

Finding User-friendly Linearizations of Partially Ordered Plans

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Provide advanced user assistance based on:

- *user-centered* planning:
plan generation, execution, repair, explanation
- user interaction:
dialog and interaction management

Example domain:

- set up a complex home theater

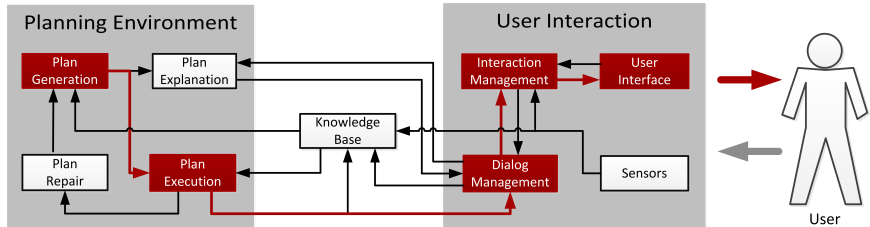


The Assembly Task:



communicate solution plan to the user:

- present the solution plan action by action
- display each primitive action in an adequate manner
 - load dialog model for each action
 - display dialog according to interaction management



Why bother about plan linearization?

- plans are executed by a human user!

How to generate plausible linearizations?

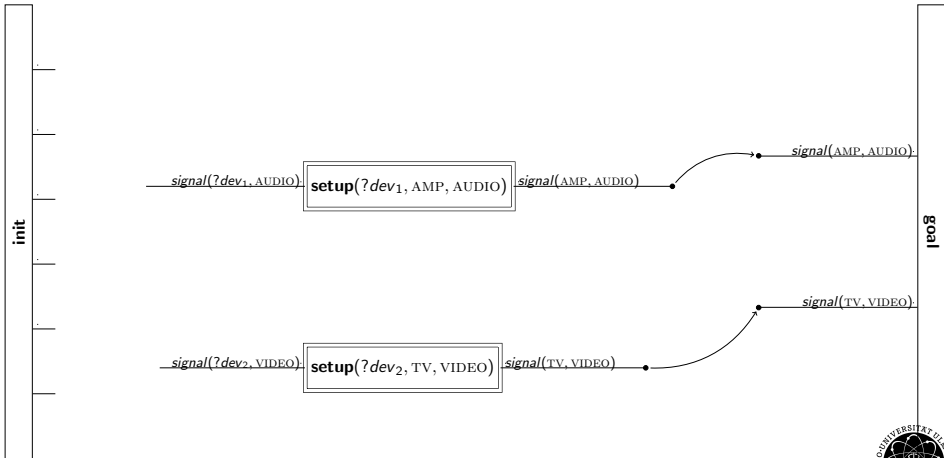
- exploit: planning domain and the solution
- how? we give three domain-independent approaches and illustrate them in the “home theater” example domain

