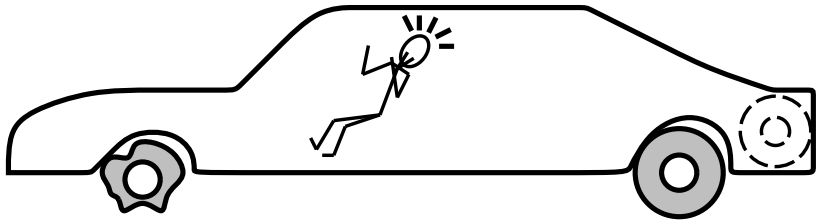
Planning and Acting

Outline

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

The real world



On(x) ~Flat(x)

START

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

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

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)

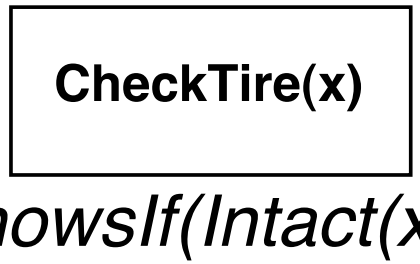
In general, some monitoring is unavoidable

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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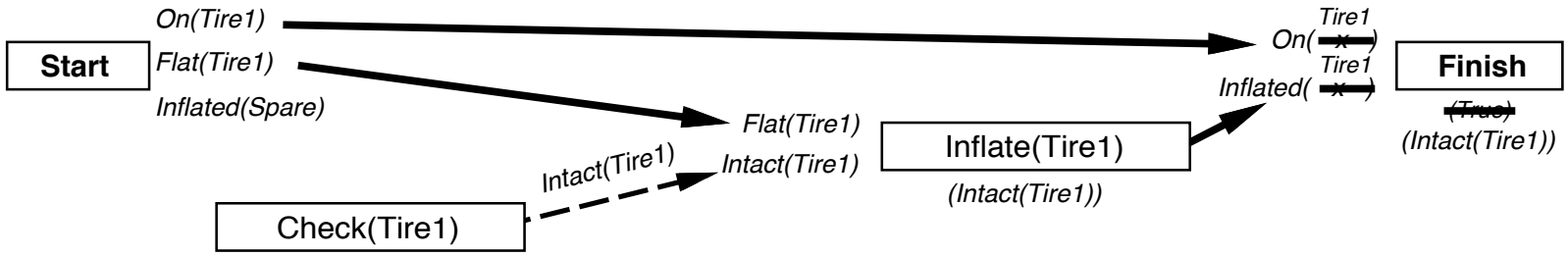
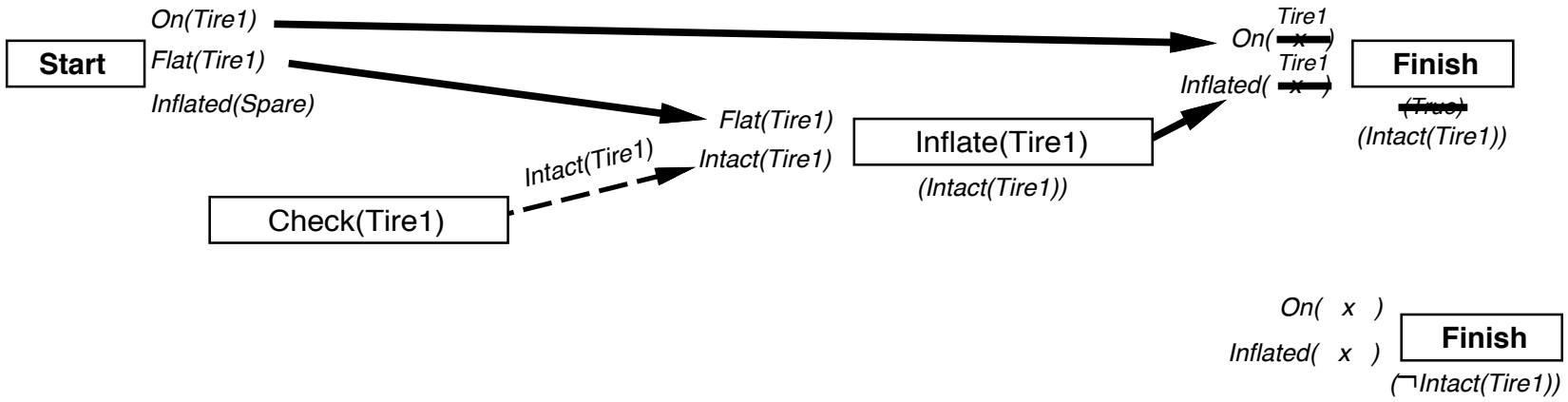
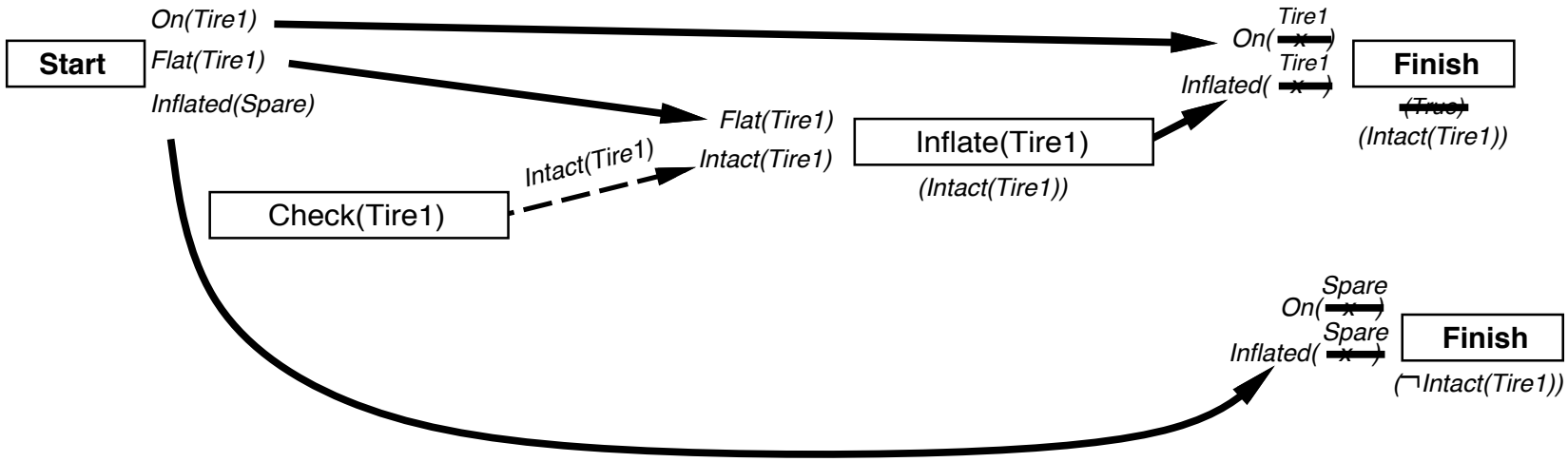


