

Landmarks

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PUI (Planning in Artificial Intelligence)

Action Landmark

Action that must be used in all plans.

Disjunctive Action Landmark

Set L of actions such that in each plan at least one $a \in L$ must be used.

$$\text{cost}(L) = \min_{a \in L} \text{cost}(a)$$

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LM-Cut Heuristic

- ▶ Admissible landmark-based heuristic
- ▶ Lower estimate of **optimal relaxed plan**
- ▶ Using disjunctive action landmarks, for a set \mathcal{L} of landmarks:

$$h_{\text{LM-Cut}} = \sum_{L \in \mathcal{L}} \text{cost}(L)$$

LM-Cut Heuristic

How to find the landmarks

1. Find preconditions which justify the cost of actions

- ▶ Using h_{\max} :

$$h_{\max}(p) = \min_{p \in \text{add}(a)} h_{\max}(a) + \text{cost}(a)$$

$$h_{\max}(a) = \max_{p \in \text{pre}(a)} h_{\max}(p)$$

2. Construct a **justification graph** using only those preconditions
3. Find a **cut** in the justification graph
4. The cut forms a **disjunctive action landmark**
5. **Discount the cost** of the landmark from the costs of all actions in the landmark
 - ▶ Results in a cost-partitioning
6. Start all over again (with the modified costs)
 - ▶ Until $h_{\max}(g) = 0$

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How to find the cut

- ▶ In the justification graph J :
 1. Find all facts p from which g is reachable by a 0-cost path $\rightarrow V_g$
 2. Find all facts p' reachable from i without visiting a fact in V^*
 3. Edges between facts in V^* and V_g form the cut