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Can Julia win the Game of Life?

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Overview

What are Cellular Automata?

- Discrete models: grid of cells, each with a state
- Simple, local rules $\rightarrow$ complex global behavior
- Used for simulating complex systems (urban, physics, biology)
- Example: Conway's Game of Life

1D Cellular Automata: Theory

- Cells in a 1D array, each with a state (e.g., 0 or 1)
- Neighborhood: e.g. cell itself + left/right neighbors
- Update rules: Neighborhood $\rightarrow$ next state

1D CA: Ruleset

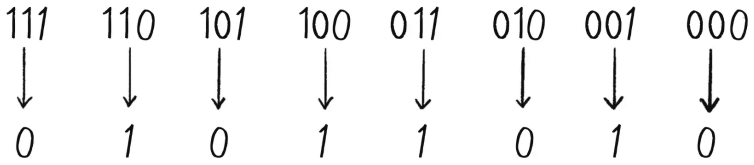


Figure: Example: Mapping neighborhood to next state (here rule number 90)

1D CA: Visualization

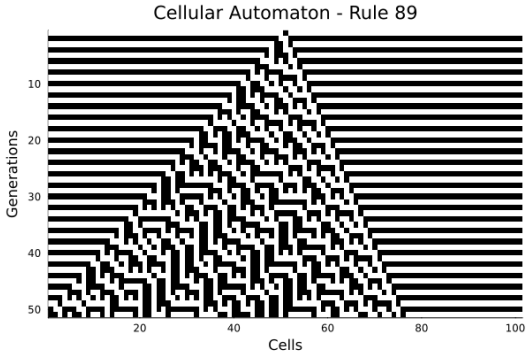


Figure: Visualization of generations as rows in a 2D grid

Wolfram Classification

- **Class 1:** Uniformity (stable)
- **Class 2:** Repetition (periodic)
- **Class 3:** Random (chaotic)
- **Class 4:** Complexity (mix of order/chaos)

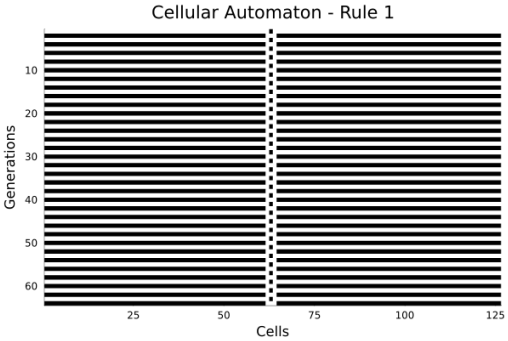


Figure: Rule 1: An example of Class 2 (repetitive)

2D Cellular Automata: Game of Life

- Grid of cells, each with 8 neighbors
- **Rules:**
  - Birth: exactly 3 alive neighbors
  - Survival: 2 or 3 alive neighbors
  - Death: < 2 or > 3 alive neighbors

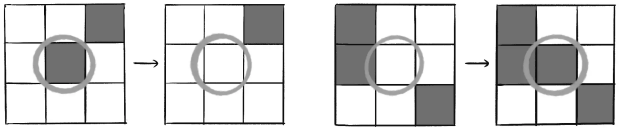
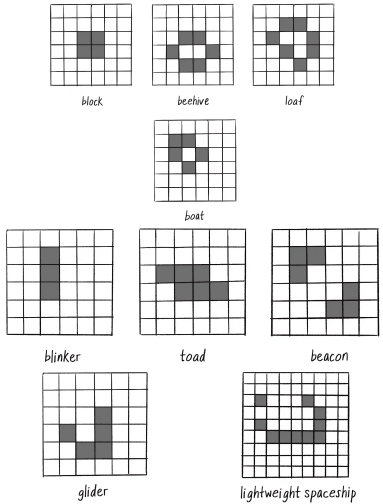


Figure: Examples of scenarios in the Game of Life, Source: `https://natureofcode.com/static/99dd5b32b72ce094d5a77f749c2ab9f0/3ca65/07_ca_28.webp`

Game of Life: Patterns

- **Stable:** Do not change
- **Oscillators:** Repeat after *n* steps
- **Spaceships:** Move across grid
- **Guns:** Emit other patterns



1D CA in Julia

Game of Life in Julia

Extending Game of Life: Infection Simulation

Why Julia for Simulation?

Discussion

Conclusions

Image sources

Thanks / References