Correction to: Transformational supervisor synthesis for evolving systems

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Abstract

The paper mentioned in the title used an incorrect implementation of the algorithms to produce the experimental results. The mistake significantly impacts the computational efficiency of the algorithms, on which they are evaluated. In this correction we explain the mistake, present the new results, and update our conclusions based on the new results.

This is a correction to Thuijsman and Reniers (2022).

In a continuation on Thuijsman and Reniers (2022), it was pointed out by an anonymous reviewer that our implementation used for the experiments contained a mistake. We are very grateful to this reviewer for pointing out this mistake. We realized that the implementation of Thuijsman and Reniers (2022) contained the same mistake.

Although the algorithms were still functionally correct, because of the mistake their computational efficiency was significantly worse than that of a proper implementation. Since Thuijsman and Reniers (2022) aims to improve computational efficiency, and uses experiments to indicate that improvement, the implementation should be properly efficient. Note that the theoretical parts of Thuijsman and Reniers (2022) are still correct, the mistake only affects the timing measurements in the experimental part of the paper.

However, because the mistake has a significant impact on the timing measurements, we present this correction. In this correction we explain the mistake, present the new results, and update our conclusions based on the new results.

In particular, the reachability search algorithms (Algorithms 3 and 4 in Thuijsman and Reniers (2022)) were not properly implemented. This is because an inappropriate data structure was used to store the transition relation. In the erroneous implementation, an *edge list* structure was used: a list of triples, each specifying an origin state, event, and target state. Using an edge list, each time the neighbors of some state are evaluated (e.g., lines 6-7 in

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Table 1 Experimental results of performing SS, ITSS, and GTSS on five variant models of the Transfer Line model

Evolution	Variant model size	Model delta size	Variant model runtime [ms]			% change from SS
			SS	ITSS	GTSS	
TL to TL_1'	$\|X'\| = 49$ $\|\longrightarrow'\| = 148$	$\|X^-\| = 16$ $\|\longrightarrow^+\| = 16$ $\|\longrightarrow^-\| = 68$	0.41	15.08	2.40	487
TL to TL_2'	$\|X'\| = 97$ $\|\longrightarrow'\| = 308$	$\|X^+\| = 32$ $\|\longrightarrow^+\| = 124$ $\|\longrightarrow^-\| = 16$	0.63	53.35	4.22	573
TL to TL_3'	$\|X'\| = 65$ $\|\longrightarrow'\| = 200$	$\|X_0^+\| = 1$ $\|X_0^-\| = 1$	0.41	0.24	0.36	-13
TL to TL_4'	$\|X'\| = 65$ $\|\longrightarrow'\| = 232$	$\|\Sigma^+\| = 1$ $\|\longrightarrow^+\| = 32$	0.39	7.16	1.11	184
TL to TL_5'	$\|X'\| = 73$ $\|\longrightarrow'\| = 228$	$\|X^+\| = 24$ $\|X^-\| = 16$ $\|\longrightarrow^+\| = 108$ $\|\longrightarrow^-\| = 80$	0.47	56.55	5.44	1058

Algorithm 3 of Thuijsman and Reniers (2022)), an iteration is performed over all transitions, leading to a complexity of $O(|X| \cdot | \longrightarrow |)$ for the algorithm overall. Instead, the transition relation should be stored using an *adjacency list*: each index in the list corresponds to a state index and stores all neighbors of that state. When an adjacency list is used, no iteration is required to find the neighbors of a state, and a complexity of $O(|X| + | \longrightarrow |)$ for the reachability search can be obtained (Kleinberg and Tardos, 2005).

The implementation has been corrected. The code repository[1] we refer to in Thuijsman and Reniers (2022) has been updated accordingly. We have repeated the experiments from Thuijsman and Reniers (2022). Tables 1, 2, and 3 respectively present the updated results relative to Tables 1, 2, and 3 in Thuijsman and Reniers (2022). Each runtime value we present in this correction is the mean runtime over 100 executions of the experiment.

We observe that in almost all experimental cases Transformational Supervisor Synthesis (TSS) requires more runtime than basic Supervisor Synthesis (SS). Perhaps in some particular cases, TSS may be quicker than SS. However, based on these updated experimental results, we must conclude that in practical cases TSS is generally less efficient than SS. Therefore, it is recommended to use SS over TSS, also for evolving systems.

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[1] https://github.com/sbthuijsman/JDEDS_TSS

Table 2 Experimental results of performing SS and GTSS for evolution of the complete Component B Wafer Logistics model

