Principles of AI Planning

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Exercise Sheet 14

Due: No submission – no grading – optional exercises

Exercise 14.1 (Planning literature)

As part of your work on exercise sheet 1, you read the paper titled "Everything You Always Wanted to Know About Planning (But Were Afraid to Ask)" by Jörg Hoffmann, published at the annual German Conference on Artificial Intelligence (KI) in 2011.
Back then, you were asked to write, as an answer to the exercise, two questions that came to your mind when reading the paper and that you would like to discuss in the exercise group.
Re-read the paper (however cursorily) and compare your impression of it you had three to four months ago and now. Does the paper give you a good overview of what material we discussed in class?
The paper can be found here: `http://fai.cs.uni-saarland.de/hoffmann/papers/ki11.pdf`

Exercise 14.2 (Weak and strong preimages)

Let $\mathcal{T} = \langle S, O, T, s_0, S_\star \rangle$ be a (nondeterministic) transition system that happens to be deterministic, i.e., for each state $s \in S$ and each label $o \in O$, there exists at most one state $s' \in S$ such that $\langle s, o, s' \rangle \in T$.

Show that for all operators $o \in O$ and all state sets $S' \subseteq S$, $\text{wpreimg}_o(S') = \text{spreimg}_o(S')$.

Exercise 14.3 (Dynamic programming)

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.

Exercise 14.4 (Nondeterministic progression search)

(a) Model the game *Tic-Tac-Toe* as a nondeterministic planning task for a grid of size $\mathbf{2} \times \mathbf{2}$ with the goal to get two markers in a row, column or diagonally. Formalize the game from the first player's perspective. See `http://en.wikipedia.org/wiki/Tic-tac-toe` if you have questions about the rules of the game.

(b) Determine a strong plan for this planning task as a graph by providing a solution graph generated by progression search.