

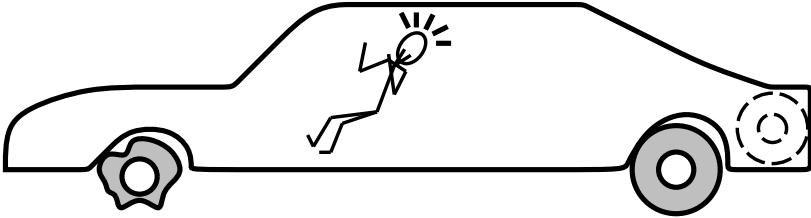
Planning and Acting

CHAPTER 13

Outline

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

The real world



START

On(x) ~Flat(x)

FINISH

*~Flat(Spare) Intact(Spare) Off(Spare)
On(Tire1) Flat(Tire1)*

On(x)

Remove(x)

Off(x) ClearHub

Off(x) ClearHub

Puton(x)

On(x) ~ClearHub

Intact(x) Flat(x)

Inflate(x)

~Flat(x)

Things go wrong

Incomplete information

Unknown preconditions, e.g., *Intact(Spare)?*

Disjunctive effects, e.g., *Inflate(x)* causes

$\textit{Inflated}(x) \vee \textit{SlowHiss}(x) \vee \textit{Burst}(x) \vee \textit{BrokenPump} \vee \dots$

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

[..., **If**(p , [*then plan*], [*else plan*]), ...]

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

CheckTire(x)

KnowsIf(Intact(x))

Conditional planning example

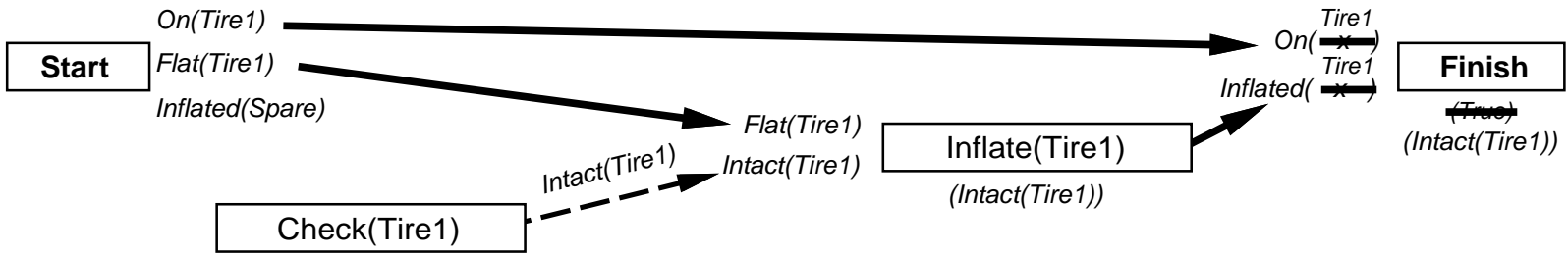
Start
On(Tire1)
Flat(Tire1)
Inflated(Spare)

On(x)
Inflated(x) **Finish**
(True)

