Life? Don't talk to me about Life. I've seen it. It's rubbish... [1]

In the late 1940s, mathematician John von Neumann became interested in what the real world could teach him about computing. Together with physicist Stanislaus Ulam, they investigated the way in which relatively simple components following simple rules can work together to form complex systems with elaborate behaviors. The obvious example of this are the cells in your body – each individual cell is, by some standard, a fairly simple device but large groups of cells working together can form complex organs like hearts, kidneys, muscles and even brains. Likewise each individual insect in an ant or termite colony is a very simple minded creature, but thousands of them working together can build amazingly complex structures.

Von Newman tried to define the set of behaviors required for each cell and the ways in which a single cell could interact with other cells. He set for himself the goal of building a system of cells that could create an exact copy of itself. By this we don't mean that each cell simply copies itself – that's trivial – but that entire arrangement of cells creates an exact duplicate of itself; sort of the equivalent of your kidney deciding to grow another kidney on its own! (Or, in a more realistic sense, the equivalent of a termite colony starting another colony somewhere else, which it can of course actually do.) It was a difficult problem but not impossible, and Ulam and von Neumann eventually found success with a cell that had twenty nine states and interacted with its four directly adjacent neighbors.

In the late 60's a British mathematician named John Conway became interested in von Neumann's work, but Conway thought von Neumann had made things far more complicated than they needed to be. After much experimentation Conway eventually settled on a two dimensional array of cells in which each cell had only two states, living or dead, and interacted with its eight neighbors by only three simple rules:

1. A living cell survives to the next generation if it has two or three neighbors.

2. A living cell dies if it has four or more neighbors (overcrowding) or if it has only one neighbor or none (isolation).

3. A dead cell becomes a living cell in the next generation if it has exactly three neighbors (birth).

They may be simple but, believe it or not, a sea of Conway's cells can do everything that von Neumann's cells could do. In fact, Conway went on to figure out ways to model AND, OR and NOT gates and other components of modern computers with his cells. Believe it or not, if you had enough of Conway's cells working together (and it would take *a lot*) then you could compute anything the most modern Pentium chip can!

A short while later Martin Gardner, who at the time edited the Mathematical Games column in *Scientific American* magazine, wrote about Conway's work. When that issue hit the streets in October of 1970 the floodgates were opened and vast quantities of time, both human and computer, was spent on generating random arrays of living and dead cells and then running them ahead in time thousands or millions of generations while people looked at the results for any "interesting" patterns.

Eventually, many fascinating patterns were discovered. Not just patterns that are stable – those are considered fairly boring – but patterns that grow and evolve over time. The Spare Time Gizmos LIFE game has a dozen or so classic LIFE patterns built into its ROM and it can display the initial pattern followed by successive generations.

Von Neumann and Ulam are both dead now, however John Conway is still alive and living in Britain. Conway never intended his invention to be a "game," and although he has always acknowledged the parallels to living creatures, he never intended it to be a model of biological systems.

To a computer scientist, algorithms like LIFE are known as "Cellular Automata" and have many practical applications, including some non-obvious things like modeling the movement of subatomic particles, predicting the behavior of large crowds of people, or explaining the spread of forest fires.

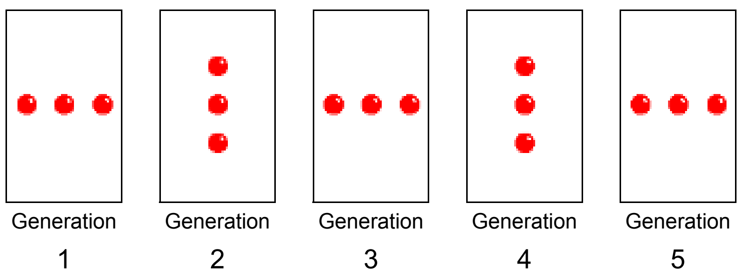


Table 1 - The Blinker

Table 1 shows a very simple LIFE pattern – it has only three cells – known as a Blinker (some people also call it a Traffic Signal or even a Flip-Flop). It oscillates between two distinct states with every new generation. If you're interested you can easily "play computer" and apply the Rules of Life to this 3x3 grid and see for yourself why it behaves this way.