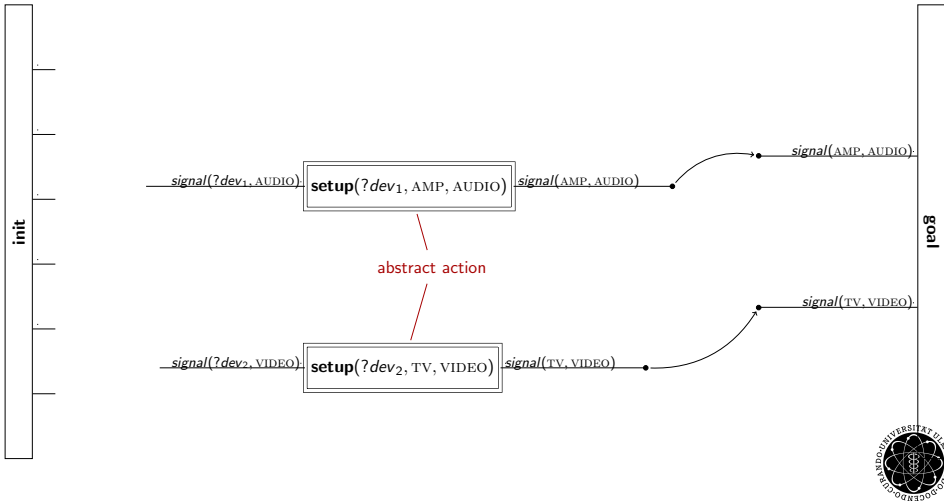


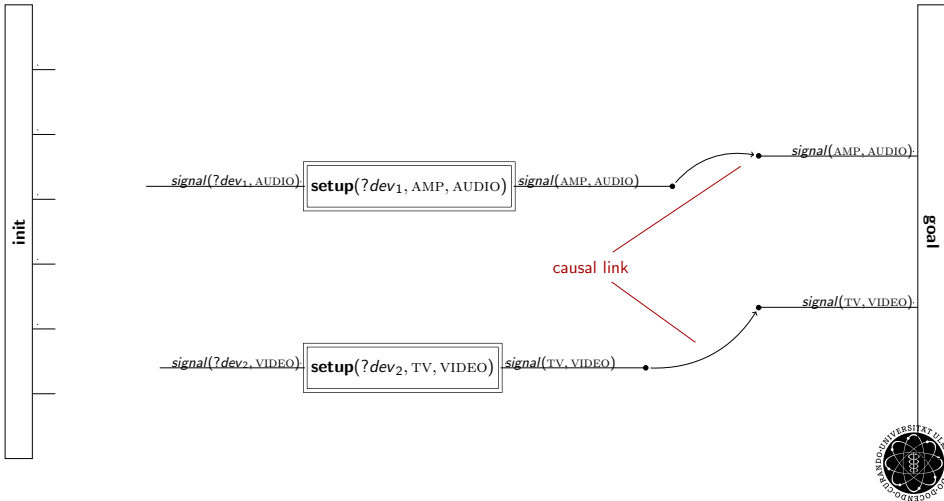
Hybrid Planning:

- approach fusing Hierarchical Task Network (HTN) Planning with Partial-Order Causal-Link (POCL) Planning
- search in the space of partial plans
- refine the initial partial plan until it is executable

