Principles of AI Planning

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Exercise Sheet 7

Due: Friday, December 13th, 2019

Send your solution to `mario.kantz@gmail.com` (PDF only) or submit a hardcopy before the lecture. The exercise sheets may and should be worked on and handed in in groups of two or three students. Please indicate all names on your solution.

Exercise 7.1 (Inaccuracy of $h_{\max}$, 2 points)

Prove that the heuristic $h_{\max}$ is arbitrarily inaccurate, i.e., for all $c \in \mathbb{R}^+$ there exists a relaxed planning task $\Pi = \langle A, I, O^+, \gamma \rangle$ such that $c \cdot h_{\max}(I) \leq h^+(I) \neq 0$.

Exercise 7.2 (Stability of h_{add}, 5 points)

Show that it is important to test for stability when computing h_{add} by giving an example where you get an unnecessarily high overestimation when not performing this test.

Hint: The solution to this exercise is a planning task and its relaxed planning graph where h_{add} is higher in the goal node in layer k than in the goal node of layer $j > k$.

Exercise 7.3 (Relaxed planning graph and heuristics, 1.5+1.5 points)

Consider the relaxed planning task Π^+ with variables $A = \{a, b, c, d, e\}$, operators $O = \{o_1, o_2, o_3\}$, $o_1 = \langle d, c \wedge (c \rhd e) \rangle$, $o_2 = \langle c, a \rangle$, $o_3 = \langle a, b \rangle$, goal $\gamma = b \wedge e$ and initial state $s = \{a \mapsto 0, b \mapsto 0, c \mapsto 0, d \mapsto 1, e \mapsto 0\}$. Solve the following exercises by drawing the relaxed planning graph for the lowest depth k that is necessary to extract a solution.

(a) Calculate $h_{\max}(s)$ for Π^+.

(b) Calculate $h_{\text{add}}(s)$ for Π^+.