

Cellular Automaton Projects

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A Cellular Automaton (CA) is a discrete or cell based model whereby cells evolve in time according to some (usually deterministic) rules. Often the rules are formulated in terms of the cell's current value and the current value of its neighbouring cells. The best known CA is John Conway's "**Game of Life**" which is a 2-dimensional square mesh CA with the rules that:

1. if an unoccupied cell has exactly 3 live neighbours it becomes occupied ("birth")
2. if an occupied (live) cell has 2 or 3 live neighbours it survives to the next generation ("survival")
3. otherwise, a live cell will die ("death" from "overcrowding" or "loneliness")

The rules can be encoded in various ways and CA models can be set up with all sorts of different rule combinations. Indeed a system can consist of automata cells that have different rule sets, or even that have rule sets that evolve genetically.

This project is to develop a Cellular Automaton simulation framework code and to study various statistical properties of different automata and rule sets. This work relates to models of Artificial Life being researched in the Albany **ALife research group** and will be able to share some analysis methods and codes.

Parts of this project could be carried out at **honours, masters or PhD level** with obviously more work required to implement more of the aspects of the system at higher levels of study. Generally Java codes are easiest to develop for this project as they support interaction and visualisation most readily, but it would also be possible to develop a code in C or C++ that is optimised for speed and which generates CA configurations on one of the cluster supercomputers.

One route for this project would be to experiment with an interactive CA simulation to **design rules** for particular purposes. In such a way automata that address particular problems such as "an explorer" or "a reproducer" or "a harvester" automaton agent might be constructed. A more advanced phase of this project is to **determine a taxonomy and classification rules** for CA models in 2 and 3 dimensions and to explore all possible rules of a particular family to find out how many fall in each category. Some very advanced work involves **using metrics for computing properties such as complexity and entropy** to characterise different CA systems. This project will suit students interested in programming and experimenting with simulations.

