Review of: "Mathematics Is Physical"

Aritra Sarkar[1]

1 Delft University of Technology

Potential competing interests: No potential competing interests to declare.

The article focuses on the thesis that abstract mathematics is influenced and limited by the underlying physical embodiment. It discusses this in the context of themes like Gödel's incompleteness theorems, Turing machines, differences in quantum and classical measurements, and irrational numbers.

While the article addresses some core issues in the philosophy of sciences (especially in mathematics, computer science, and physics), I think it would be more complete and valuable to include the following aspects that it currently does not consider:

1. Algorithmic Information Theory: AIT specifically studies this disbalance between enumerated programs (or laws, theories, sets of axioms) and the much larger set of non-halting programs (algorithmic random numbers). It would be valuable to consider articles like https://arxiv.org/abs/cs/0610153 .
2. Quantum Turing Machines: While TM is discussed, its quantum mechanical version and related generalizations like the Deutsch-Church-Turing principle should be considered when discussing quantum information processing implementations.
3. Curry-Howard-Lambek correspondence: This can be invoked to considerably reduce similar discussions using proofs and programs. Gregory Chaitin's book, Thinking About Gödel And Turing, and Noson S. Yanofsky's book, The Outer Limits of Reason, discuss similar ideas as this article.
4. Born rule: This quantum mechanical principle of projective measurement can be expressed mathematically, so I don't see why principles like no-cloning and measurement collapse that represent properties of an inherent quantum system (not a classical simulation of it) cannot be considered in a holistic theory which encompasses both the quantum and classical representations in a single formalism. For example, https://arxiv.org/abs/1805.03306 and https://arxiv.org/abs/2005.07325 discuss this.
5. Computational Complexity Theory: Problems like P vs. NP, and BQP vs. BPP, also provide another perspective to the resource scaling for computation (or proofs). In this respect, while quantum and classical information representations can be embodied in quantum or classical medium, quantum (including measurements), is a generalization in terms of resources though they are at the same Turing degree of computability.
6. My enthusiasm to review this article is based on a project I undertook to demonstrate the core thesis of this article. It can be accessed here https://community.wolfram.com/groups/-/m/t/2575951 The limitation of theorem proving is a well-understood limitation of engineered systems. Besides, universal artificial intelligence models, like AIXI, AIXI-tl, and QKSA, are based on the same idea as this article.

Parts of the article are superfluous and reiterate the motivation too many times (what is provable in a limited number of symbols and steps is a subset of all possible conjectures). As a minor comment, my aesthetic preference is to reduce the line width and make the text more to the point.

In summary: while this article touches on some interesting ideas, I fail to appreciate the novelty. It would be more valuable to the scientific community if presented as a more comprehensive survey of related ideas.