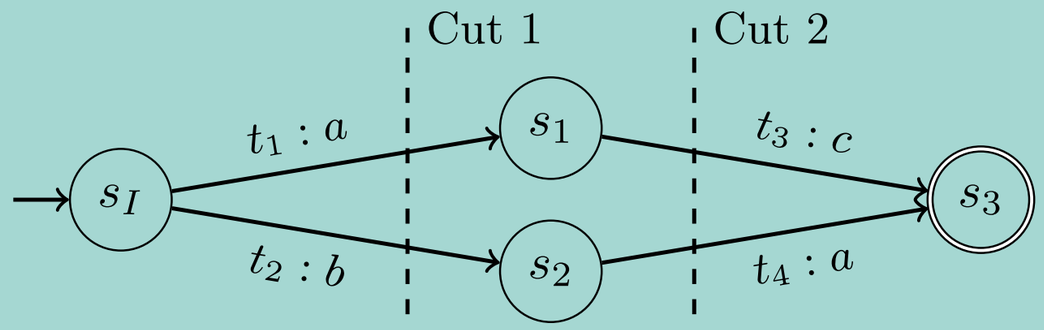
Cuts in abstractions are landmarks.



They yield interesting operator-counting and transition-counting constraints.

Example

Operator Landmarks

$$\sum_{o \in O_C} Y_o \geq 1 \qquad \text{for all cuts } C$$

$$\begin{aligned} Y_a + Y_b &\geq 1 && \text{// Cut 1} \\ Y_a + Y_c &\geq 1 && \text{// Cut 2} \end{aligned}$$

- Satisfied by one use of operator a.

Transition Landmarks

$$\sum_{t \in C} Y_t \geq 1 \qquad \text{for all cuts } C$$

$$\sum_{\substack{t \in T \\ \text{label}(t)=o}} Y_t = Y_o \qquad \text{for all operators } o$$

$$\begin{aligned} Y_{t_1} + Y_{t_2} &\geq 1 && \text{// Cut 1} \\ Y_{t_3} + Y_{t_4} &\geq 1 && \text{// Cut 2} \\ Y_{t_1} + Y_{t_4} &= Y_a && \text{// Link a} \\ Y_{t_2} &= Y_b && \text{// Link b} \\ Y_{t_3} &= Y_c && \text{// Link c} \end{aligned}$$

- Shows that two operators are required.

For disjoint cuts, project out transition-counting variables

$$\sum_{o \in O_S} Y_o \geq |S| \qquad \text{for all subset of cuts } S$$

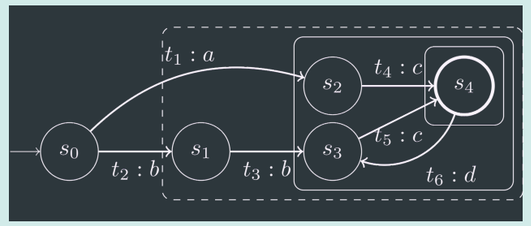
$$\begin{aligned} Y_a + Y_b &\geq 1 && \text{// Cut 1} \\ Y_a + Y_c &\geq 1 && \text{// Cut 2} \\ Y_a + Y_b + Y_c &\geq 2 && \text{// Cuts 1 + 2} \end{aligned}$$

- No loss in accuracy
- Not all subsets required.
- Approximation possible

Finding Cuts

- Any way of cutting is fine.
- Our method is inspired by LM-cut.
  1. Cut off goal zone
  2. Reduce cost of transitions in cut
  3. Repeat
- variants for disjoint/overlapping cuts

Example



Efficient data structure to store cuts

$$\text{Cuts} = \{\{t_4, t_5\}, \{t_1, t_3\}, \{t_1, t_2\}\}$$
$$\text{States} = \{s_4, s_3, s_2, s_1, s_0\}$$

Theoretical Connections

- Details depend on cut generation and used constraints.
- Most informed version is non-negative cost partitioning over landmarks.
  - Dominates non-negative saturated posthoc optimization.
  - Dominated by non-negative optimal cost partitioning.

Experiments

- Projecting out transition-counting variables helps.
- Approximating constraints helps.
- Overall there is not much benefit over operator-counting constraints.
  - Needs better cut generation.

Transition Landmarks from Abstraction Cuts
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