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Principles of AI Planning

Exercise Sheet 10

17.01.2020

Exercise 10.1 - Affecting labels vs. orthogonality

Prove the following: Let $\mathcal{A}_i$ be an abstraction of some transition system $\mathcal{T}$ with abstraction mapping α_i for $i \in \{1, 2\}$. If no label of $\mathcal{T}$ affects both $\mathcal{A}_1$ and $\mathcal{A}_2$, then α_1 and α_2 are orthogonal.
Definition of orthogonality:
Let α_1 and α_2 be abstraction mappings on $\mathcal{T}$. We say that α_1 and α_2 are orthogonal if for all transitions $\langle s, l, t\rangle$ of $\mathcal{T}$, we have $\alpha_i(s) \neq \alpha_i(t)$ for at most one $i \in \{1, 2\}$.
Definition of affecting transition labels.
For a transition system $\mathcal{A}$ and a label l of $\mathcal{A}$, we say that l affects $\mathcal{A}$ if $\mathcal{A}$ has a transition $\langle s, l, t\rangle$ with $s \neq t$.

Exercise 10.2 - Potential heuristics: consistency constraints

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:

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

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:

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

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