How to Make Your Planner Rude

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Multi-Agent Planning

- Reason about plans of other entities
  - What are you going to do in the future?
- Reason about interactions between agents' plans
  - Do my plans conflict with yours?
  - Are there opportunities to help or be helped?
- Allow flexible planning interactions
  - Most research focuses on specific context
    - » Collaborative agents, selfish agents, adversarial agents
  - How can we support range of planning "personalities"
    - » rude, authoritative, helpful, meek

Example

- Husband's goals
  - Bring home groceries
  - Then play soccer

- Wife's goals
  - Drink beer on the beach

- Complication
  - One SUV family

Husband: a helpful interaction

- Plan:
  - Drive car to grocery store
  - Drop groceries at home
  - Drive to soccer game

- Seek opportunities to be helpful
  - Communicate my plans
    - » "I'm planning to go to the market and then playing soccer"
  - Notice relationship to wife's goals
    - » Wife often needs things from the market
  - Suggest helpful activities
    - » "Honey, can I buy you anything from the market?"
  - Don't cause conflicts with wife's plans

Wife: a rude interaction

- Plan:
  - Tell husband to buy beer
  - While he's unpacking, take car and beer to beach

- Seek opportunities to slack off
  - Take advantage of husband's actions
    - » "Yes, please get me beer"
  - Ignore conflicts I introduce in husband's plan
    - » Taking car means husband can't play soccer. OH WELL...
  - EXCEPT when in my interest
    - » Don't interfere with his plan to get the beer
  - Lie through your teeth
    - » Don't tell husband I'm going to beach (till it's too late. Ha Ha)

Issues

- Involves traditional planning knowledge
  - Must reason about how to achieve goals
  - Must understand causal structure between actions
    - » Being at market is precondition of buying beer
  - Must understand plan conflicts
    - » The car can't be at two places at the same time
- But can't plug and chug current planning techniques
  - Planning algorithms typically focus on single-agent planning
    - » Represent a single plan
    - » Don't distinguish between my actions and your actions
  - Involves knowledge that goes beyond the scope of planning
    - » e.g. When should I communicate my plans to someone

