An Investigation of Cellular Automata Dynamics

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Introduction

John Conway's Game of Life consists of a field of square cells, each of which can be alive or dead and has eight cells around it. Under his rules, every living cell that had exactly two or three living neighbors would survive into the next generation. Every dead cell with exactly three living neighbors would be alive in the next generation. This project enables different cells to have different rulesets; every cell that is born inherits its rules from the cells around it, but can also mutate, based on a probability partially inherited from its neighbors.

Abstract

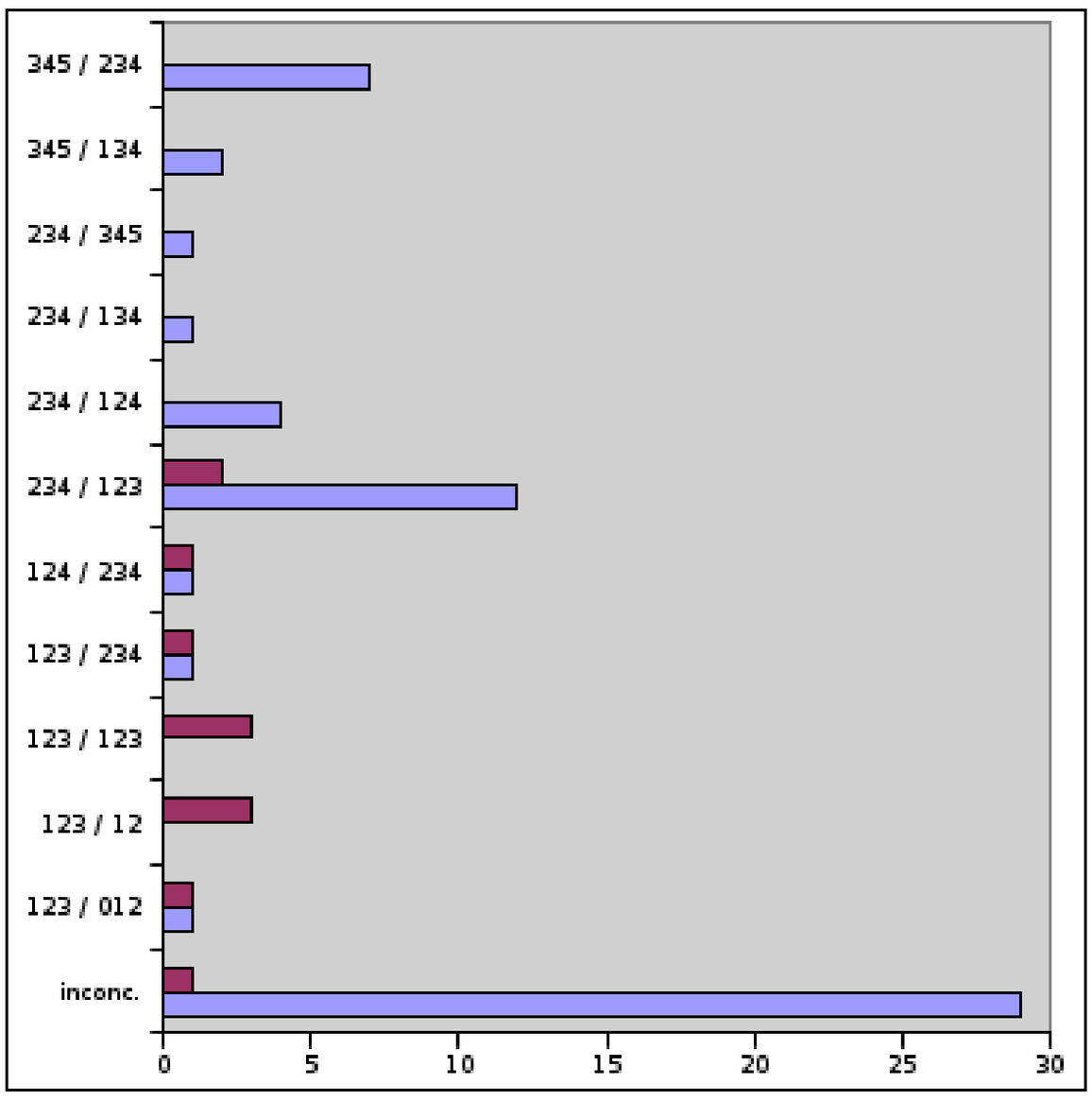
John Conway's Game of Life showed that simple rules can generate amazingly complex patterns. Using variations of the rules he devised, one can learn about the advantages of different sets of rules and the implications for simple evolution and chaos theory.

Procedures

The field is initially set with two or more rulesets active; each cell is randomly set to be alive or dead, and its neighbors share its rules. After one set dominates the board, it and its opponents are recorded. When twenty of these trials have been run, the rulesets occurring at the end of trials are recorded and ordered by the number of trials in which they were present. These rulesets are then matched against each other in the second round of testing to determine relative strengths.

Conclusions

It has already been observed that certain types of rulesets are more successful on a crowded board; for example, cells which require few neighors to survive do better than cells that need many. Also, in most trials with a simple ruleset pitted against a variation on that same set, the simpler ruleset wins easily. However, if a simple ruleset is pitted against a variation on a set that tends to be stronger than the former set, there is no visible pattern; either could win. Also, the number of preliminary trials containing a particular ruleset is not terribly indicative of its relative successfulness; a set that only dominated in a couple of initial trials could cover the board in most of its secondary trials.



legend: abc/def.ghi/jkl=ghi/jkl by a%

Ruleset surviving with a,b,c living neighbors and being born with d,e,f living neighbors occupied (100-a)/2% of the board, while ruleset surviving with g,h,i living neighbors and being born with j,k,l living neighbors occupied (100-a)/2+a% of the board.

- 234/123.345/134=234/123 by 88%
- 234/124.345/134=234/124 by 10%
- 345/234.345/134=345/234 by 96%
- 234/123.124/234=234/123 by 100%
- 345/234.124/234=345/234 by 100%
- 345/134.124/234=345/134 by 100%
- 234/124.124/234=234/124 by 100%
- 234/123.123/234=234/123 by 93%
- 345/234.123/234=345/234 by 100%

legend:

red bar=number of trials in which ruleset covered a large part of the board,

blue bar=number of trials in which ruleset covered all of the board