Can a mathematical model solve The Mystery of Life?

The mystery of life may sound complex, but what if the complexity could be concretized by something as simple as a pile of sand?

Let's think about the bigger picture of life. For example: Why do trees look like they do? Why did life advance from single cells to multi-cellular? or, How did life arise in the first place? These questions used to have the "simple" answer that: Someone must have designed it all! Humanity's strive to understand this "higher power" has resulted in many scientific explanations, but the conundrum of life itself is still persistent. Now, envision that life can be described by a simple set of rules in a discrete mathematical model.

This model can be described by considering a pile of sand as seen in Figure 1. If you slowly add sand grains on top of this pile, an avalanche will eventually occur. The event of this avalanche means that a critical state of the sandpile was reached, where the pile no longer could receive more sand grains and remain in rest. This critical state can be quantified by considering the subsystem of each sand grain's nearest neighbors. If several of these subsystems in the pile fulfills certain criteria or *rules*, where the subsystems' internal friction is less than the gravitational pull, a cascade caused by the domino effect would lead to this landslide of sand. It is these specific *rules* that are the heart of the model. In our sandpile, these rules are characterized by the forces of gravity and friction, but let us apply this model to something that is more "life-like" than sand, where the causes of the local rules are something else.

Figure 1, Sand grains being added to a pile of sand.

Figure 2, Starling murmuration.

Think of a system where each sand grain is replaced by a starling. Flocks of starlings can be seen in complex formations like the one in Figure 2. However, imagine that the starlings follow some rules, related to their nearest neighbors, in the same way as the sand grains in a sandpile do. These rules (in the starling system) cause it to self-organize into these patterns, as the birds move across the sky. So, instead of being steered by gravity and friction, their rules are based on something else, i.e. the cluster of birds has its version of "gravity" (perhaps related to the wind).

Let us take this model one step further and look at a system of cells instead. One can easily picture that a system of cells also follows some rules and, what if these rules were the underlying cause that multi-cellular organisms emerged some 3 billion years ago? Some system-specific "gravity" may have caused the cells to cluster with other cells and, eventually, *their rules* caused the cells to merge.

We have now postulated that this mathematical model, perhaps, describes how life behaves as a system and maybe it can even describe why life exists in the first place. Everything we know could be based on a simple set of rules; it is just that we don't necessarily know what these rules are. Specifically, this study will make use of the presented model to investigate and analyze life as a complex physical system. By studying several different computer-simulated theoretical systems (i.e. not based on anything real) that follow the described model, their long-term behavior can be analyzed. The results of these simulations are hypothesized to establish a direct connection between the presented mathematical model and intelligence (i.e. the main ingredient of what we call life).