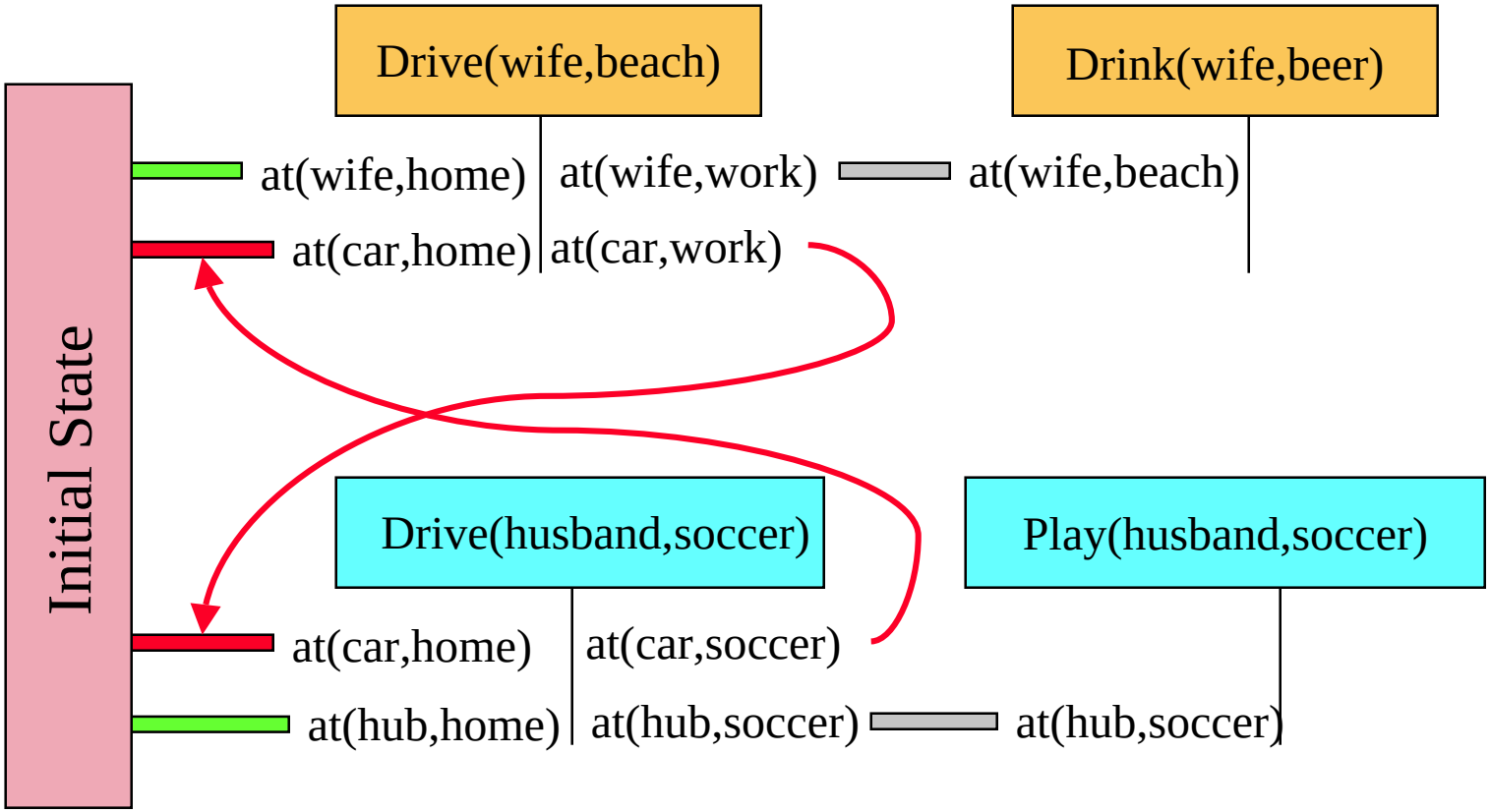
Approach

- Take classical planner
  - Develops plans
  - Detects interactions between actions
- Add a Plan Manager
  - **Represents multiple plans**
  - **Controls the plan generation process**
  - Manages planning stances
  - Manages communication