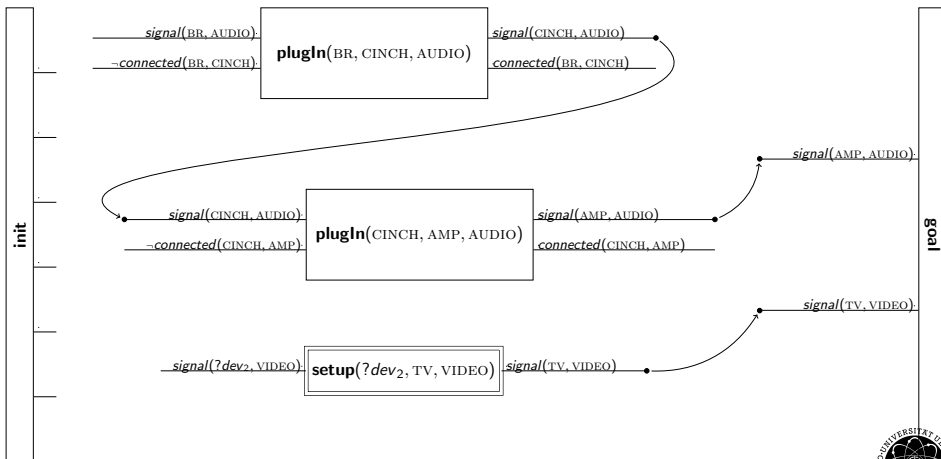


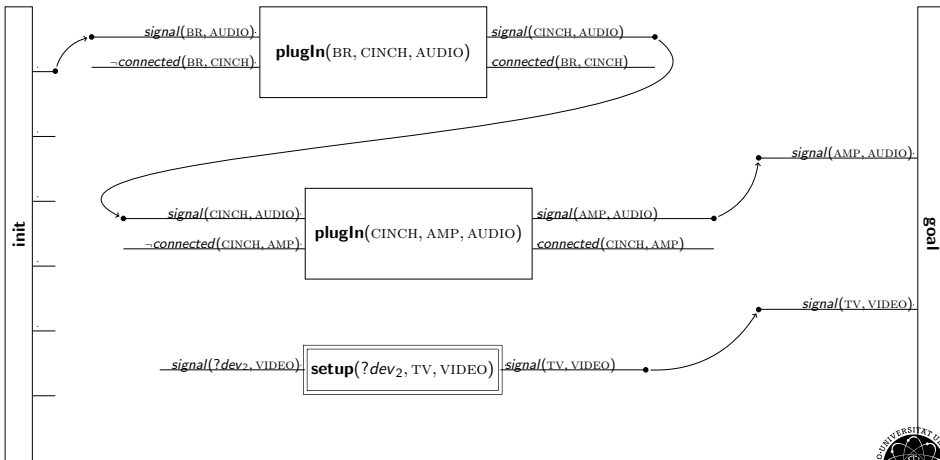


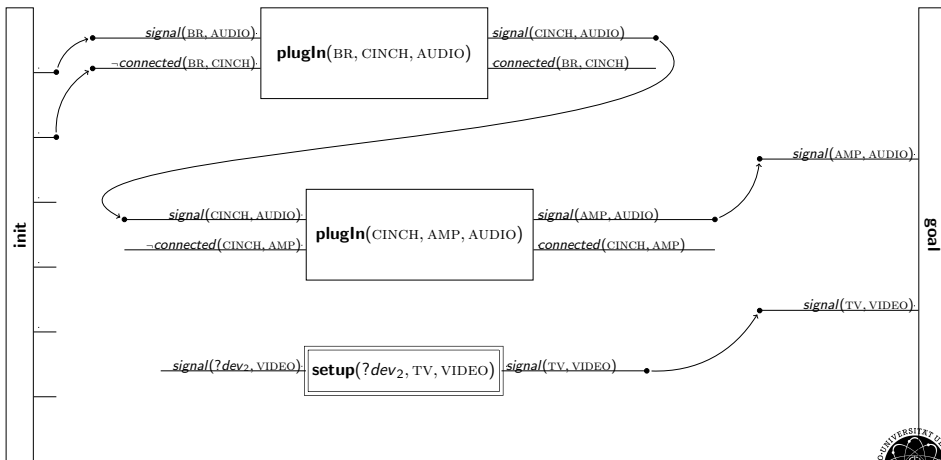


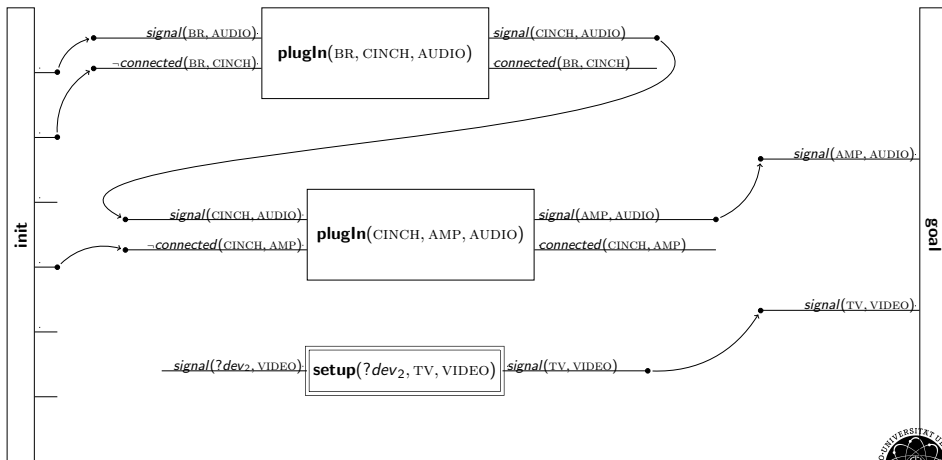


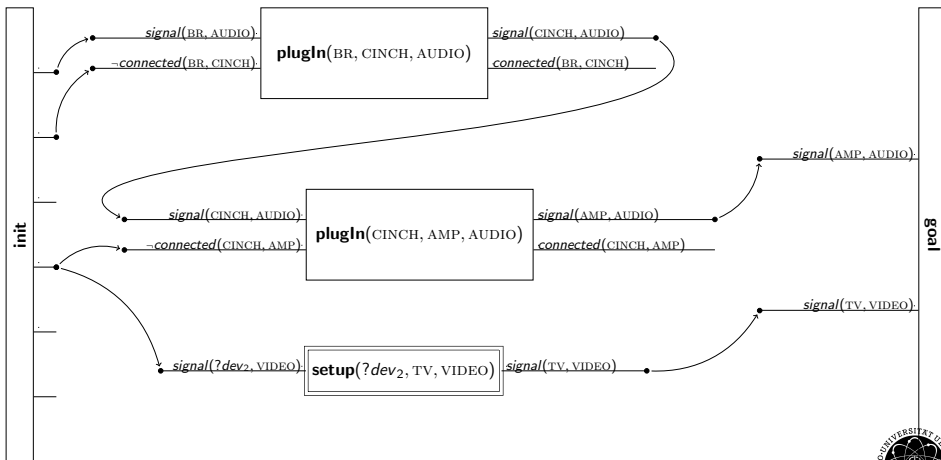


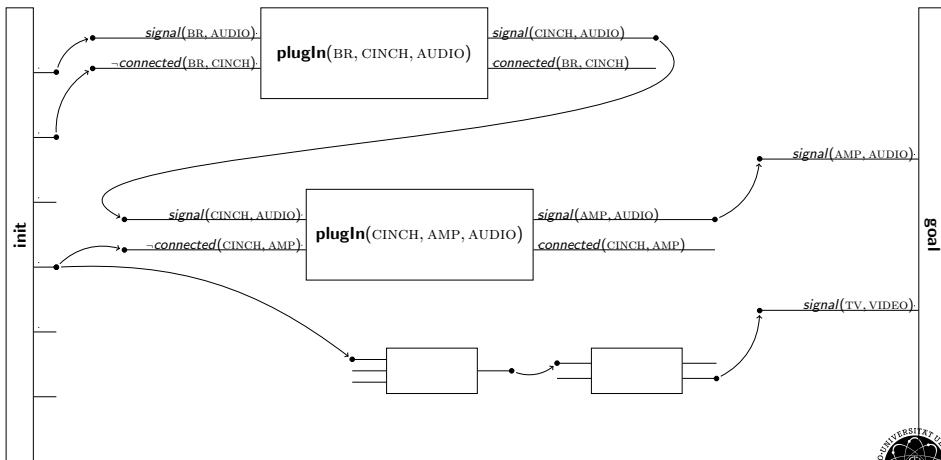


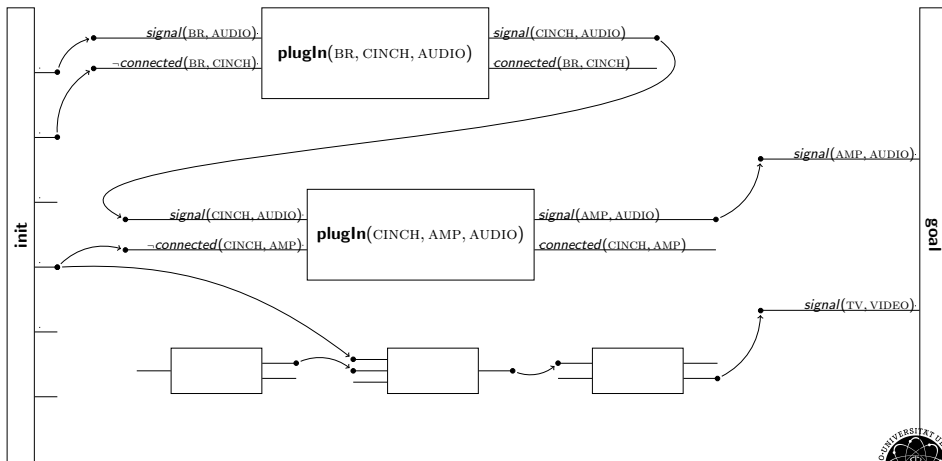


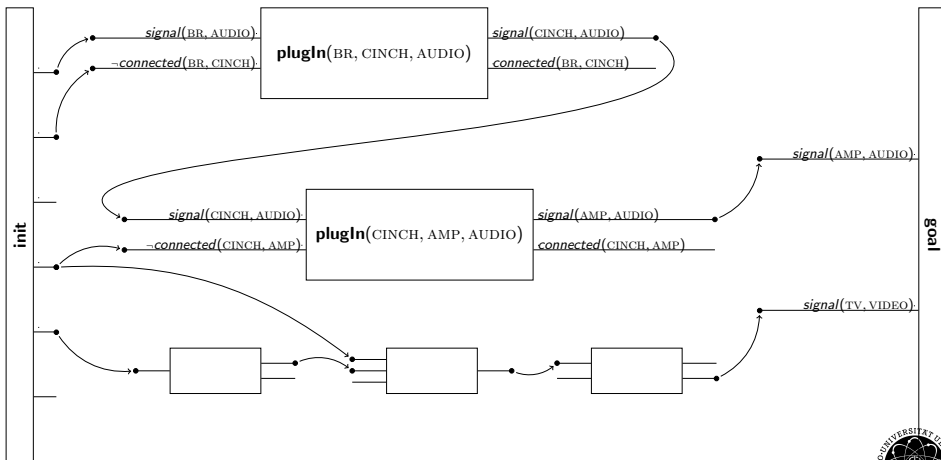


