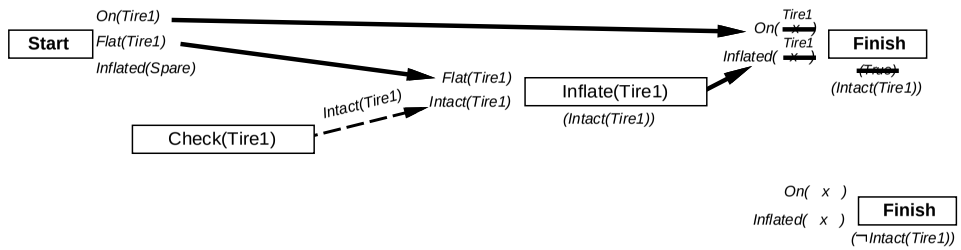
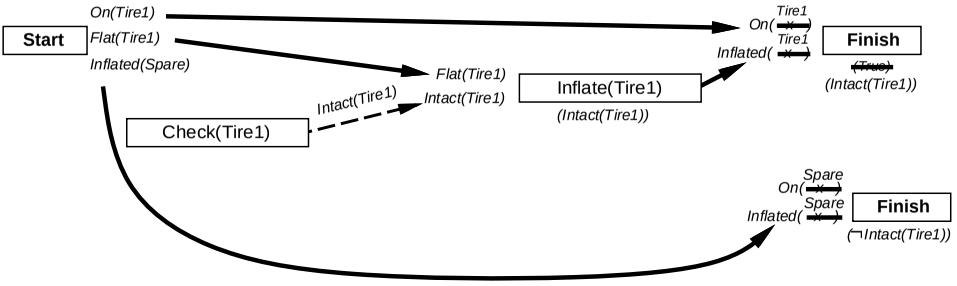


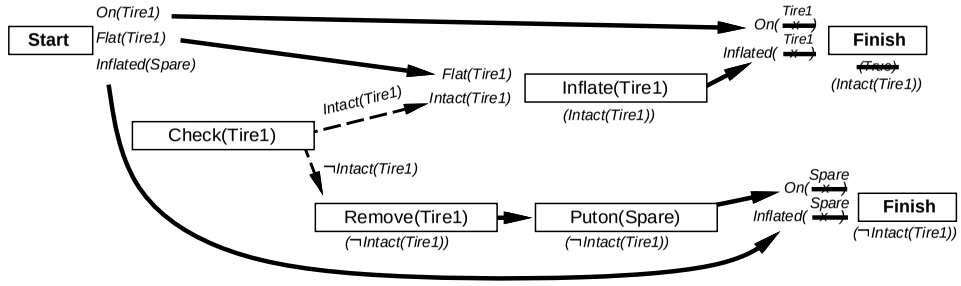
Conditional planning example



Conditional planning example



Conditional planning example



Monitoring

Execution monitoring

"failure" = preconditions of *remaining plan* not met

preconditions = **causal links at current time**

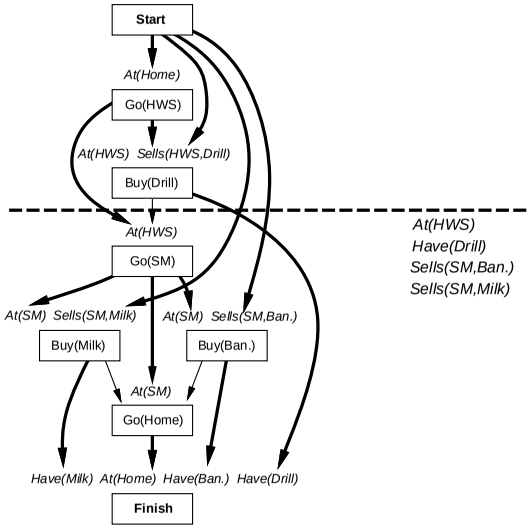
Action monitoring

"failure" = preconditions of *next action* not met

(or action itself fails, e.g., robot bump sensor)

In both cases, need to *replan*

Preconditions for remaining plan



Replanning

Simplest: on failure, replan from scratch

Better: plan to get back on track by reconnecting to best continuation
Generates "loop until done" behavior with no explicit loop