## General Identifiability with Arbitrary Surrogate Experiments – Errata

Sanghack Lee<sup>1</sup>, Juan D. Correa<sup>2</sup>, and Elias Bareinboim<sup>3</sup>

<sup>1</sup>Graduate School of Data Science, Seoul National University <sup>2</sup>Computer Science Department, Universidad Autónoma de Manizales <sup>3</sup>Department of Computer Science, Columbia University

The original manuscript left implicit the enforcement of the positivity constraint, which is standard since at least [Pearl, 2000, p. 77]. This should be made explicit by updating Def. 4 as follows (changes marked in red):

**Definition 4** (g-Identifiability). Let **X**, **Y** be disjoint sets of variables,  $\mathbb{Z} = \{\mathbf{Z}_i\}_{i=1}^m$  be a collection of sets of variables, and let  $\mathcal{G}$  be a causal diagram.  $P_{\mathbf{x}}(\mathbf{y})$  is said to be g-identifiable from  $\mathbb{Z}$  in  $\mathcal{G}$ , if  $P_{\mathbf{x}}(\mathbf{y})$  is uniquely computable from positive distributions  $\{P(\mathbf{V} \setminus \mathbf{Z} \mid do(\mathbf{z}))\}_{\mathbf{Z} \in \mathbb{Z}, \mathbf{z} \in \mathfrak{X}_{\mathbf{Z}}}$ , in any causal model which induces  $\mathcal{G}$ .

All the soundness proofs in the paper do not rely on positivity. Still, to enforce positivity in the converse, it suffices to update Eq. (1) in the paper as follows (changes marked in red):

$$t_i \leftarrow \bigoplus_{\mathcal{H} \in \mathcal{F}_i} \left( \bigoplus_{V \in pa(T)_{\mathcal{H}}} v_{\mathcal{H}} \oplus \bigoplus_{U \in \mathbf{U}_{\mathcal{H}}^T} u_{\mathcal{H}} \right).$$
(A.1)

Now note that the outer xor in Eq. (A.1) can be distributed to write  $t_i$  in terms of its parents in the thicket:

$$t_{i} \leftarrow \bigoplus_{V \in pa(T)_{\mathcal{F}_{i}}} v_{i} \oplus \bigoplus_{U \in \mathbf{U}^{T}, \mathcal{H} \in \mathcal{F}_{i}} u_{\mathcal{H}}.$$
  
$$\leftarrow \bigoplus_{V \in pa(T)_{\mathcal{F}_{i}}} v_{i} \oplus \bigoplus_{U \in \mathbf{U}_{\mathcal{F}_{i}}^{T}} u_{i}.$$
(A.2)

If the sizes of crossing UCs and frontiers, both in  $\mathcal{F}_i$ , are equivalent mod 2, then pick one  $T_i^*$  from the frontiers of  $\mathcal{F}_i$ and define  $t_i^*$  as the negation of Eq. (A.2). Finally, for every R in the bottom of the thicket, it suffices to check  $\bar{t} = 0$ instead of t = 0 and append ' $\oplus \tilde{u}_R$ ' to Eq. (2) and (3) where  $P(\tilde{U}_R = 0) \neq 0.5$ . These represent key changes, but for more detailed and gentle explanation, please refer to the full technical report [Lee et al., 2019].

## References

Sanghack Lee, Juan D. Correa, and Elias Bareinboim. General identifiability with arbitrary surrogate experiments. Technical Report R-46, Causal AI Lab, Columbia University, 2019. https://causalai.net/r46.pdf.