Planning and Optimization

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Exercise Sheet 5

Due: November 2, 2016

Exercise 5.1 (1+2 marks)
Consider the planning task $\Pi = \langle V, I, O, \gamma \rangle$ in positive normal form with

$$
\begin{aligned}
V &= \{\mathit{haveCake}, \mathit{haveQuiche}, \mathit{haveSugar}, \mathit{haveNoSugar}, \mathit{notHungry}\}\\
I &= \{\mathit{haveCake} \mapsto \mathbf{F}, \mathit{haveQuiche} \mapsto \mathbf{F}, \mathit{haveSugar} \mapsto \mathbf{T},\\
&\qquad \mathit{haveNoSugar} \mapsto \mathbf{F}, \mathit{notHungry} \mapsto \mathbf{F}\}\\
O &= \{\mathit{bake}, \mathit{eatCake}, \mathit{eatQuiche}\} \text{ with}\\
&\qquad \mathit{bake} = \langle \top, (\mathit{haveSugar} \rhd \mathit{haveCake}) \wedge (\mathit{haveSugar} \rhd \neg \mathit{haveSugar}) \wedge\\
&\qquad\qquad (\mathit{haveSugar} \rhd \mathit{haveNoSugar}) \wedge (\mathit{haveNoSugar} \rhd \mathit{haveQuiche}), 5\rangle,\\
&\qquad \mathit{eatCake} = \langle \mathit{haveCake}, \neg \mathit{haveCake} \wedge \mathit{notHungry}, 1\rangle,\\
&\qquad \mathit{eatQuiche} = \langle \mathit{haveQuiche}, \neg \mathit{haveQuiche} \wedge \mathit{notHungry}, 1\rangle\\
\gamma &= \mathit{haveCake} \wedge \mathit{notHungry}
\end{aligned}
$$

(a) Provide the delete relaxation Π^+ of Π.

(b) Provide a sequence π of operators from O such that π^+ is a plan for Π^+ but π is no plan for Π.

Exercise 5.2 (1 mark)
Provide a planning task $\Pi = \langle V, I, O, \gamma \rangle$ in positive normal form such that Π is unsolvable and Π^+ is solvable.

Exercise 5.3 (4 marks)
In the lecture, we have shown that the `BCPlanEx` problem restricted to delete-relaxed planning tasks is NP-complete (chapter C2, slides 11 and 12 in the handout version). In this exercise, we consider the special case of delete-relaxed planning tasks where, in addition, for every delete-relaxed operator o^+, $\mathit{pre}(o^+)$ is a single atom or $\top$ and $\mathit{eff}(o^+)$ is an atomic effect. Prove that the `BCPlanEx` problem for delete-relaxed planning tasks restricted to operators of this kind (i.e., to operators o^+ where $\mathit{pre}(o^+)$ is a single atom or $\top$ and $\mathit{eff}(o^+)$ is an atomic effect) is still NP-complete.

Hint: Reduction from the set cover problem. Make use of zero-cost operators.

Please turn around

Exercise 5.4 (4 marks)

Consider the planning task $\Pi = \langle V, I, O, \gamma \rangle$ with

$$\begin{aligned}
V &= \{a, b, c, d, e, f, g, h\} \\
I &= \{c \mapsto \mathbf{T}\} \cup \{v \mapsto \mathbf{F} \mid v \in V \setminus \{c\}\} \\
O &= \{o_1, o_2, o_3, o_4\} \text{ with} \\
&\quad o_1 = \langle a, b, 1 \rangle \\
&\quad o_2 = \langle b, a, 1 \rangle \\
&\quad o_3 = \langle c, d \wedge (d \rhd e) \wedge (b \rhd f), 1 \rangle \\
&\quad o_4 = \langle e \vee h, g, 1 \rangle \\
\gamma &= g
\end{aligned}$$

(a) Provide the relaxed task graph $RTG(\Pi^+)$ of Π graphically.

(b) Give the most conservative valuation of $RTG(\Pi^+)$.

(c) Provide a consistent valuation of $RTG(\Pi^+)$ that is different from your solution to exercise 5.4 b).

The exercise sheets can be submitted in groups of two students. Please provide both student names on the submission.