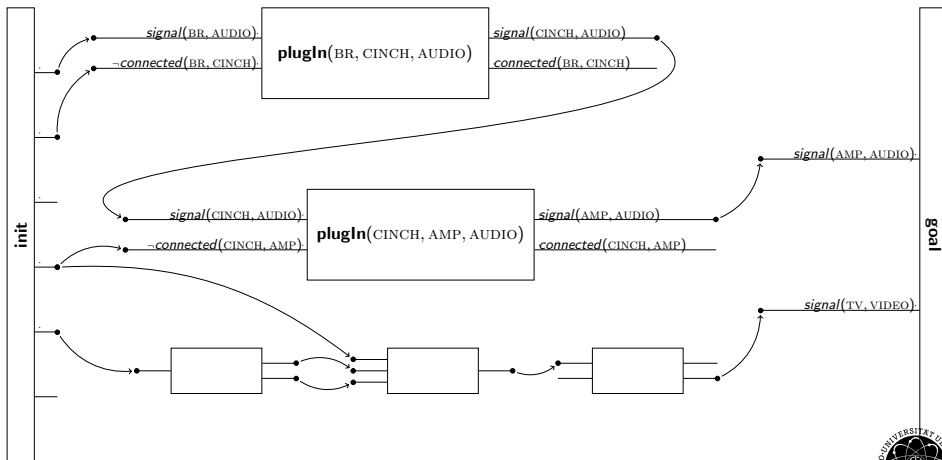


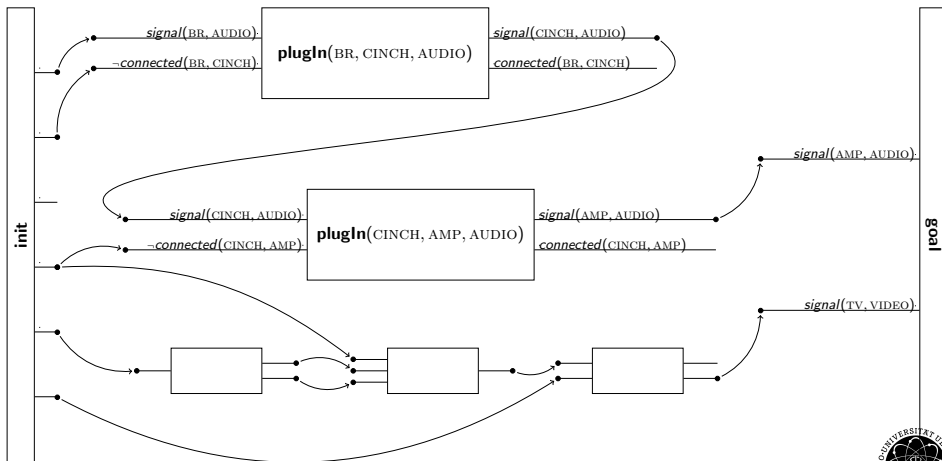




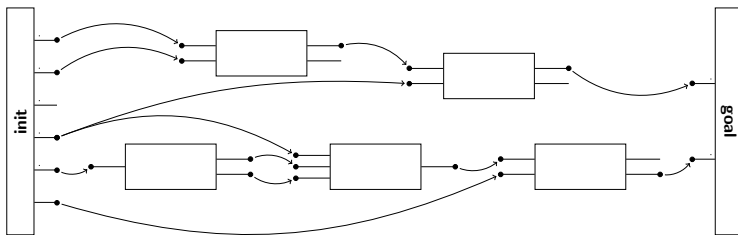




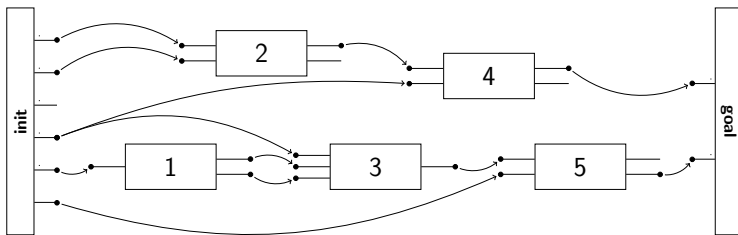




generate a plausible linearization of the actions:

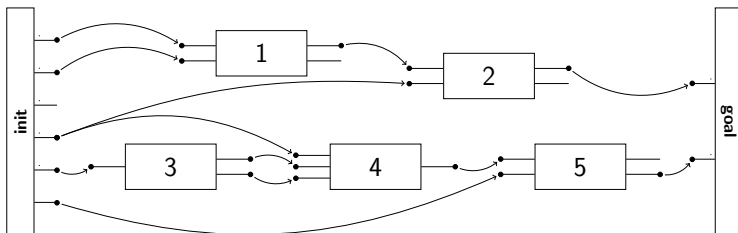


generate a plausible linearization of the actions:



- 1: connect ...
- 2: connect CINCH cable (the first end) with Blu-ray player
- 3: connect ...
- 4: connect CINCH cable (the other end) with AV receiver
- 5: connect ...

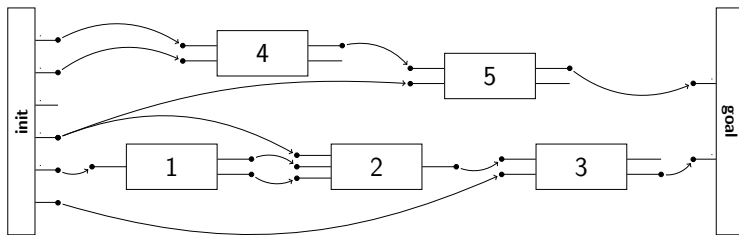
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generate a plausible linearization of the actions:



- 1: connect ...
- 2: connect ...
- 3: connect ...
- 4: connect CINCH cable (the first end) with Blu-ray player
- 5: connect CINCH cable (the other end) with AV receiver

information used for finding user-friendly plan linearizations:

- the planning domain and
- the solution to the given planning problem

we introduce three domain-independent linearizations approaches based on:

- **action parameters**
- **causal links** in the plan
- **decomposition hierarchy**