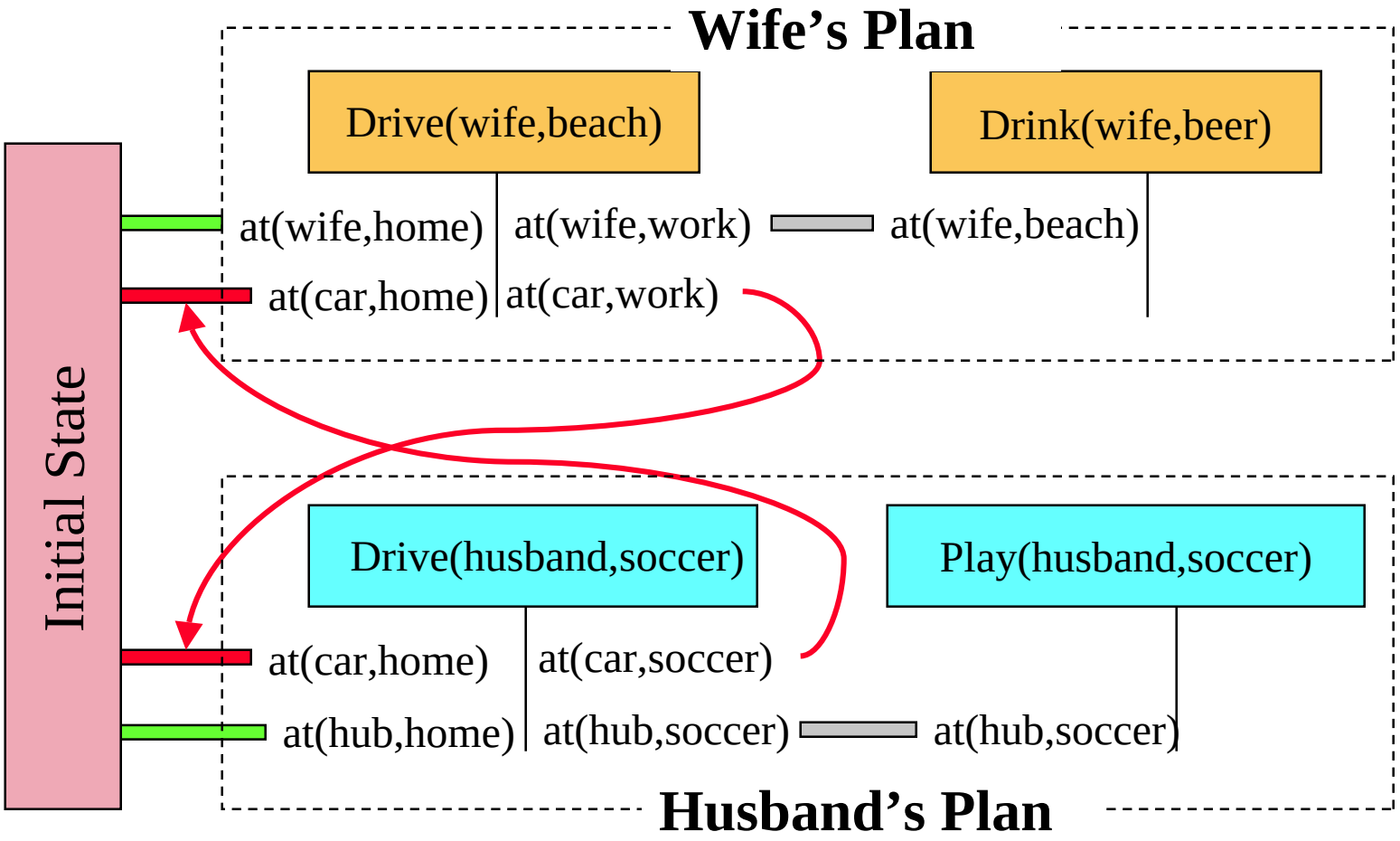
Representing Multiple Plans

- Redefine the notion of a “plan”
  - Traditionally, a plan is everything in planner’s memory
  - Distinguish between plan and “plan network”
  - A plan is some subset of the plan network
    - » Plans can be associated w/ activities of different agents
    - » Plans can be associated w/ different, loosely related goals
- Plan Manager does bookkeeping
  - Which activities belong to which plans

Example


Drive(wife,beach)
Drink(wife,beer)
Initial State
at(wife,home)
at(wife,work)
at(wife,beach)
at(car,home)
at(car,work)
Drive(husband,soccer)
Play(husband,soccer)
at(car,home)
at(car,soccer)
at(hub,home)
at(hub,soccer)
at(hub,soccer)

