Planning and Optimization

M. Helmert, G. Röger University of Basel
T. Keller, M. Wehrle Fall Semester 2016

Exercise Sheet 9

Due: November 30, 2016

Exercise 9.1 (3+2+1 marks)

Consider the following STRIPS planning task $\Pi = \langle V, I, O, G \rangle$ with variable set $V = \{a, b, c\}$, initial state $I = \{a, b\}$, operator set $O = \{o_1, o_2\}$ with

- $pre(o_1) = \{a\}$, $add(o_1) = \{c\}$, $del(o_1) = \{b\}$, $cost(o_1) = 2$,
- $pre(o_2) = \{c\}$, $add(o_2) = \{b\}$, $del(o_2) = \emptyset$, $cost(o_2) = 1$,

and goal $G = \{a, b, c\}$.

(a) Compute $h^2_\Pi(I, G)$ using the algorithm shown in Chapter 17 (slide 21 in the handout version). Provide the intermediate computation steps of the algorithm. In each step, provide the results from the regression operator and for the cost updates.

(b) Provide the compilation to $\Pi^2 = \langle V', I', O', G' \rangle$ of Π by specifying V', I', O', and G'.

(c) Compute $h^{max}_\Pi(I)$ and $h^{max}_{\Pi^2}(I')$. Compare and discuss these values with $h^2_\Pi(I, G)$.

Exercise 9.2 (2 marks)

Consider the following planning task $\Pi = \langle V, I, O, G \rangle$ in set representation:

$$\begin{aligned}
V &= \{\text{T-at-A}, \text{T-at-B}, \text{P1-in-T}, \text{P2-in-T}\} \\
I &= \{\text{T-at-A}, \text{P1-in-T}, \text{P2-in-T}\} \\
O &= \{\langle \{\text{T-at-A}\}, \{\text{T-at-B}\}, \{\text{T-at-A}\}, 1 \rangle\} \\
G &= \{\text{T-at-B}, \text{P1-in-T}, \text{P2-in-T}\}
\end{aligned}$$

Use the provided task to show the theorem from chapter C18, slide 17 in the handout version, i.e., that there are STRIPS planning tasks Π, $m \in \mathbb{N}_1$ and admissible heuristics h such that $h^*_\Pi(s) < h_{\Pi^m}(s^m)$ for some state s of Π.

Exercise 9.3 (4 marks)

Consider the delete-free STRIPS planning task $\Pi = \langle V, I, O, G \rangle$ in normal form, where

$$\begin{aligned}
V &= \{a, b, c, d, e, f, g\} \\
I &= \{a\} \\
O &= \{o_1, \ldots, o_6\} \\
o_1 &= \langle a \rightarrow c \rangle_1 \\
o_2 &= \langle a \rightarrow b, d \rangle_2 \\
o_3 &= \langle b, c \rightarrow e, f \rangle_5 \\
o_4 &= \langle c \rightarrow f \rangle_3 \\
o_5 &= \langle d, f \rightarrow e \rangle_1 \\
o_6 &= \langle e, f \rightarrow g \rangle_0 \\
G &= \{g\}
\end{aligned}$$

Compute $h_{\text{LM-cut}}(I)$. In each iteration of the algorithm, provide one of the possible justification graphs, the cut, the value by how much $h_{\text{LM-cut}}(I)$ is increased and the altered operator costs.

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