Sensitivity Analysis for Saturated Post-hoc Optimization in Classical Planning

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Motivation
- cost partitioning is essential for strongest optimal planning heuristics
- two prevalent strategies:
  - recompute in every state — expensive
  - precompute fixed amount over sampled states — approximation
- new work: reuse LP solutions if provably optimal

Saturated Post-hoc Optimization Heuristic LP

\[
\begin{align*}
\text{minimize} & \quad \sum_{\ell \in L} \text{cost}(\ell) \cdot Y_{i}\text{ s.t.} \\
\sum_{\ell \in L} \text{mscf}(\ell) \cdot Y_{i} & \geq h(s) \quad \text{for all } h \in H \\
Y_{i} & \geq 0 \quad \text{for all } \ell \in L
\end{align*}
\]

Sensitivity Analysis for LPs
Analyzes a solved LP and gives perturbation ranges under which the current solution stays optimal.

Tested Variants
Condition for solving new LP:
- \( h_{\text{SPhO}} \): always
- \( h_{\text{SPhO eqdist}} \): for unique \( (h_1, \ldots, h_n) \)
- \( h_{\text{SPhO grouped}} \): for unique grouped \( (h_1, \ldots, h_n) \)
- \( h_{\text{SPhO range}} \): if range based SA not applicable
- \( h_{\text{SPhO 100\%}} \): if 100% Rule based SA not applicable

Conclusions
- up to 6 orders of magnitude fewer LP solver calls
- speed-up by up to 100x

Future Work
- apply to other cost partitioning heuristics
- theoretical insights from interpreting Sensitivity Analyses

Speeding up optimal planning with LP Sensitivity Analysis

Abstraction Heuristics

Cost Partitioning
Distribute action costs \( \text{cost}(a) \) between \( n \) heuristics such that:
\[
\sum_{i=1}^{n} \text{cost}(a) \leq \text{cost}(a)
\]