Example

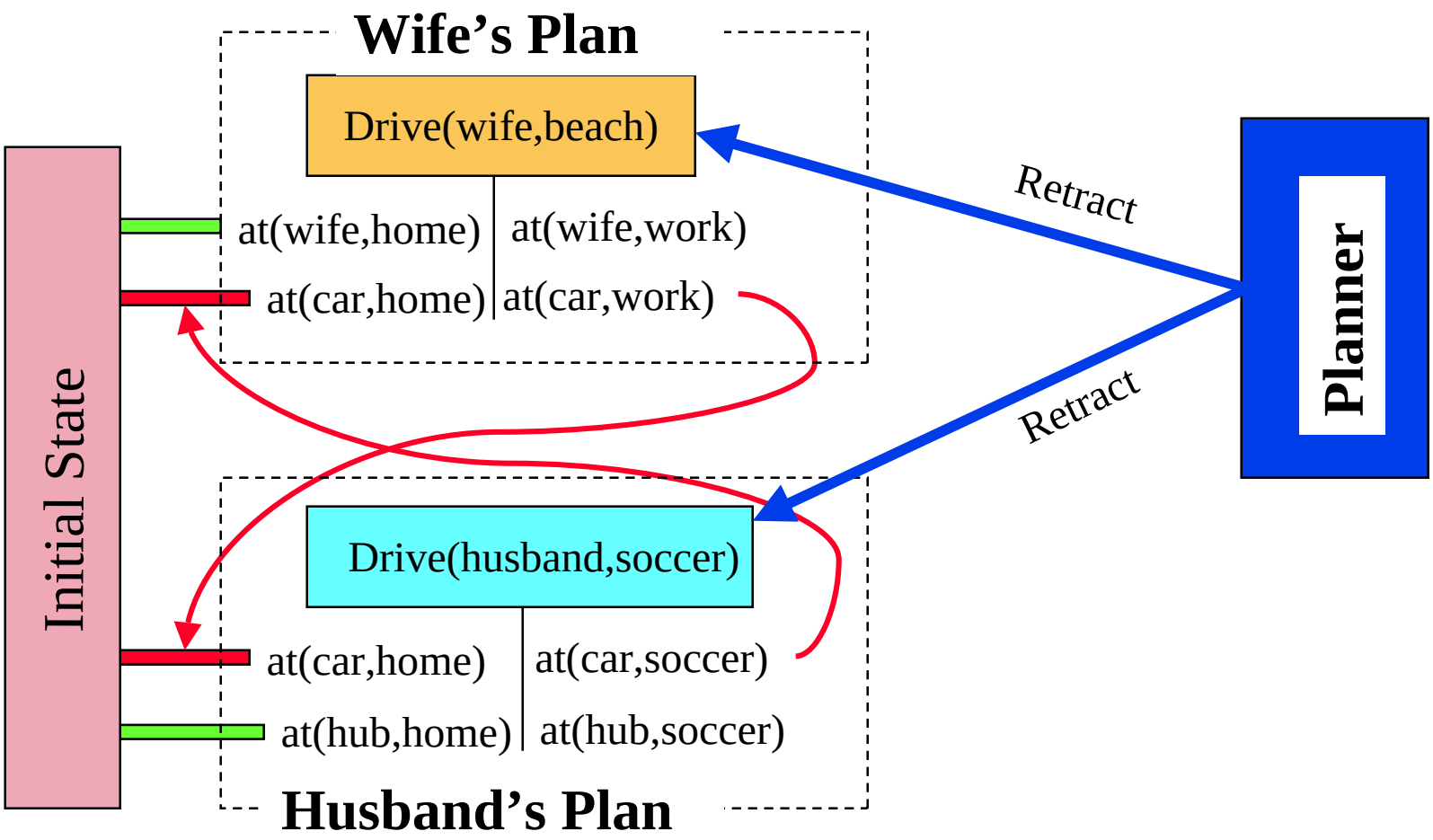

Wife's Plan
Drive(wife,beach)
Drink(wife,beer)
at(wife,home)
at(wife,work)
at(wife,beach)
at(car,home)
at(car,work)
Initial State
Drive(husband,soccer)
Play(husband,soccer)
at(car,home)
at(car,soccer)
at(hub,home)
at(hub,soccer)
at(hub,soccer)
Husband's Plan

