

## Applying GPU computing to the simulation of life-like cellular automata

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I am proposing a project to harness the massively distributed processing environment of a GPU for the challenge of evolving life-like cellular automata, an inherently distributed task. The application I plan to build should be able to run any implementation of life-like automata – including the famous Conway’s Game of Life – with a considerable performance improvement from the GPU.

Cellular automata is a form of discrete model used in the study of computability, mathematics, and theoretical biology. Life-like automata is a commonly studied subtype of CA that meets the following criteria:

- There is a single array of cells with two dimensions
- Each cell has two states (“alive” or “dead”)
- Each cell has a Moore neighborhood of adjacent cells
- At each time step, the automata evolves the state of every cell based on its current state and the states of those around it.

The most famous example is Conway’s Game of Life, a simulation which displays an extraordinary number of life-like forms. These patterns of cells can appear, disappear, persist, and even move throughout the landscape. Other more recently discovered variations can produce even more impressive forms. Various life-like rules can create “organisms” that grow like slime, move like cells, and even self-replicate.

Running large scale simulations of cellular automata is a computationally demanding task. For an asynchronous processor, each cell must be painstakingly updated across a grid of many millions. A distributed computing environment could easily parallelize the task, and a GPU would provide just such a device. GPUs (graphics processing units) are available in almost all consumer devices and employ parallelized computing principles to solve graphical tasks. In recent years, graphics card manufactures and open source developers have released tools to enable general access to the distributed processing on GPUs.

The foundation of this project is not unprecedented, several publications have already discussed the process of translating cellular automata into a GPU programming task.<sup>[1][2]</sup> For this project I plan to continue their work by creating a new application for simulating categorically life-like automata with a GPU.

1. Gibson, Michael J., Edward C. Keedwell, and Dragan A. Savić. "An Investigation of the Efficient Implementation of Cellular Automata on Multi-core CPU and GPU Hardware." *Journal of Parallel and Distributed Computing* 77 (2015): 11-25. Web.
2. Topa, Paweł, and Paweł Młoczek. "GPGPU Implementation of Cellular Automata Model of Water Flow." *Parallel Processing and Applied Mathematics Lecture Notes in Computer Science* (2012): 630-39. Web.