Principles of AI Planning

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Exercise Sheet 10

Due: Monday, January 27th, 2014

Exercise 10.1 (Weak vs. strong stubborn sets, 7 points)
Show that *weak* stubborn sets admit exponentially more pruning than *strong* stubborn sets.

Hint: Consider the family of planning tasks $(\Pi_n)_{n\in\mathbb{N}}$, where $\Pi_n = \langle V_n, I_n, O_n, \gamma \rangle$ is the planning task with the following components:

- $V_n = \{a, x, y, b_1, \dots, b_n\}$ with variable domains $\mathcal{D}_a = \mathcal{D}_x = \mathcal{D}_y = \{0, 1\}$ and $\mathcal{D}_{b_i} = \{0, 1, 2\}$ for all $i \in \{1, \dots, n\}$
- $O_n = \{o, o', o_d, \overline{o_d}, o_1, \dots, o_n, \overline{o_1}, \dots, \overline{o_n}\}$
- $pre(o) = \{a \mapsto 0\}$, $e\!f\!f(o) = \{x \mapsto 1\}$
- $pre(o') = \{a \mapsto 0\}$, $e\!f\!f(o') = \{y \mapsto 1\}$
- $pre(o_d) = \{a \mapsto 0\}$, $e\!f\!f(o_d) = \{a \mapsto 1, b_1 \mapsto 1, \dots, b_n \mapsto 1\}$
- $pre(\overline{o_d}) = \{a \mapsto 1\}$, $e\!f\!f(\overline{o_d}) = \{a \mapsto 0, b_1 \mapsto 1, \dots, b_n \mapsto 1\}$
- $pre(o_i) = \{b_i \mapsto 1\}$, $e\!f\!f(o_i) = \{b_i \mapsto 2\}$ for $1 \leq i \leq n$
- $pre(\overline{o_i}) = \{b_i \mapsto 2\}$, $e\!f\!f(\overline{o_i}) = \{b_i \mapsto 1\}$ for $1 \leq i \leq n$
- $I_n = \{a \mapsto 0, x \mapsto 0, y \mapsto 0, b_1 \mapsto 0, \dots, b_n \mapsto 0\}$
- $\gamma = \{x \mapsto 1, y \mapsto 1\}$

Exercise 10.2 (Dynamic programming, 3 points)
Consider the propositional nondeterministic planning task $\Pi' = \langle A', I', O', \gamma' \rangle$, with

- the set of variables $A' = \{a, b, c\}$,
- initial state $I' = \{a \mapsto 0, b \mapsto 0, c \mapsto 1\}$,
- set of operators $O' = \langle o_1, o_2, o_3 \rangle$, where
  - $o_1 = \langle a, \{b \wedge c, b \wedge \neg c\} \rangle$,
  - $o_2 = \langle \neg a \wedge b, \{a \wedge \neg b, a\} \rangle$,
  - $o_3 = \langle \neg b, \{\neg a \wedge b\} \rangle$
- and goal $\gamma' = a \wedge b$

Determine a strong plan for Π' by computing backward distances with the dynamic programming algorithm.

You can and should solve the exercise sheets in groups of two. You can send your solution to `ortlieb@informatik.uni-freiburg.de`. Please give both your names on your solution.