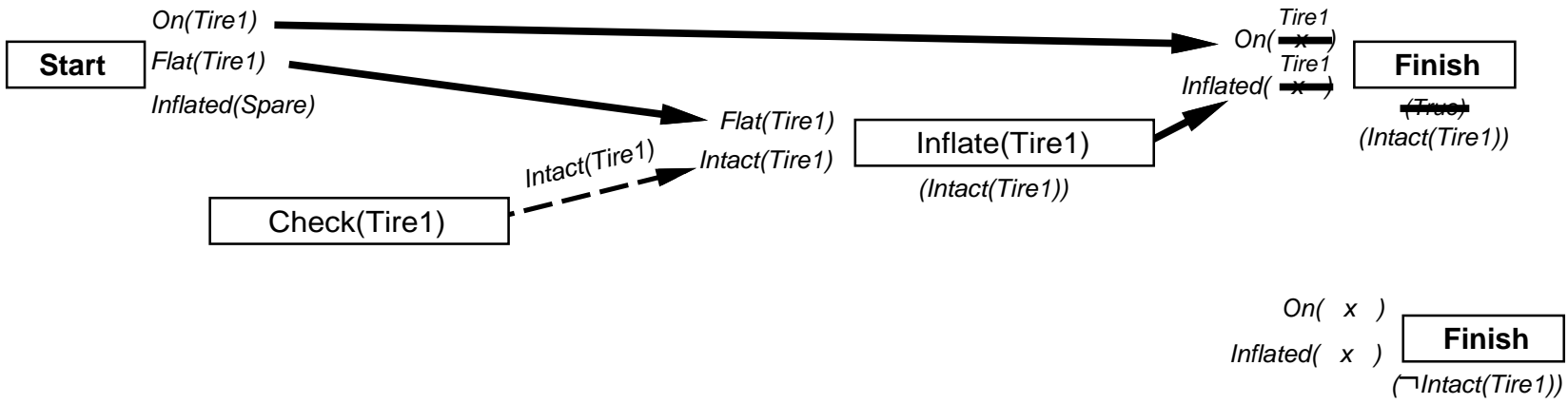
Conditional planning example



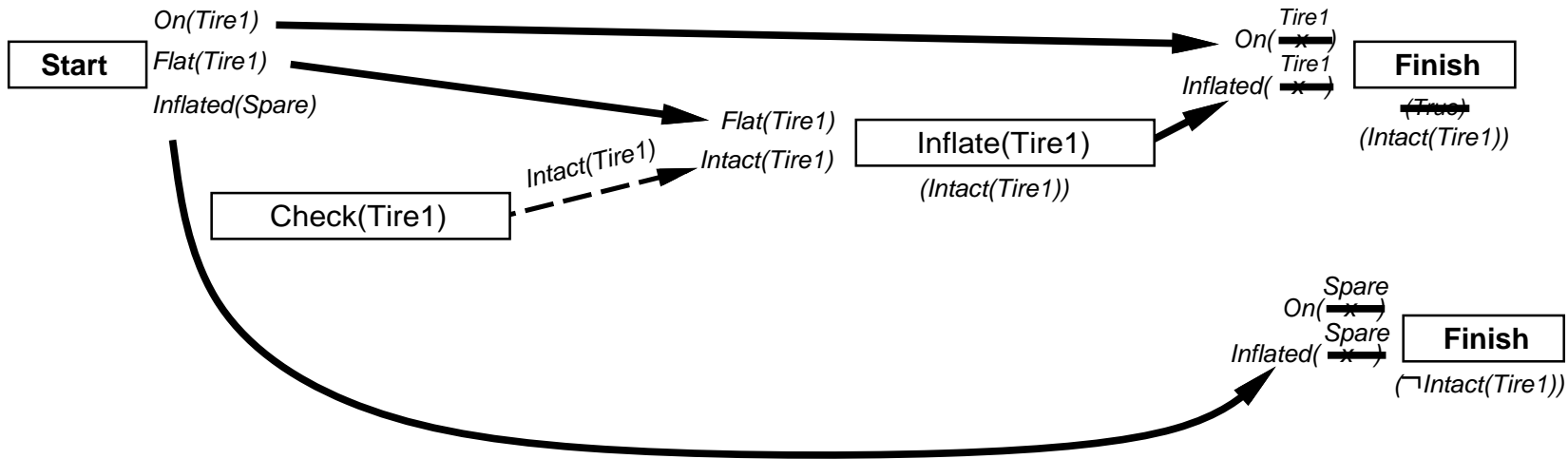
Conditional planning example



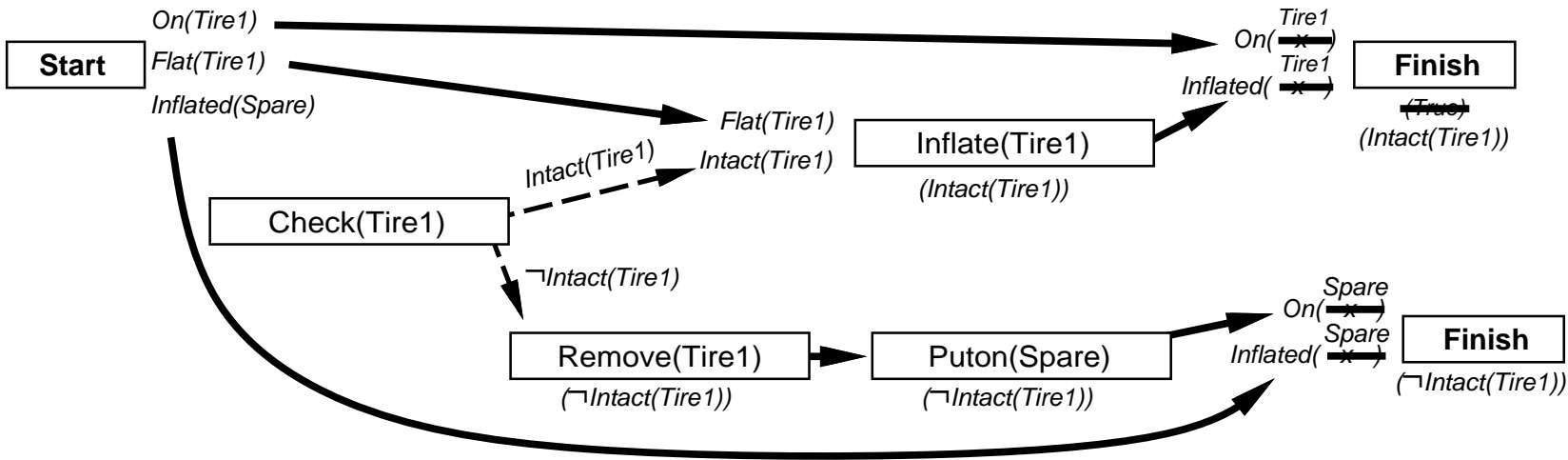
Conditional planning example



Conditional planning example



Conditional planning example



Monitoring

Execution monitoring

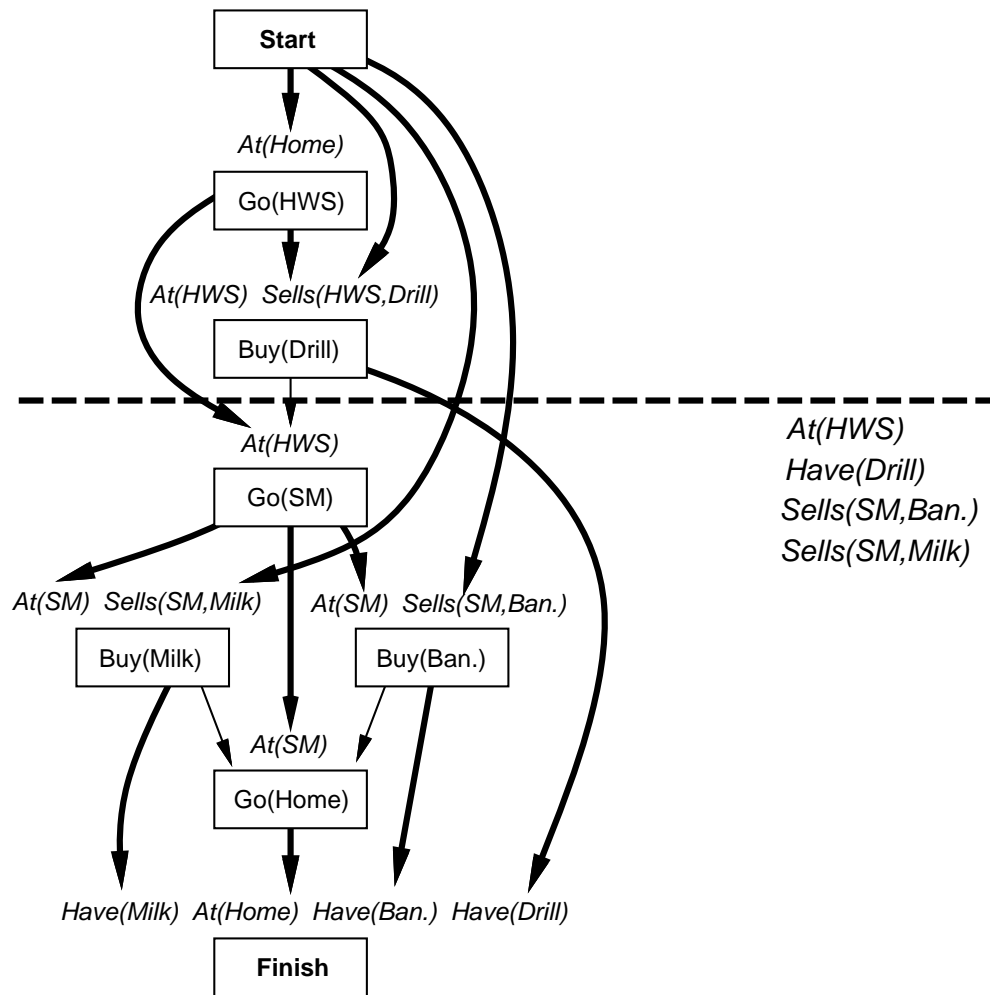
“failure” = preconditions of *remaining plan* not met
preconditions = causal links at current time

