Stochastic Cellular Simulation

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Introduction

The Stochastic Cell Survival simulation resembles John Conoway's Game of Life. The main difference between Simple Cellular Automation and The Game of Life is that Simple Cellular Automation (SCS) is in 1D and utilizes probability instead of pure determinism. SCS initializes an array of 0s and 1s placed in random order that allows the user to state the amount of 1s in that array. Then, given the rules of the game those filled cells either die out or evolve eventually taking up the whole array based on the amount of time run.

Physical Relevance

At this point in development, SCS is too early and too theoretical to hold any deep physical relevance, it is unknown if the system will reach a chaotic state as in most cases the system will either undergo a fast or slow decay to a steady state. At it's current point, SCS is just a simulation of probability and more over how long the system takes to reach a steady state.

Plot information

In this paper there is little information on the plots so: The x axis represents the lattice size from lattice point $i = 0$ at $x = 0$ to the lattice point $i = N$ (size of lattice) at $x = N$. And the the y axis represents the steps the simulation was run from $t = 0 \rightarrow t = y$.

Rules

•Filled cells

If the cell is filled in previous time step then it has a 50/50 chance of survival.

•Filled neighbors

If the cell is unfilled but, its neighbors are filled, survival probability goes as follows: 2 neighbors have a 50/50 chance of survival. 1 neighbor has a 25% chance of survival and 75% death.

•Filled cells and neighbors

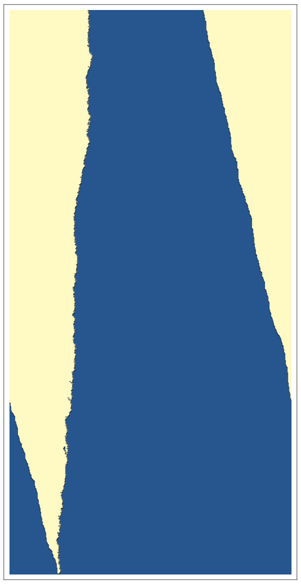
If the cell is filled and it's neighbors are filled in the previous time step, its probability of survival is 100%.

•Unfilled cells and neighbors

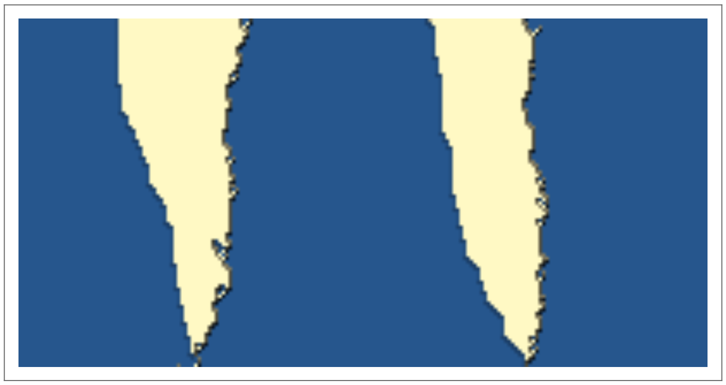
If the cell is unfilled and it's neighbors are unfilled in the previous time step, it has a zero probability of surviving.

1 Behavior (Cell growth)

By far the most common type of evolution. If one starts values at over 2 it is very likely to get a growing system.

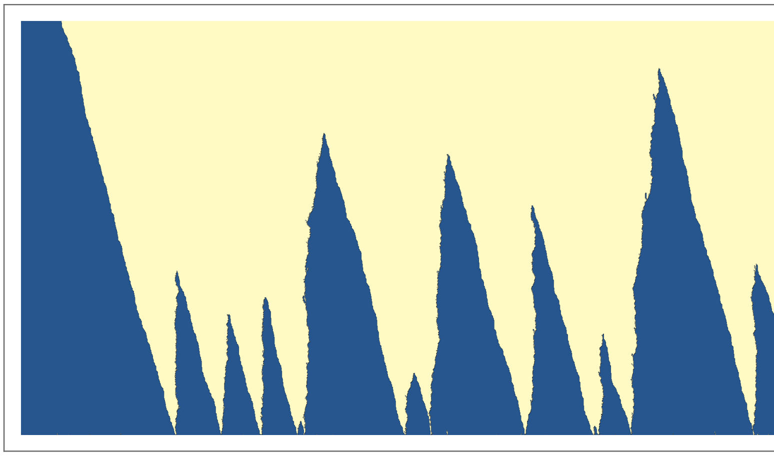


(a) 500 lattice points with 1 initially filled cell running for 1000 steps



(b) 200 lattice points with 3 initially filled cells running for 100 steps

(c) 200 lattice points with 12 initially filled cells running for 100 steps

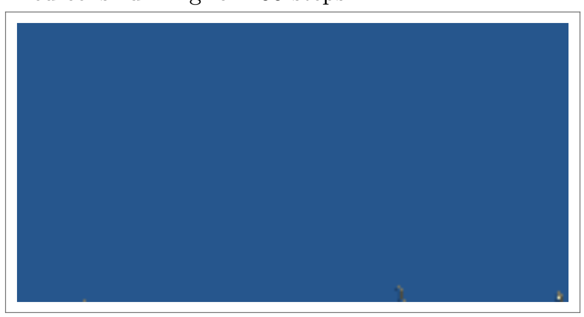


(d) 2000 lattice points with 35 initially filled cells running for 1000 steps

2 Behavior (Cell death)

Uncommon to get any growth that propagates for a bit, then fizzles out. In most cases setting the amount of 1s in the initial lattice to just 1 will cause a very fast death in that cell.