Controlling the Planner

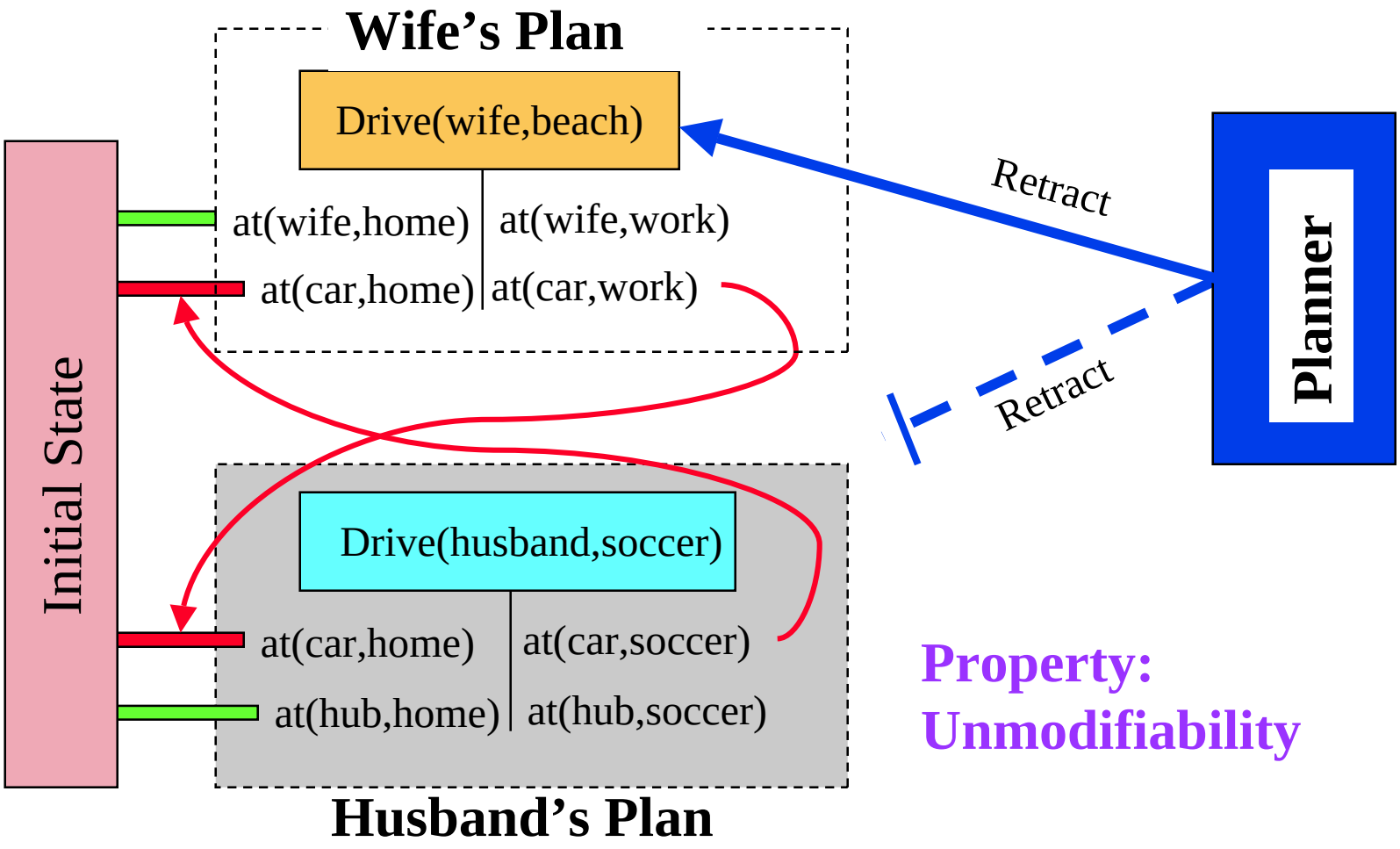
- Plan manager associates primitives with plans
- These interact to determine search control

- Example from Wife's perspective
  - Need to get to the beach
  - Problem
    - » If husband takes car to soccer, I can't go to beach

