Erratum for “What Causes a System to Satisfy a Specification?”

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On page 10 of the “What causes a system to satisfy a specification?” [Chockler et al. 2008] (first paragraph, just before Definition 2.3), we describe Boolean circuits as a special case of binary causal models where each gate of the circuit is a variable of the model. In other words, the inner gates of the circuit are also variables, whose values are computed based on the values of the inputs in the current context. While this is indeed the most general definition of Boolean circuits as causal models, it is in fact not the definition we use in the remainder of the paper. Starting with Definition 2.3, we assume that the set of variables consists of the set of inputs to the circuit, and the output; there are no variables corresponding to the inner gates of the circuit. Thus, the particular structure of the circuit is immaterial; all we care about is the input and output. Thus, the only equation of interest is the one defining output in terms of the input. The restriction of binary causal models where the only variables are the input and output variables seems appropriate for discussing coverage and causality in formal verification, the topic of our paper; all the results of the paper with the exception of Theorem 4.2 apply only to causal models that are circuits.

In this setting, for AC2, the set $\vec{Z}$ in the definition typically consists of $\vec{X}$ and $\phi$. With this choice, we can simplify AC2(b) so that it just requires that $(M, \vec{u}) = [\vec{X} \leftarrow \vec{x}, \vec{W} \leftarrow \vec{w}'] \phi$.

We remark that the notation in Definition 2.3 is misleading. The set of variables that we refer to as $\vec{X}$ corresponds to the set $\vec{W}$ of Definition 2.1 (We did not use $\vec{w}$ and $\vec{w}'$ in this definition because we used $w$ to denote a gate of the circuit.)

As we said above, Theorem 4.2 holds for arbitrary binary causal models, and not only for circuits. In Theorem 4.1, $FP^{NP[\log n]}$-hardness result is proved for circuits. Since circuits are a special case of binary causal models, we immediately get hardness for binary causal models. The upper bound is given in the paper; we just note here that the proof applies to arbitrary binary causal models, not just circuits.

In Section 3 and in Theorem 4.4, we describe computing the degree of responsibility for circuits that are constructed in the process of model-checking Kripke
structures. The definition of the degree of responsibility uses only the values of inputs to the circuit and the value of the output of the model-checking process, thus the internal structure of these circuits is immaterial for the definition. However, we do use details of the internal structure and size of the circuits in the algorithms.

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Finally, we note that in the paper, we use the definition of causality taken from the conference version of the HP paper [Halpern and Pearl 2001], whereas in the references, we list the journal version of the same paper [Halpern and Pearl 2005]. The journal version was published when our paper was still under review, so the references were fixed, while the definition stayed the same. There is a significant difference between clause AC2(b) in the journal version of the paper and the corresponding clause in the conference version. This difference has an impact on the complexity of algorithms for computing causality.

REFERENCES