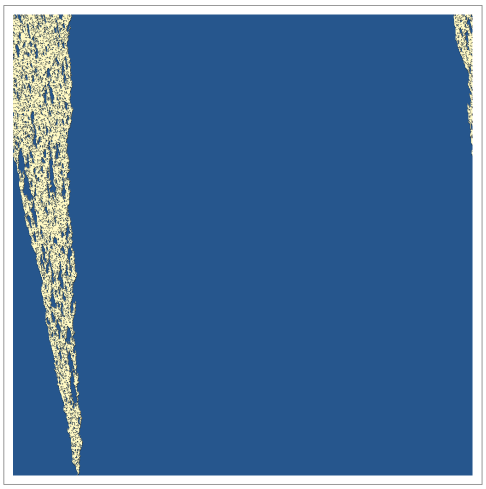
(a) 200 lattice points with 5 initially filled cells running for 100 steps



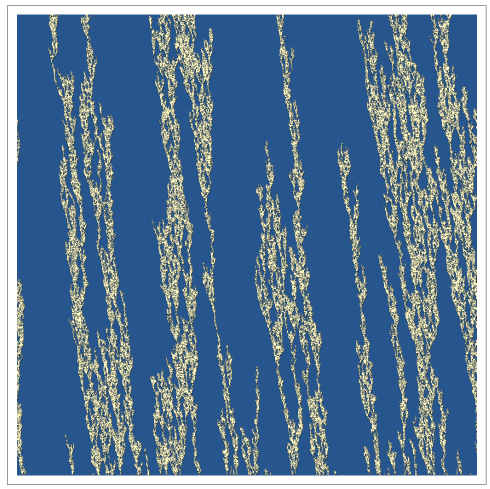
(b) 200 lattice points with 3 initially filled cells running for 100 steps

Changing System Dynamics

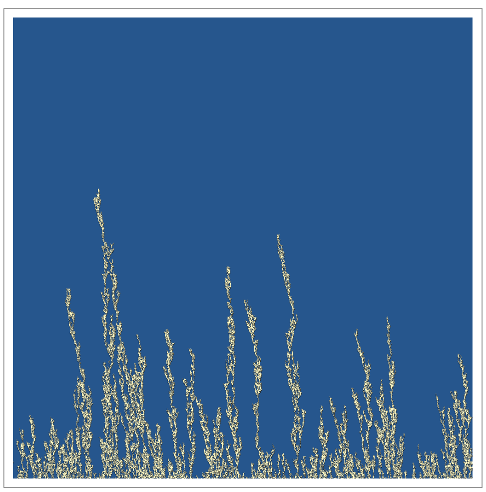
To curb the system dynamics to be more stringent on cell survival, additions to the program can be made to the percentage survival. For example, in the case where a filled cell and neighboring cells only have a 90% (Instead of the 100% in previous depictions). This addition allows growing and decaying off behaviors.



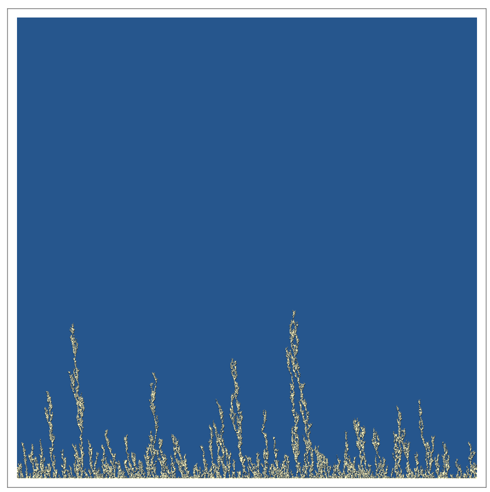
(a) Lattice size 1000 with 1 point and 90% survival rate



(b) Lattice size 1000 with 100 points and 80% survival



(c) Lattice size 1000 with 500 points and a 70% survival rate



(d) Lattice size 1000 with all filled points and a 60% survival rate

Conclusion

This model uses a bit of determinism to probabilistically decide if a cell survives or dies off in it's algorithm. In the first case it is very favorable for the cell to survive if it has any neighbors and guarantees survival if it as surrounding neighbors. In the second cases where the probability was changed, cell survival become less and less likely as probability decreased(Which makes sense).

Further Work:

- **2d simulations**

- **Unrandomizing filled cells and selecting where they are placed in an array**

- **Real time evolution**