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

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Since the article starts out with some statements about physical laws and closed systems etc., I want to understand the assumed context of this work. From the perspective of physical laws, all of biology is about information preservation in varying environments. All self-sustaining living organisms (thus excluding viruses) are using energy to keep entropy at bay. Why the need to reproduce? One could solve this information preservation problem simply by using energy to only preserve the state of an organism, focusing only on immortality and completely ignoring reproduction. This approach requires a lot of energy because chemistry is fundamentally stochastic so there must be a lot of error correction required for every process. The other problem with immortality as an information preservation solution is that it may not be robust against environmental changes. Here, one can imagine diurnal changes, for example, which are not difficult to account for, but also spatial large deviations of resources on longer time scales. Thus another solution is to replicate inexactly and often (bacteria) or more precisely and rarely (whales), but in either case, allow changes in the DNA that will propagate. For multicellular organisms, the preservation of germline DNA in as perfect a form as possible is therefore a major endeavor.

Now, if one wants to study emergent phenomena such as evolution, and I personally don't see why Alife is interesting except for understanding such concepts, then one must contend with the fact that there are two distinct forms of robustness in biology: genetic robustness (or why are children similar to their parents) and homeostatic robustness (or how can humans inhabit Lapland and the Sahara). So a central question is: How do genetic robustness and homeostatic robustness coexist with speciation? Presumably this must arise from limits to the extent of neutral mutations that can be consistent with genetic robustness of the initial organism while preserving homeostatic robustness. Conjecturally, when the two cannot be preserved together, it requires a new species where this coexistence can again be manifested. This brings us to much larger questions such as those raised by Kirschner and Gerhart in their book, ‘The plausibility of life’.

This paper presents results in cellular automata in a context in which homeostatic robustness is never called into action, and therefore there is no question of a new species arising, at least from the perspective that I have outlined above. I found the simulations amusing but, as the author discusses frankly and honestly in the concluding section, I'm not really sure what these results illuminate since there is no pressure of any sort other than avoiding death. Drift happens but since there is no competing influence that impairs function of any form, could one go so far as to say that speciation requires a specific connection between form and function?

The paper would benefit from a closer proof reading. For example, ‘do no change’ → ‘do not change’, ‘models were organisms' → 'models where organisms', 'it own egg' → 'it's own egg', 'highjack' → 'hijack'. I do not understand why the author thinks that deep neural networks are designed for convergence, because in fact, it takes some amount of care in their parameter initialization for this to be achieved.