



10th Theoretical Assignment in Artificial Intelligence (WS 2006/2007)

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Exercise 10.1

Consider the following planning problem, where A, B, C and D are constants supposed to represent persons, and x, y and z are variables:

$Op(\text{ACTION: } Start,$
 EFFECT: $ambitious(A) \wedge lazy(C) \wedge lazy(D) \wedge collaborate(A, B)$
 $\wedge collaborate(B, C) \wedge collaborate(C, D)$)

$Op(\text{ACTION: } Finish,$
 PRECOND: $collaborate(A, D) \wedge leader(A)$)

$Op(\text{ACTION: } Meeting(x, y, z),$
 PRECOND: $collaborate(x, y) \wedge collaborate(y, z)$
 EFFECT: $collaborate(x, z)$)

$Op(\text{ACTION: } FindGroupLeader(x, y, z),$
 PRECOND: $ambitious(x) \wedge lazy(y) \wedge lazy(z),$
 EFFECT: $leader(x) \wedge \neg collaborate(x, y) \wedge \neg collaborate(x, z)$)

Generate a partial order plan with the POP algorithm! For this exercise, assume that the POP algorithm first tries to satisfy $collaborate(A, D)$! Give a description for every step of the planning process with new *casual links* (including the preconditions for which the causal link was added). Moreover, describe any new operator you want to add as well as the resulting *threats* (that is, steps that might delete a precondition protected by a causal link) and the ordering constraints included to resolve the threats (by ordering the threats to come before or after the causal link). You need not give a complete diagram of the plan for every step. Give a diagram of the final plan, inclusive causal link, as well as their preconditions and ordering constraints.

Exercise 10.2

Consider a shopping problem, where the shopping agent can use the following operators:

$Op(\text{ACTION: } Start,$
 EFFECT: $At(Home) \wedge Sells(HWS, Drill) \wedge Sells(SM, Milk) \wedge Sells(SM, Banana)$)

$Op(\text{ACTION: } Finish,$
 PRECOND: $Have(Drill) \wedge Have(Milk) \wedge Have(Banana)$)

$Op(\text{ACTION: } Go(there),$
 PRECOND: $At(Here)$
 EFFECT: $At(there) \wedge \neg At(Here)$)

$Op(\text{ACTION: } Buy(x),$
 PRECOND: $At(store) \wedge Sells(store, x),$
 EFFECT: $Have(x)$)

Here, *SM* stands for *Supermarkt* and *HWS* for *Hardware store*. We want to include money, at least in a simple way.

- (a) Let *CC* denote a credit card that the agent can use to buy any object. Modify the description of *Buy* so that the agent has to have its credit card in order to buy anything.
- (b) Write a *PickUp*-Operator that enables the agent to *Have* an object if it is portable and at the same location as the agent and owned by the agent. (Hint: you need to change the vocabulary of the domain.)
- (c) Whenever the agent changes his location the credit card has to change its location as well if the agent has it with him.
 - i. Give a plausible specification of *Go*, such that it has *Have* as precondition and appropriate changes of *At* as effects.
 - ii. Why is that not a correct way to update the location of objects that the agent has with him? (5 P)
 - iii. How would you handle this problem in this context? Explain.
 - iv. What should be done to enable a complete correct specification of *Go*?

Exercise 10.3

Consider Johnny, who is unemployed and not married. He does not suffer from depression. He can take the following actions:

- Johnny can go look for a job, if he is unemployed, free from depression, and not married. The result is that he will not be unemployed, but suffer from depression.
- Johnny can go to a therapist if he is depressed. Afterwards, he will not be depressed any more.
- Johnny can make a proposal to Mary if he is not unemployed. In this case he will be married.

Assume that Johnny's goal is to be married and not depressive.

1. Formalise these statements as a planning problem!
2. Construct a planning graph (until it *levels off*)! Indicate all mutex links (and what kind of mutex links these are – *inconsistent effects*, *interference*, *competing needs* or *inconsistent supports*)!
3. How can you use the planning graph to check if there is a solution to the planning problem?
4. Use the *GRAPHPLAN* algorithm to extract the solution (you can use the algorithm on p.298 ff. in Russell/Norvig, or the algorithm presented on the lecture slides)! Indicate each step!
5. Use partial order planning to generate a partial order plan. What differences to *GRAPHPLAN* do you notice?
6. Assume there is one more thing Johnny can do – if he is crazy, he can kidnap Mary and force her to marry him. This will result in marriage, but requires Johnny to be crazy (assume that initially he is not). Does this extra operator change the way graph planning looks for a solution? Can it make a difference for the way the POP algorithm searches for a solution?

Exercise 10.4

Show the following: When a literal does not appear in the final level of the planning graph, it cannot be achieved.