SAN JOSÉ STATE UNIVERSITY

SJSU Undergraduate Research Grants

New Geometries for Cellular Automata

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Abstract

A cellular automaton is a collection of "cells" arranged in a geometric pattern (often the Cayley graph of a group) in which the state of each cell evolves according to some rule based on the current state of its immediate neighborhood. We investigate cellular automata on the infinite free trivalent tree. Specifically, using both experiments done with interactive software of our own design and theoretical methods, we describe ways in which natural generalizations of Conway's Game of Life to the infinite trivalent tree are affected the geometry of the tree. We also describe possible future directions.

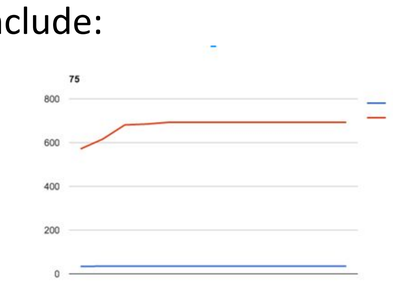
Project Activities or Findings

Results on number of survivors include:

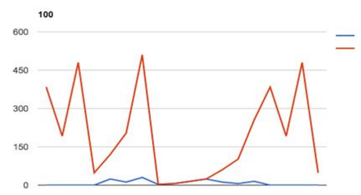
- repeating/alternating numbers
- constant trends

Most interesting rules are:

- rule to survive: 1-1, 2-2, 3-3
- rule to spawn: 1-1, 1-2



random # of cells: 75%, RTS: 1-3, RTB: 1-1

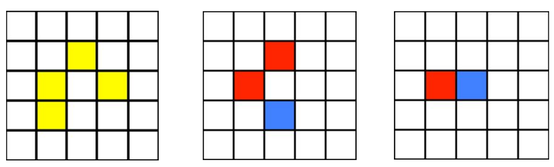


random # of cells: 100%, RTS: 1-1, RTB: 1-2

red - total survivors in tree (radius used: 8)
blue - number of survivors in bounded radius within tree (bounded radius: 4)

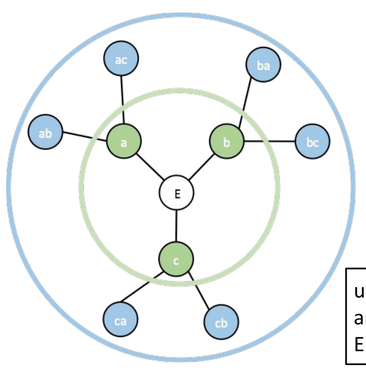
Conway's Game of Life: 2D grid where a cell has 8 possible neighbors

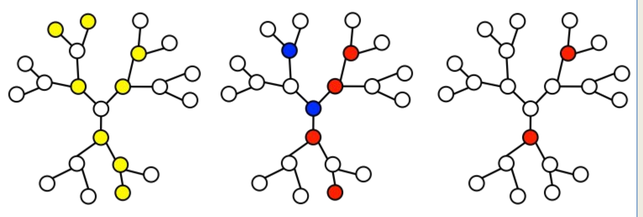
Initial: at time t | at time t + 1 | at time t + 2



Rules:
At time t + 1, a cell survives if it had 2-3 neighbors at time t. (RTS: 2-3)
At time t + 1, a dead cell comes alive (is born) if 3 of its neighbors were alive at time t. (RTB: 3-3)

Tree Life: Free trivalent tree where a node has 3 possible neighbors



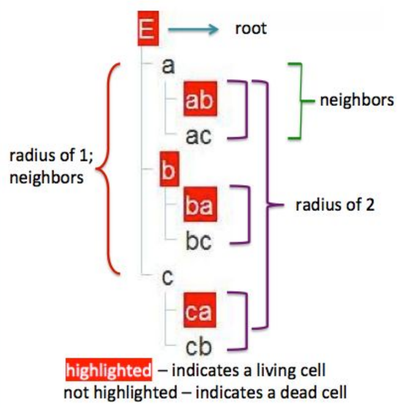


Initial: at time t | at time t + 1 | at time t + 2

use of an alphabet (a, b, c) and radius for tree structure; E represents root node

Rule used in example:
RTS: 1-1
RTB: 3-3
(radius of 3)

Software Features



Create New Tree | Expand/Contract

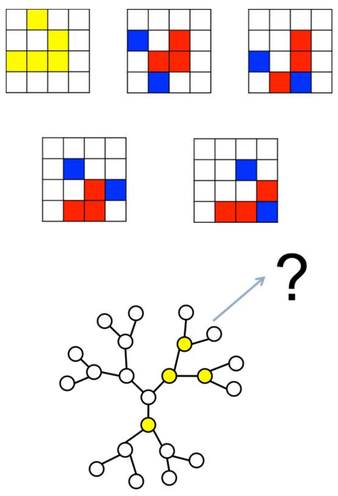
Random # Cells | Random % Cells

Read Tree | Save Tree

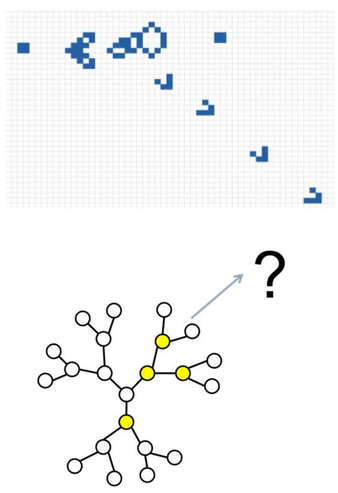
TimeStep | Rules | Advance n Steps

Future Research Questions

Is there a tree glider?



Is there a tree glider gun?



Citations

- Berlekamp, Elwyn R.; Conway, John H.; Guy, Richard K. Winning ways for your mathematical plays. Vol. 4. Second edition. A K Peters, Ltd., Wellesley, MA, 2004.