Evolution	Variant model size	Model delta size	Variant model runtime [ms]		% change from SS
			SS	GTSS	
$B1$ to $B2$	$\|X'\| = 69\,121$ $\|\longrightarrow'\| = 1\,042\,548$	$\|\Sigma^+\| = 1$ $\|\longrightarrow^+\| = 4\,320$	138	140	1
$B2$ to $B3$	$\|X'\| = 77\,761$ $\|\longrightarrow'\| = 1\,154\,772$	$\|X^+\| = 8\,640$ $\|\Sigma^+\| = 8$ $\|\longrightarrow^+\| = 112\,224$	153	1256	723
$B3$ to $B4$	$\|X'\| = 73\,441$ $\|\longrightarrow'\| = 1\,102\,980$	$\|X^-\| = 4\,320$ $\|\Sigma^-\| = 1$ $\|\longrightarrow^-\| = 51\,792$	147	1126	668
$B4$ to $B5$	$\|X'\| = 73\,441$ $\|\longrightarrow'\| = 1\,121\,412$	$\|\Sigma^+\| = 4$ $\|\longrightarrow^+\| = 18\,432$	146	230	58
$B5$ to $B6$	$\|X'\| = 73\,441$ $\|\longrightarrow'\| = 1\,121\,412$	$\|\Sigma^+\| = 1$ $\|\Sigma^-\| = 1$ $\|\longrightarrow^+\| = 4\,320$ $\|\longrightarrow^-\| = 4\,320$	147	270	83
$B6$ to $B7$	$\|X'\| = 73\,441$ $\|\longrightarrow'\| = 1\,130\,052$	$\|\Sigma^+\| = 3$ $\|\Sigma^-\| = 1$ $\|\longrightarrow^+\| = 12\,960$ $\|\longrightarrow^-\| = 4\,320$	147	318	117
$B7$ to $B8$	$\|X'\| = 78\,337$ $\|\longrightarrow'\| = 1\,200\,980$	$\|X^+\| = 4\,896$ $\|\Sigma^+\| = 5$ $\|\Sigma^-\| = 1$ $\|\longrightarrow^+\| = 75\,824$ $\|\longrightarrow^-\| = 4\,896$	156	973	522
$B8$ to $B9$	$\|X'\| = 73\,441$ $\|\longrightarrow'\| = 1\,102\,980$	$\|X^-\| = 4\,896$ $\|\Sigma^-\| = 10$ $\|\longrightarrow^-\| = 98\,000$	146	1650	1031
$B9$ to $B10$	$\|X'\| = 78\,337$ $\|\longrightarrow'\| = 1\,200\,980$	$\|X^+\| = 4\,896$ $\|\Sigma^+\| = 10$ $\|\longrightarrow^+\| = 98\,000$	155	960	521
$B10$ to $B11$	$\|X'\| = 83\,233$ $\|\longrightarrow'\| = 1\,267\,012$	$\|X^+\| = 4\,896$ $\|\Sigma^+\| = 4$ $\|\longrightarrow^+\| = 66\,032$	165	773	368

Table 3 Experimental results of performing SS and GTSS for evolution of the reachable part of the Component B Wafer Logistics model

Evolution	Variant model size	Model delta size	Variant model runtime [ms]		% change from SS
			SS	GTSS	
$B1$ to $B2$	$\mid X' \mid = 59\,185$ $\mid \longrightarrow' \mid = 892\,460$	$\mid \Sigma^+ \mid = 1$ $\mid \longrightarrow^+ \mid = 3\,680$	94	109	16
$B2$ to $B3$	$\mid X' \mid = 66\,545$ $\mid \longrightarrow' \mid = 988\,252$	$\mid X^+ \mid = 7\,360$ $\mid \Sigma^+ \mid = 8$ $\mid \longrightarrow^+ \mid = 95\,792$	106	1065	901
$B3$ to $B4$	$\mid X' \mid = 62\,865$ $\mid \longrightarrow' \mid = 944\,036$	$\mid X^- \mid = 3\,680$ $\mid \Sigma^- \mid = 1$ $\mid \longrightarrow^- \mid = 44\,216$	100	848	751
$B4$ to $B5$	$\mid X' \mid = 62\,865$ $\mid \longrightarrow' \mid = 959\,732$	$\mid \Sigma^+ \mid = 4$ $\mid \longrightarrow^+ \mid = 15\,696$	100	188	88
$B5$ to $B6$	$\mid X' \mid = 62\,865$ $\mid \longrightarrow' \mid = 959\,732$	$\mid \Sigma^+ \mid = 1$ $\mid \Sigma^- \mid = 1$ $\mid \longrightarrow^+ \mid = 3\,680$ $\mid \longrightarrow^- \mid = 3\,680$	101	182	80
$B6$ to $B7$	$\mid X' \mid = 62\,865$ $\mid \longrightarrow' \mid = 967\,092$	$\mid \Sigma^+ \mid = 3$ $\mid \Sigma^- \mid = 1$ $\mid \longrightarrow^+ \mid = 11\,040$ $\mid \longrightarrow^- \mid = 3\,680$	100	227	126
$B7$ to $B8$	$\mid X' \mid = 67\,033$ $\mid \longrightarrow' \mid = 1\,027\,520$	$\mid X^+ \mid = 4\,168$ $\mid \Sigma^+ \mid = 5$ $\mid \Sigma^- \mid = 1$ $\mid \longrightarrow^+ \mid = 64\,596$ $\mid \longrightarrow^- \mid = 4\,168$	108	771	616
$B8$ to $B9$	$\mid X' \mid = 62\,865$ $\mid \longrightarrow' \mid = 944\,036$	$\mid X^- \mid = 4\,168$ $\mid \Sigma^- \mid = 10$ $\mid \longrightarrow^- \mid = 83\,484$	99	1266	1175
$B9$ to $B10$	$\mid X' \mid = 67\,033$ $\mid \longrightarrow' \mid = 1\,027\,520$	$\mid X^+ \mid = 4\,168$ $\mid \Sigma^+ \mid = 10$ $\mid \longrightarrow^+ \mid = 83\,484$	107	814	663
$B10$ to $B11$	$\mid X' \mid = 71\,201$ $\mid \longrightarrow' \mid = 1\,083\,780$	$\mid X^+ \mid = 4\,168$ $\mid \Sigma^+ \mid = 4$ $\mid \longrightarrow^+ \mid = 56\,260$	112	649	478

Data Availability The implementation of the algorithms and models can be found here: https://github.com/sbthuijsman/JDEDS_TSS

References

Kleinberg J, Tardos E (2005) Algorithm Design. Addison-Wesley Longman Publishing Co., Inc, USA

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