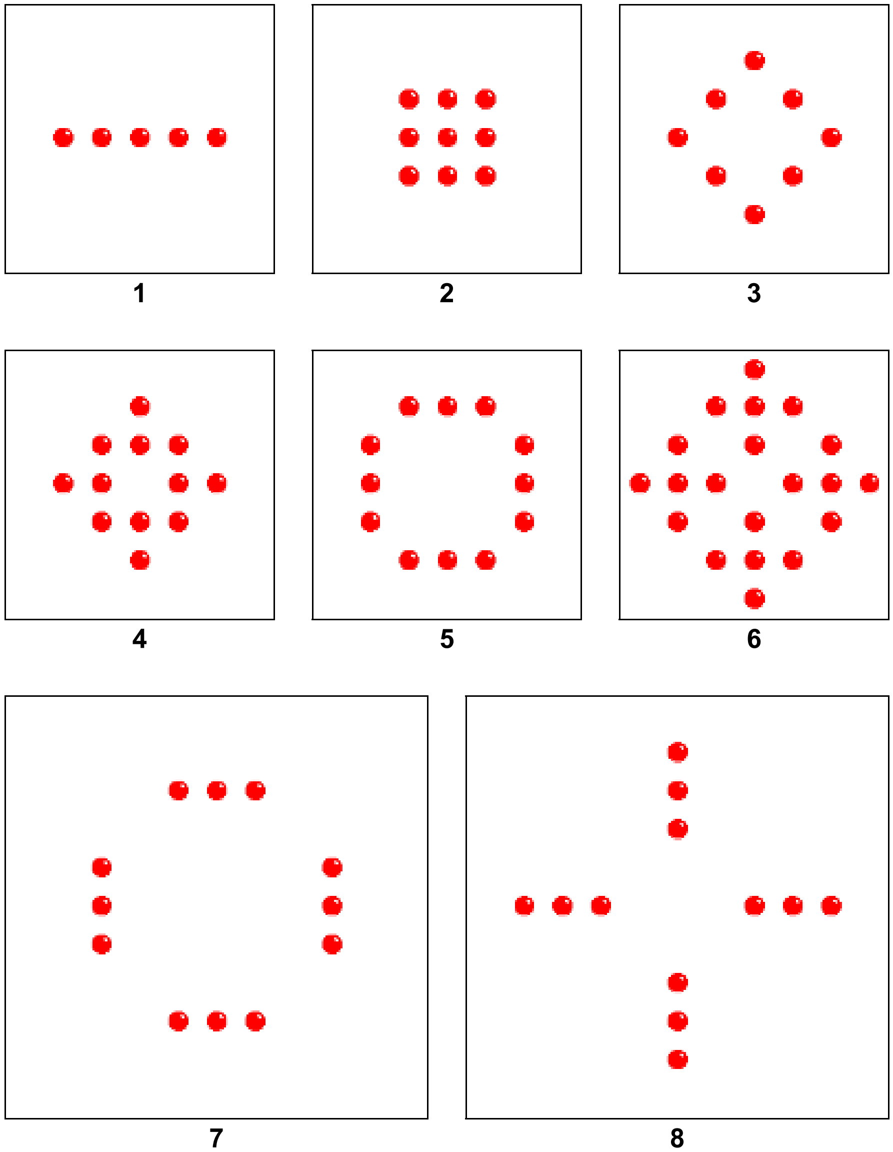
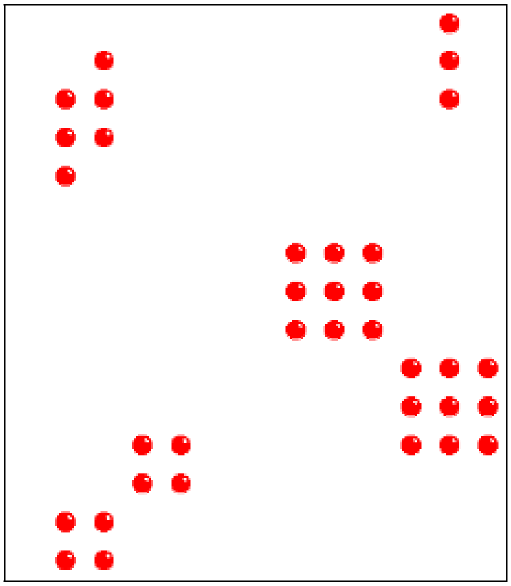
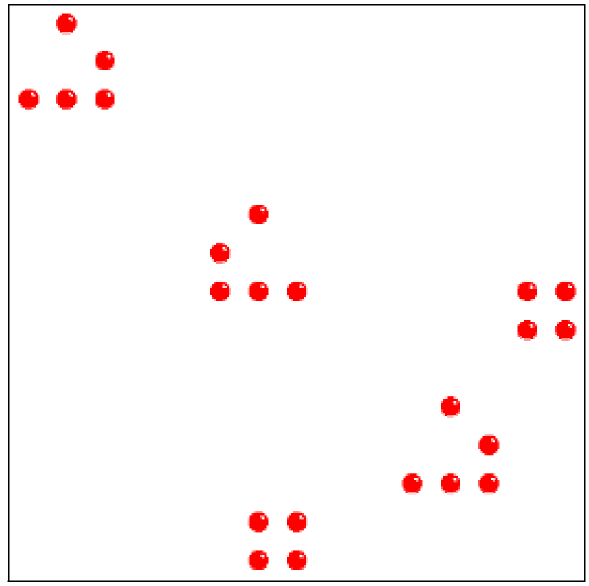


