Decomposed Replay Using Hiding and Reduction

Eric Verbeek
• Preliminaries
  – Monolithical replay
  – Decomposed replay
• Hiding and Reduction
  – Problem with decomposed replay
  – Approach
  – Reduction rules
  – Results
• Wrapping up
  – Conclusions
  – Future work
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\[ \langle a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 \rangle \]
Synchronous move on $a_1$ and $t_1$
\[ \langle a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 \rangle \]
Synchronous move on $a_2$ and $t_3$
\[ \langle a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 \rangle \]

No match
\langle a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 \rangle

\begin{array}{cccccccc}
<table>
<thead>
<tr>
<th>a_1</th>
<th>\tau</th>
<th>a_2</th>
<th>a_3</th>
<th>a_4</th>
<th>\tau</th>
<th>a_5</th>
<th>a_6</th>
<th>\tau</th>
<th>a_7</th>
<th>a_8</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_1</td>
<td>t_2</td>
<td>t_3</td>
<td>t_4</td>
<td>t_5</td>
<td>t_6</td>
<td>t_7</td>
<td>t_8</td>
<td>t_9</td>
<td>t_{10}</td>
<td>\rangle</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
\end{array}
Computation times for replay

- DMKD 2006: 12-42 act.

Takes too long

Not decomposed
• Preliminaries
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• Merging alignments
  – Pseudo alignment
  – Alignment of alignments
  – Stitching rules
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Decomposition of net into subnets

- Places join arcs
- Silent transitions join arcs
- Transitions with same label join arcs
\[ \langle a_1, a_2, a_3, a_4, a_6 \rangle \]
Subalignments

Visible model move
• Non-decomposed costs 0 if and only if decomposed costs 0
• Decomposed costs less or equal to non-decomposed costs
Decomposed replay is faster

Computation times, with provided nets

DMKD 2006
12-42 act.

IS 2014
32-59 act.

BPM 2013
275-429 act.

Monolithic replay takes too long

Decomposed replay is faster
Decomposed replay is slower
Infeasible

Computation times for replay – provided nets
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Decomposed replay is faster

Decomposed replay is slower

Infeasible

BPIC 2012
36 act.

BPIC 2015
356-410 act.

Computation times for replay – discovered nets
‘Flower’ construct
5 source transitions

3 sink transitions

Log a22f0n05 – Problematic subnet
Sink transition - comparison
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• Hide visible transition ‘not covered’ by subnet
• Apply behavior-preserving reduction rules afterwards
Subnet by hiding and reduction
Hiding and reduction - comparison

No source transitions
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Behavior-preserving reduction rules (1)

Legend

- an invisible transition
- a visible transition
- any transition
- a place containing $x$ tokens in the initial and every final marking (where $x > 0$)
- an unmarked place
- any place
- any number of these objects (includes connected arcs)
- updating initial and final markings if needed
Behavior-preserving reduction rules (2)

Legend

- an invisible transition
- a visible transition
- any transition
- a place containing $x$ tokens in the initial and every final marking (where $x > 0$)
- an unmarked place
- any place
- any number of these objects (includes connected arcs)
- updating initial and final markings if needed

Need sibling

Needs $x$ tokens
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Computation times, with discovered nets

Hide-and-reduce replay is faster
Hide-and-reduce replay is slower
Infeasible

Monolithic replay

+ Hide-and-reduce replay is faster
× Hide-and-reduce replay is slower
○ Infeasible
Computation times, with provided nets

Hide-and-reduce replay is faster
Hide-and-reduce replay is slower
Infeasible

prAm6
prBm6
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Decomposed replay sometimes much worse
  - On discovered nets
    - From less than 10 seconds to more than 1000 seconds

Hide&Reduce replay never much worse
  - On discovered or provided nets
    - Typically faster if it takes more than 10 seconds
    - From more than 1000 seconds to just above 10 seconds

On provided nets
  - Decomposed replay
    - as it is fastest

On discovered nets
  - Hide&Reduce replay
    - as it provides the most answers in 1000 seconds
The Process Mining Toolkit

ProM
Revision 28643
6.6

Wil van der Aalst / Peter van den Brand / Massimiliano de Leoni / Boudewijn van Dongen / Dirk Fahlnd / Christian Günther / Bart Hompes / Maikel Leemans / Sander Leemans / Xixi Lu / Felix Mannhardt / Eric Verbeek / Michael Westergaard
"Replay using Decomposition" Plug-in in ProM 6.6

The inputs

The plug-in

The outputs
Configuring the plug-in

The configuration to select
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• **Cost-preserving reduction rules**
  – Any reduction rule is fine, as long as it preserves the costs for any possible trace
  – Behavior-preserving implies cost-preserving, but might not equal
  – More rules?
    • Leading to better reduction?
Questions?