Planning and Acting

Chapter 13

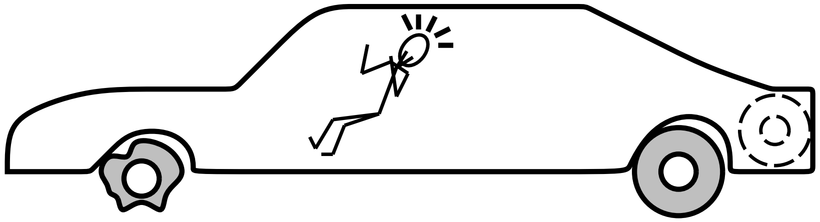
Outline

◇ The real world

◇ Conditional planning

◇ Monitoring and replanning

The real world



On(x) ~Flat(x)

FINISH

START

~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

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

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

<u>Conditional planning</u>

Plan to obtain information (**observation actions**)

Subplan for each contingency, e.g.,

$[Check(Tire1), \textbf{If}(Intact(Tire1), [Inflate(Tire1)], [CallAAA])]$

Expensive because it plans for many unlikely cases

<u>Monitoring/Replanning</u>

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

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

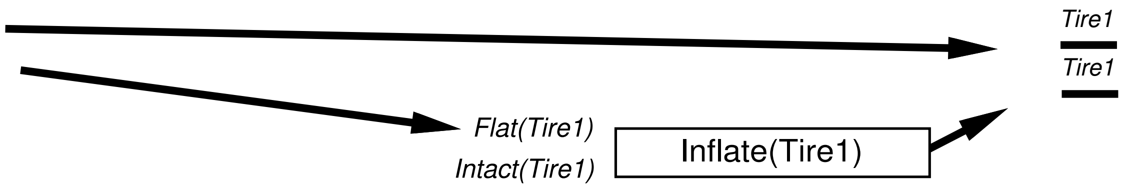
Execution: check p against current KB, execute "then" or "else"

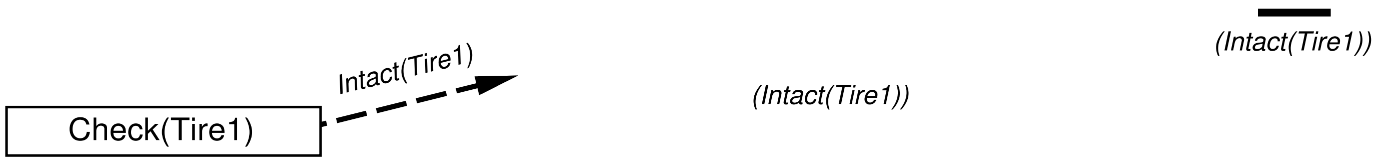
Conditional planning: just like POP except
  if an open condition can be established by <u>observation</u> action
    add the action to the plan
    complete plan for each possible observation outcome
    insert conditional step with these subplans

$\boxed{\textbf{CheckTire(x)}}$

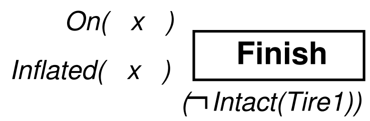
KnowsIf(Intact(x))

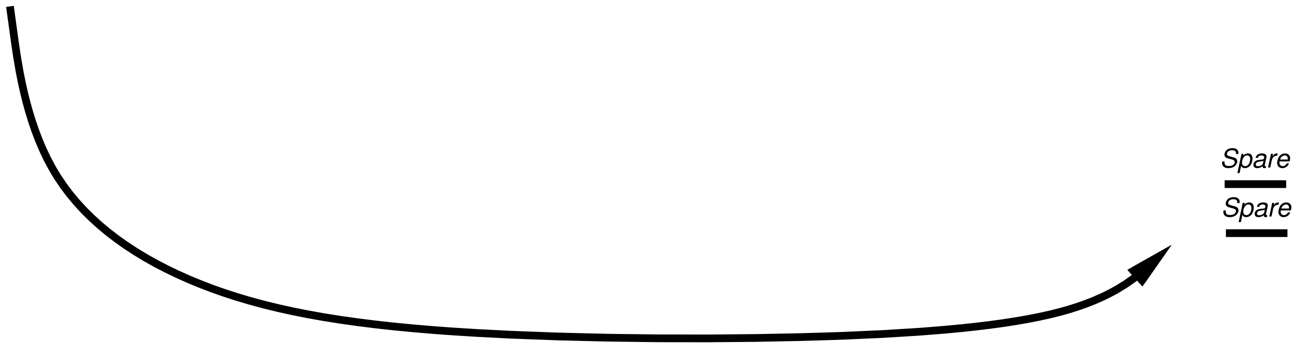
Conditional planning example

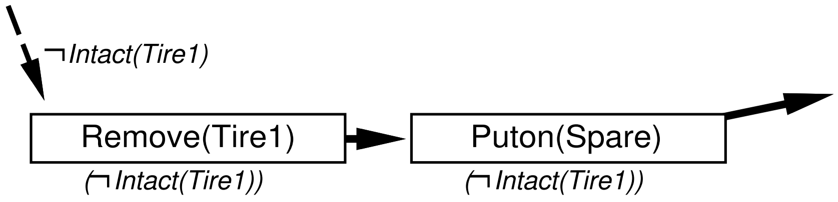

Tire1
Tire1
Flat(Tire1)
Intact(Tire1)
Inflate(Tire1)