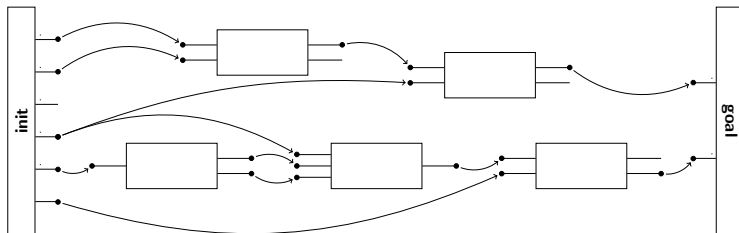


Parameter-based plan linearization

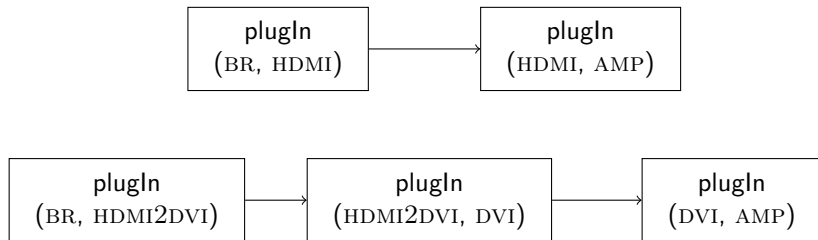
- actions represent activities to do
 - parameters introduce the items/objects/subjects to use
- execute actions involving the same parameters consecutively



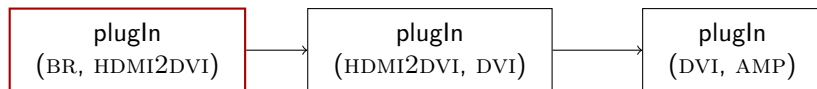
Solution plan (schematically, with causal structure)



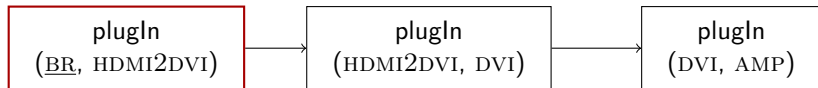
Solution plan (ordering constraints, action schemata)



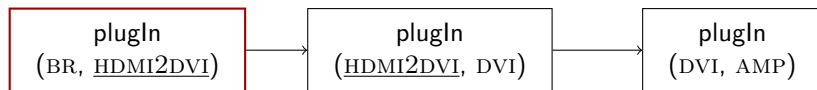
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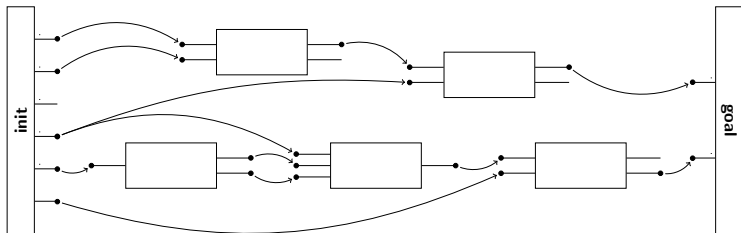


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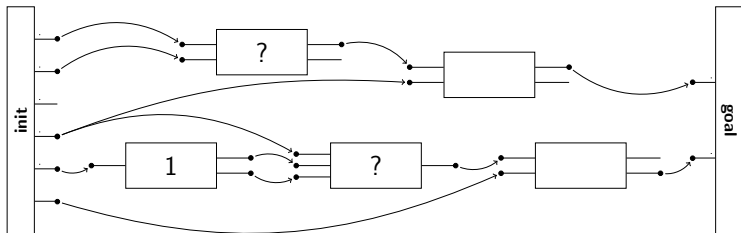
Causal link-based plan linearization

- causal links explicitly represent the causal structure of the plan
 - each link was introduced to solve a flaw – all links are required
- execute connected actions consecutively