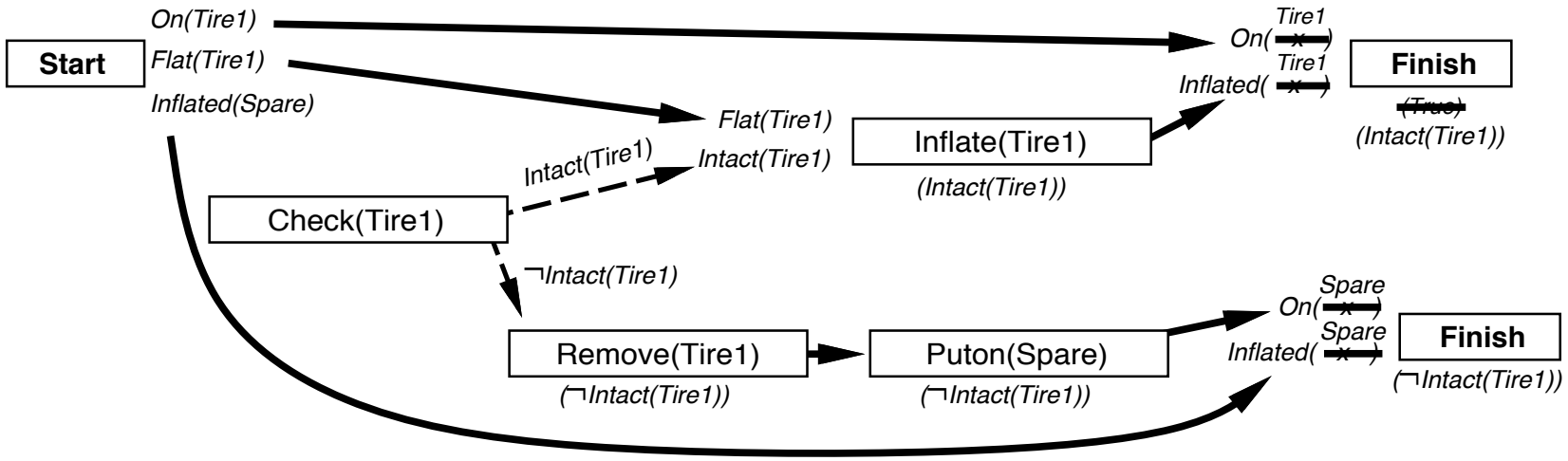
Conditional planning example



Conditional planning example



Conditional planning example



Monitoring

Execution monitoring

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

preconditions = causal links at current time

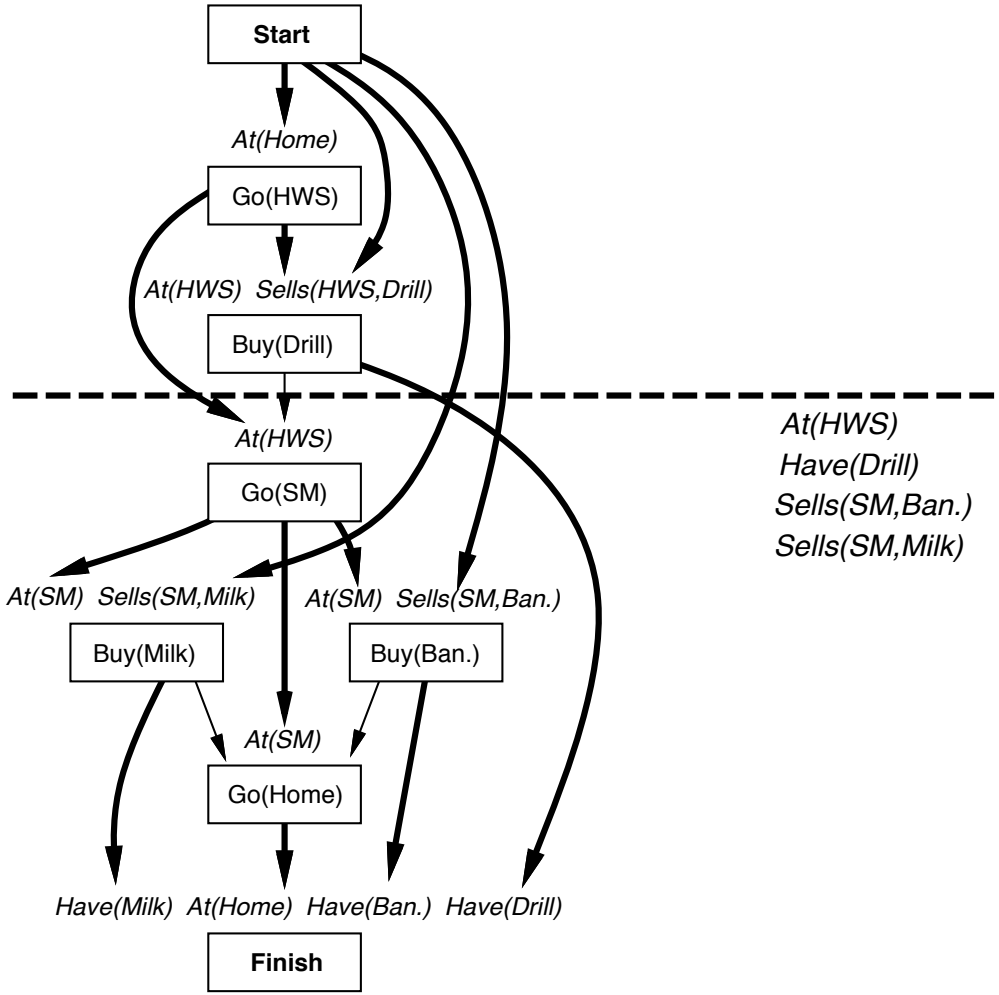
Action monitoring

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