Action monitoring

“failure” = preconditions of *next action* not met
(or action itself fails, e.g., robot bump sensor)

In both cases, need to *replan*

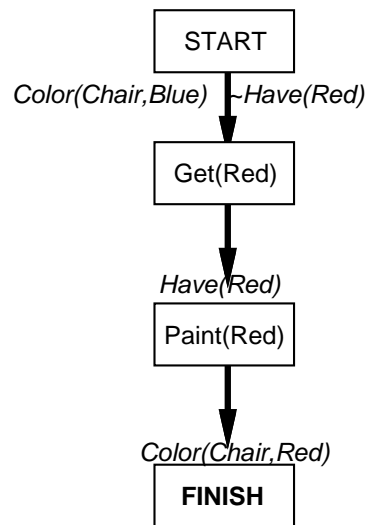
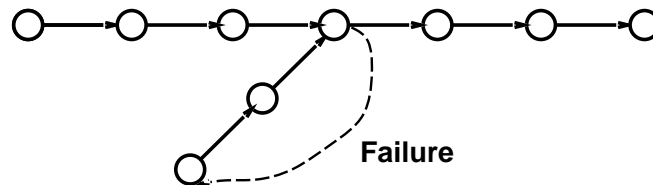
Preconditions for remaining plan



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



PRECONDITIONS

FAILURE RESPONSE

none

N/A

Have(Red)

Fetch more red

Color(Chair,Red)

Repaint