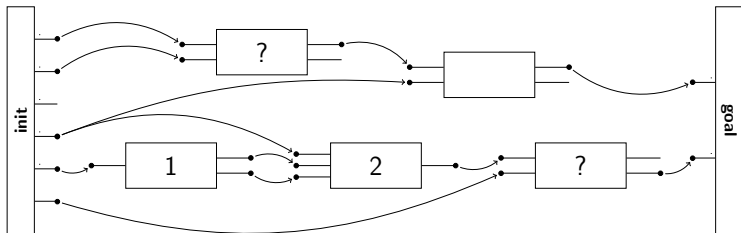
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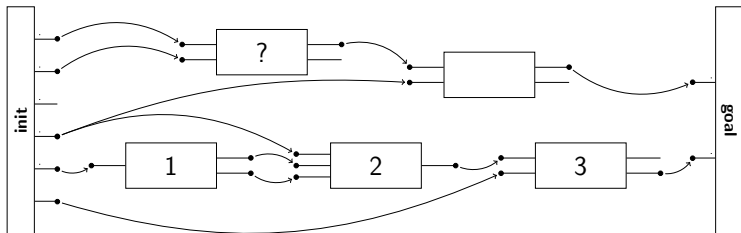
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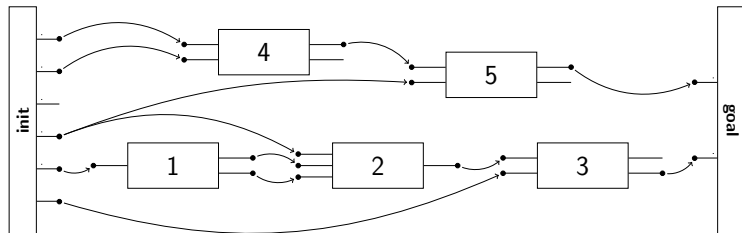
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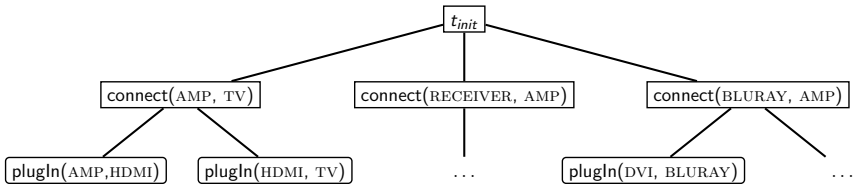
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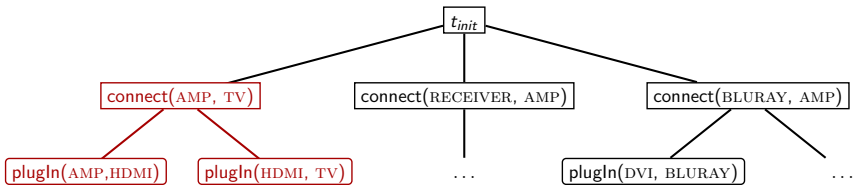


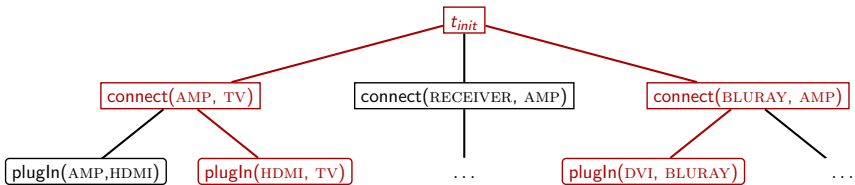
Decomposition-based plan linearization

- domain contains expert knowledge
 - tasks that are introduced by the same method implement the same abstract task (→ semantically related!)
 - we generalize this relationship to tasks that are not in the same method (→ use Task Decomposition Graph (TDG))
- execute actions that are close to each other in the TDG consecutively









Possibilities for Empirical Evaluation

- the utilities have to be evaluated empirically
- what is the objective?
 - imitating human behavior
 - maximize subjective appraisal of humans executing a plan
 - optimize some objective (measurable) metric



Summary

- plan linearization is required if we plan for human users
- we gave three domain-independent utility functions that may help to find reasonable linearizations
- illustrated it in the “home theater” example domain
- all given utilities depend on the planning model
- causal link-based linearization additionally depends on the planning process
- outlined possible objectives and ways to evaluate the different utilities

