Erratum to "Simulating Dynamic Systems Using Linear Time Calculus Theories"

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Abstract

We point out and correct a small mistake in the paper "Simulating Dynamic Systems Using Linear Time Calculus Theories".

Ten years ago, we published a paper on simulating dynamic systems using linear time calculus theories [1]. This paper show how to extend the IDP language and system [2] to capture temporal domains. The original paper, however, contained a faulty claim in one of the theorems. In this short note, we correct the faulty claim and provide a counterexample to the original claim. The original claim (Theorem 4.4 in the original paper) was the following.

Theorem 0.1 *Let $\mathcal{T}$ be an LTC-theory and φ a universal bistate sentence. Then $\mathcal{T} \models \varphi$ iff $\mathcal{T}_t \models te(\varphi)$.*

However, only one of the implications holds. The corrected version is as follows.

Theorem 0.2 *Let $\mathcal{T}$ be an LTC-theory and φ a universal bistate sentence. If $\mathcal{T}_t \models te(\varphi)$ then $\mathcal{T} \models \varphi$.*

The reason is that the LTC theory might contain small hidden invariants. A minimal counterexample is

Example 0.3 *Consider the LTC theory $\mathcal{T}$ consisting of a single definition*

$$\left\{ \begin{array}{l} on(\mathcal{I}). \\ \forall t : off(\mathcal{S}(t)) \leftarrow on(t). \\ \forall t : on(\mathcal{S}(t)) \leftarrow off(t). \end{array} \right\}.$$

The theory describes a simple system constantly switching between an "on" and an "off" state. The formula $\varphi := \forall t : on(t) \vee on(\mathcal{S}(t))$ is a bistate invariant of the system in the sense $\mathcal{T} \models \varphi$. However, it is not the case that $\mathcal{T}_t \models te(\varphi)$ since $te(\varphi)$ does not have information about the first time point.

While this was a mistake in the original paper, only the correct direction of the theorem was used later on. This has no impact on the correctness of the rest of the paper.

References

[1] Bart Bogaerts, Joachim Jansen, Maurice Bruynooghe, Broes De Cat, Joost Vennekens, and Marc Denecker. Simulating dynamic systems using linear time calculus theories. *Theory Pract. Log. Program.*, 14(4-5):477–492, 2014.

[2] Broes De Cat, Bart Bogaerts, Maurice Bruynooghe, Gerda Janssens, and Marc Denecker. Predicate logic as a modeling language: the IDP system. In Michael Kifer and Yanhong Annie Liu, editors, *Declarative Logic Programming: Theory, Systems, and Applications*, pages 279–323. ACM / Morgan & Claypool, 2018.