Example

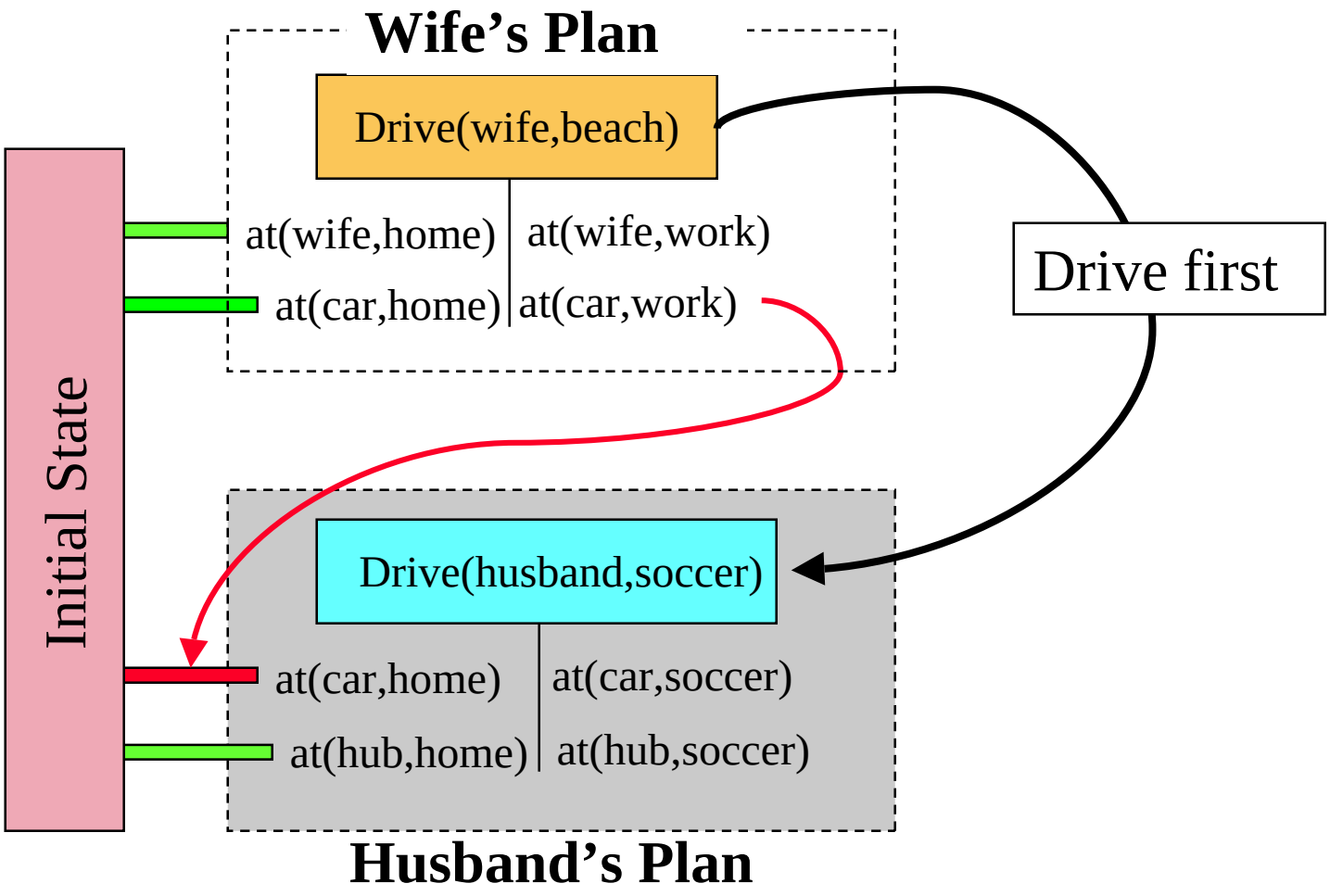

Wife's Plan
Drive(wife,beach)
at(wife,home)
at(wife,work)
at(car,home)
at(car,work)
Initial State
Retract
Planner
Retract
Drive(husband,soccer)
at(car,home)
at(car,soccer)
at(hub,home)
at(hub,soccer)
Husband's Plan