Table 2 – Evolution of the Pattern "FIVE"

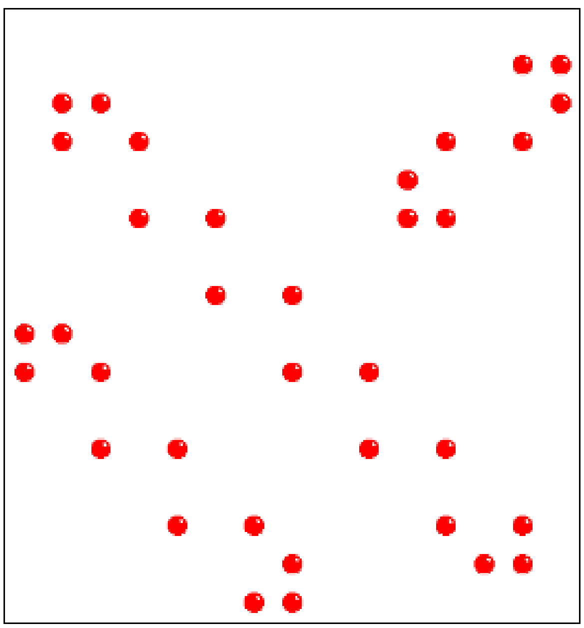
Table 2 shows the result of adding just two more cells to the initial pattern. This pattern, unimaginatively known as “FIVE”, goes thru several stages of evolution before settling down to four synchronized blinkers. Table 3 shows the initial states of just a few of the LIFE patterns built into the firmware of this project. You can amuse yourself by trying to figure out how they will evolve, or you can build the project and see!



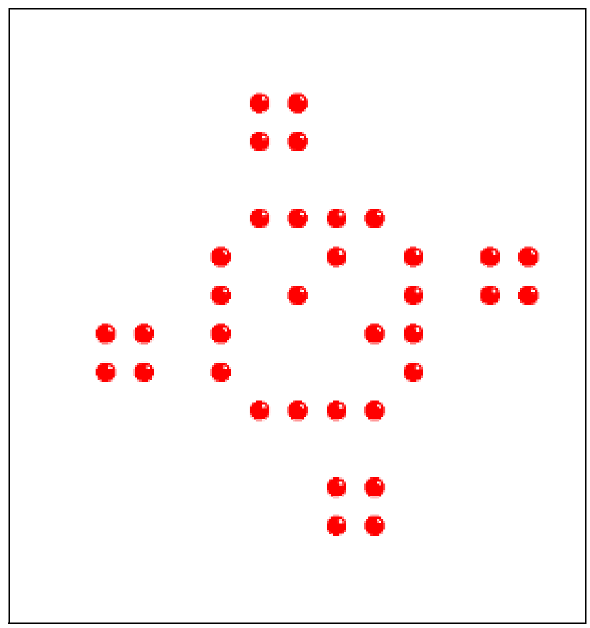
Different forms of Blinkers



Gliders



Barber Poles



The Clock

Table 3 - A Few Other LIFE Patterns

[1] With apologies to Douglas Adams, *The Hitchhiker's Guide to the Galaxy*, and Marvin.