

Principles of AI Planning

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Exercise Sheet 10

Due: Friday, January 11th, 2019

Send your solution to `drexlerd@tf.uni-freiburg.de` or submit a hardcopy before the lecture.

Exercise 10.1 (Potential heuristics: consistency constraints, 6 points)

Let $\Pi = \langle V, I, O, \gamma \rangle$ be an SAS⁺ planning task in transition normal form, and let $\mathcal{F} = \{f_{v=d} \mid v \in V, d \in \mathcal{D}_v\}$ be the set of all atomic features over Π . Finally, let

$$h(s) = \sum_{\text{fact } v=d} w_{v=d} \cdot f_{v=d}(s)$$

be the potential heuristic with potentials $w_{v=d}$ for all $v \in V, d \in \mathcal{D}_v$, such that for all $o \in O$, the following constraint is satisfied:

$$\sum_{\text{fact } v=d \text{ consumed by } o} w_{v=d} - \sum_{\text{fact } v=d \text{ produced by } o} w_{v=d} \leq \text{cost}(o) .$$

Prove: Then h is consistent, i. e., $h(s) - h(t) \leq \text{cost}(o)$ for all transitions (s, o, t) in $\mathcal{T}(\Pi)$.

Remark: The definition of consumers and producers originally given on the slides was wrong. The correct definitions should read as follows: Fact $v = d$ is *consumed* by operator $o \in O$ if $v = d$ is a precondition of o , but not an effect of o . It is *produced* by o if it is an effect of o , but not a precondition of o .

Exercise 10.2 (Exponential plan length, 4 points)

Prove that the shortest plan of a planning task can be exponential in the number of variables, i.e., for all $n \in \mathbb{N}$ there is a planning task $\Pi = \langle A, I, O, \gamma \rangle$ with $|V| = n$ such that $|\pi| = O(2^{|n|})$ where $|\pi|$ is the length of a plan.

Hint: Try to construct a family of planning tasks where the execution of the shortest plan visits each state once.

You may and should solve the exercise sheets in groups of two. Please state both names on your solution.