

Can cellular automata provide a new understanding of complexity?

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Governments, financial systems, wars and pandemics are the result of local interactions between human beings, or at least that was the case before the internet. Just like human societies, cellular automata also develop into complex and seemingly unpredictable states. Maybe by better understanding a simple model such as the cellular automaton we could better understand systems that are way harder to crack. Some scientists even say that cellular automata contain secrets about the most fundamental nature of reality on a quantum level, and should even be considered as a candidate for a theory of everything.

Most of the public is not familiar with cellular automata. Fundamentally a cellular automaton is a model of computation consisting of a grid of cells with value zero or one that evolves at each time step. The evolution of each cell is based on local rules that define the value at the next time step based on the values of the cells next to it. The main point here is that every interaction is local.

The same property of locality is shared by other systems. In a magnet the final magnetisation comes from the interaction between the single atoms and in a gas the properties come from the collisions between the molecules. Think about the air in your room, every single molecule is doing its own thing and wiggling around, colliding with other molecules at a very high speed and producing what you experience as air. It is impossible to keep track of all of them, but statistical measures can give you the information you really need, such as temperature and pressure.

By using the statistical measures of the most well-understood complex systems (thermodynamical systems) to study and create a framework for one of the most basic complex system (cellular automaton), it could be possible to generalize the results to systems that are more complex so we could reach towards a better understanding of them. This thesis is aimed at trying to build the foundations to follow that direction.