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

In both cases, need to *replan*

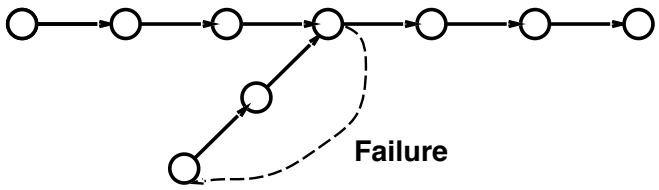
Preconditions for remaining plan

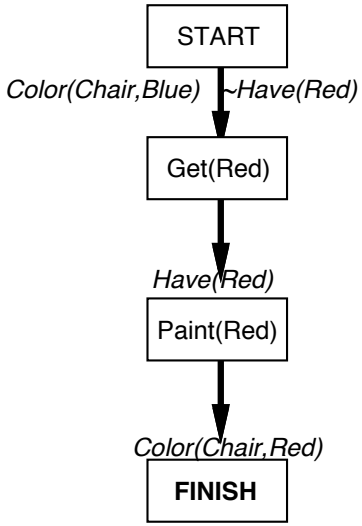


Replanning

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





PRECONDITIONS	FAILURE RESPONSE
none	**N/A**
Have(Red)	**Fetch more red**
Color(Chair,Red)	**Repaint**