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Principles of AI Planning

Exercise Sheet 11

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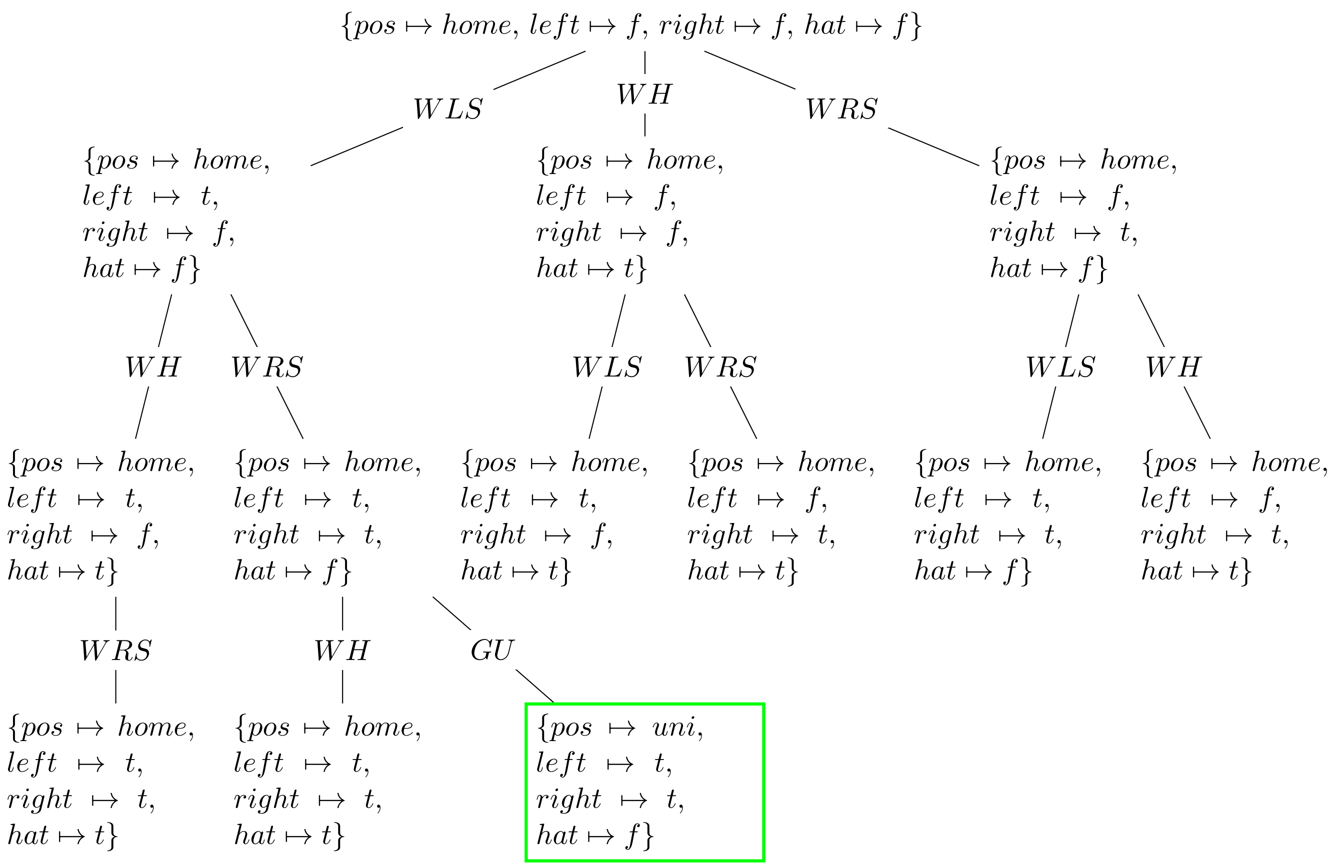
Exercise 11.1 - Strong stubborn sets

Consider the SAS^+ planning task Π with variables $V = \{pos, left, right, hat\}, \mathcal{D}_{pos} = \{home, uni\}$ and $\mathcal{D}_{left} = \mathcal{D}_{right} = \mathcal{D}_{hat} = \{t, f\}$. The initial state $I = \{pos \mapsto home, left \mapsto f, right \mapsto f, hat \mapsto f\}$ and the goal specification is $\gamma = \{pos \mapsto uni\}$. There are four operators in O, namely

$$
\begin{array}{rcl}
\text{wear-left-shoe (WLS)} & = & \langle pos = home \land left = f, left := t\rangle \\
\text{wear-right-shoe (WRS)} & = & \langle pos = home \land right = f, right := t\rangle \\
\text{wear-hat (WH)} & = & \langle pos = home \land hat = f, hat := t\rangle \\
\text{go-to-university (GU)} & = & \langle pos = home \land left = t \land right = t, pos := uni\rangle
\end{array}
$$

(a) Draw the breadth-first search graph (with duplicate detection) for planning task Π without any form of partial-order reduction.



(b) Draw the breadth-first search graph (with duplicate detection) for planning task Π using strong stubborn set pruning. For each expansion of a node for a state s, specify in detail how T_s (and thus $T_{app(s)}$) are computed, i.e., explain how the initial disjunctive action landmark is chosen and how operators are iteratively added to T_s as part of necessary enabling sets or interfering operators, respectively. Break ties in favor of *wear-left-shoe* over *wear-right-shoe.*

How many node expansion do you save with strong stubborn sets compared to plain breadthfirst search? What about the lengths of the resulting solutions?

$$\{pos \mapsto home,\, left \mapsto f,\, right \mapsto f,\, hat \mapsto f\}$$

$$\Big|\; WLS \;\Big|$$

$$\{pos \mapsto home,\, left \mapsto t,\, right \mapsto f,\, hat \mapsto f\}$$

$$\Big|\; WRS \;\Big|$$

$$\{pos \mapsto home,\, left \mapsto t,\, right \mapsto t,\, hat \mapsto f\}$$

$$\Big|\; GU \;\Big|$$

$$\boxed{\{pos \mapsto uni,\, left \mapsto t,\, right \mapsto t,\, hat \mapsto f\}}$$

Exercise 11.2 - Weak vs. strong stubborn sets

Show that *weak* stubborn sets admint exponentially more pruning than *strong* stubborn sets.