Lifted delete-relaxation heuristics are competitive with their ground versions and superior to other lifted heuristics.

Relaxed Reachability and Datalog

\[
\begin{align*}
Q(X) & \leftarrow P(X, Y), R(X). \\
R(Y) & \leftarrow P(X, Y), R(X).
\end{align*}
\]

Features

- Additive or max heuristic
- Early stopping
- No action predicates
- Lazy Search + Preferred operators

Algorithm

Computing the additive heuristic

1: \( V := \text{DEFAULT-HASH-TABLE}(\text{Atom}, \mathbb{R}^\infty, \infty) \)
2: \( \text{queue} := \text{PRIORITY-QUEUE}(\text{Atom}, \mathbb{R}^+) \)
3: \( M := \emptyset \)
4: \( \text{for} \ \text{fact} \in F \ \text{do} \)
5: \( \text{V[fact]} := 0 \)
6: \( \text{queue}.\text{PUSH}(\text{fact}, 0) \)
7: \( \text{while} \ \text{not} \ \text{queue}.\text{EMPTY()} \ \text{do} \)
8: \( p := \text{queue}.\text{POP-MIN()} \)
9: \( \text{if} \ p \not\in M \ \text{then} \)
10: \( \ M := M \cup \{p\} \)
11: \( \text{for} \ (\text{head}, \text{body}) \in \text{NEW-RULES}(p, M, R) \ \text{do} \)
12: \( \text{cost} := w + \sum_{q \in \text{body}} V[q] \)
13: \( \text{if} \ \text{cost} < V[\text{head}] \ \text{then} \)
14: \( V[\text{head}] := \text{cost} \)
15: \( \text{queue}.\text{PUSH}(\text{head}, \text{cost}) \)
16: \( \text{return} \ V \)

Number of expansions, compared to to previous state-of-the-art lifted planner

<table>
<thead>
<tr>
<th>Heuristics</th>
<th>IPC</th>
<th>HTG</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifted Goalcount</td>
<td>597</td>
<td>382</td>
<td>979</td>
</tr>
<tr>
<td>Lifted Additive + Lazy P.O.</td>
<td>754</td>
<td>362</td>
<td>1116</td>
</tr>
<tr>
<td>Ground additive + Lazy P.O.</td>
<td>839</td>
<td>298</td>
<td>1137</td>
</tr>
</tbody>
</table>