Check(Tire1)
Intact(Tire1)
(Intact(Tire1))
(Intact(Tire1))


On(x)
Inflated(x)
Finish
(¬ Intact(Tire1))


Spare
Spare


¬Intact(Tire1)
Remove(Tire1)
(¬Intact(Tire1))
Puton(Spare)
(¬Intact(Tire1))

Monitoring

Execution monitoring

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

preconditions = <u>causal links at current time</u>

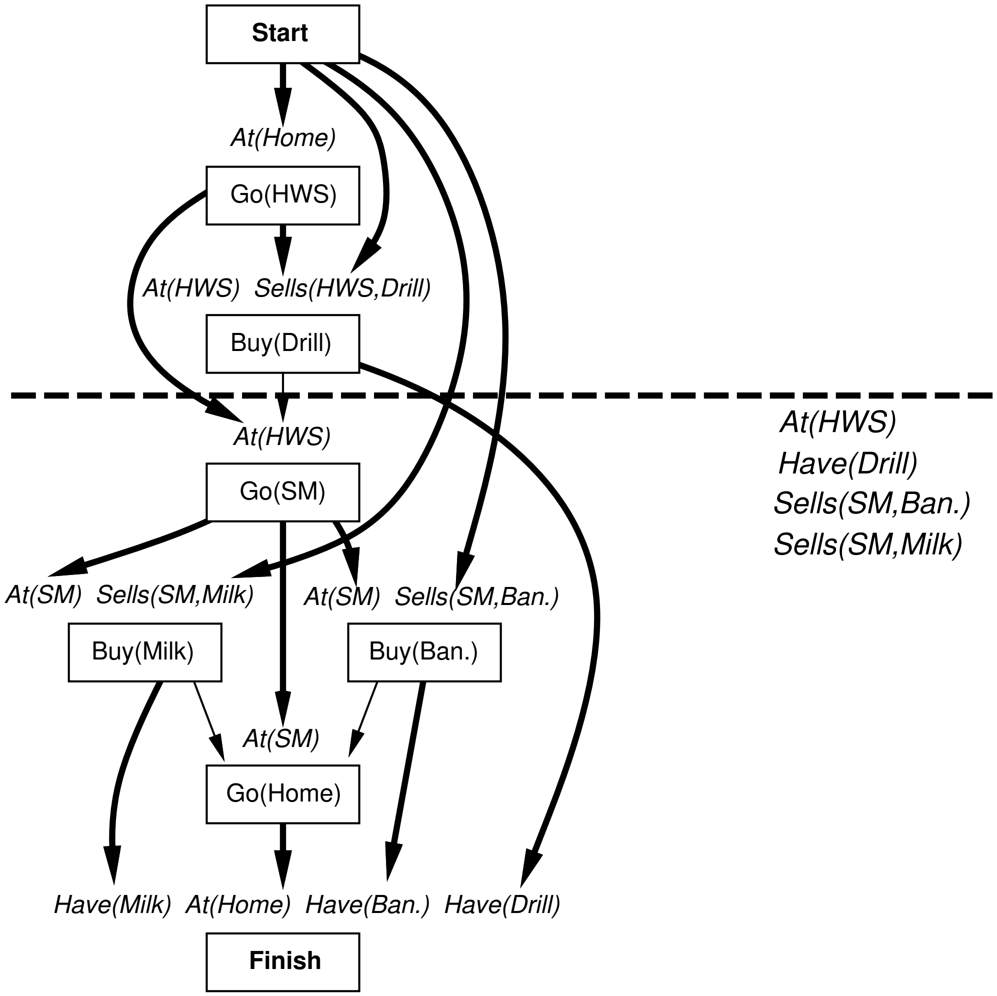
Action monitoring

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

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

In both cases, need to *replan*

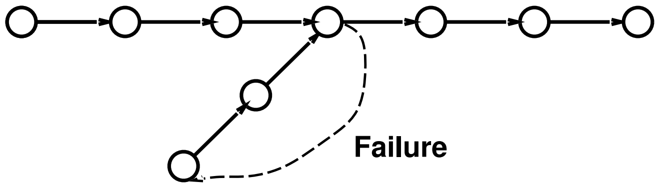
Preconditions for remaining plan

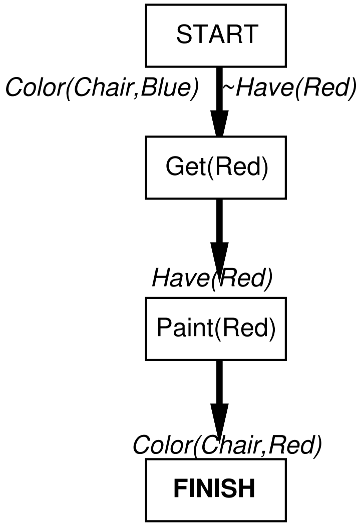


Replanning

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