Example

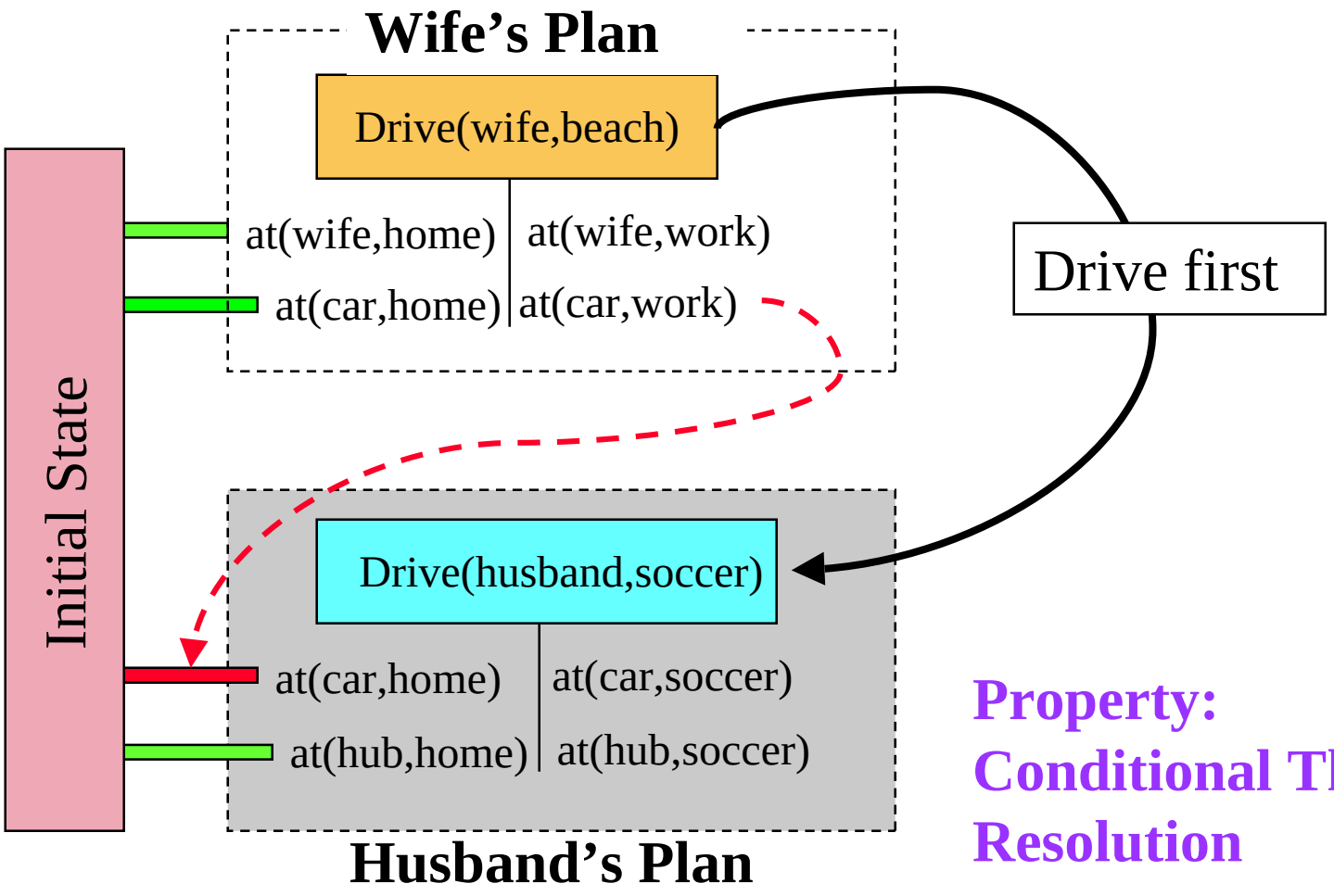


Property: Unmodifiability

Example


Wife's Plan
Drive(wife,beach)
at(wife,home)
at(wife,work)
at(car,home)
at(car,work)
Drive first
Initial State
Drive(husband,soccer)
at(car,home)
at(car,soccer)
at(hub,home)
at(hub,soccer)
Husband's Plan

Example



Property:
Conditional Threat Resolution

Control Primitives

- Plan executability
  - Can I initiate tasks in this plan?
- Threat resolution
  - If an decision in one plan introduces a threat in another, is this ok?
  - If ok, Filter out actions by planner to resolve these threats
- Role assignments
  - Assume tasks have an “agent” variable
  - Determines which agents can the planner bind to that variable
    - » if I’m helpful I can add myself to tasks in your plan
    - » if I’m authoritative I can add you to tasks in my plan
  - Represented by codesignation constraints

Summary

- Nuggets
  - Supports flexible inter-agent interactions
  - Models organizational interactions in Army simulations
  - Loose coupling between planner and plan manager
    - » Can uses existing planners “as is”
- Coal
  - Specific to “partial-order” planners
  - Gets pretty confusing