Review of: "Self-Replication, Spontaneous Mutations, and Exponential Genetic Drift in Neural Cellular Automata"

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Potential competing interests: No potential competing interests to declare.

(This review is the fruit of my reading and discussion with my post-doc Vassilis Papadopoulos).

First of all, I'd like to say that despite a few weaknesses in the present form, I very much enjoyed reading this very original and insightful paper: it really brings new ideas to the table, illustrates them nicely, suggests very interesting new directions, and is absolutely worth reading in the present form!

Key Strengths and Novelties of the Paper:

– The idea of performing self-reproduction by training an NCA to evolve an egg into an organism that will lay an egg and move away is very nice, and the illustrations are convincing. It gives a very simple path to self-replication (including some evolution) that is drastically different from the more intrinsic/logical ideas of Von Neumann's Cellular Automata (which are based upon Turing machine ideas).

– Perhaps as a counterpoint to the ‘divergence’ emphasized in the paper, I found the resilience/robustness of the organisms surprisingly good (so that's more of a ‘convergence’ thing). It is quite remarkable that they so often manage to produce fertile offspring.

– The encoding of genes in egg structure or with relative positions are interesting ideas, that could lead to more discoveries.

– The general view is very inspiring.

Key Weaknesses of the Paper:

– The framing is that of open-ended evolution. While it is good and important to have big questions in mind, I am not sure that the progress made by this paper is exactly going into that direction; at least, the paper does not show much diversity in what comes out of the process, quite far from what we would expect from open-ended evolution; furthermore, the big selector for open-ended evolution is the ability to self-reproduce, and this is not really studied in depth.

– The focus on the genetic drift makes sense if the goal is to study open-ended evolution; however, we don't see anything very clear in terms of that. Certainly not ‘exponential genetic drift’ (maybe the only thing that can be said is that there are abrupt points of transition), unless the word ‘exponential’ is used in a very liberal way (which it shouldn't in a scientific paper).

Some points that can be improved:

– Some of the writing/spelling. Automata is the plural of Automaton.

– In the discussion about Turing completedness, the phrasing can mislead people. For instance, what is meant by ‘Von Neumann Cellular Automaton’ (in the context of the paper of Manukyan)? I am not aware that this means more than ‘Cellular Automaton’, yet in the context, it could be understood that it implies Turing completedness.

– For the example with the plants, while the ideas are interesting, it is not completely clear how things fit in the context of the things before: is there self-reproduction occuring in that instance… if yes, how?