CrossFinder and Minesweeper Solver - Custom Game of Life Variants

This repository contains two distinct Python Projects,Combining Cellular Automata with Game Development. The projects are as follows:

1. **CrossFinder**: An innovative variant of Conway's Game of Life, meticulously engineered to detect and manipulate cross shapes within a grid environment. Diverging from the conventional Game of Life, CrossFinder integrates additional states and tailor-made rules aimed at pinpointing and transforming cross-shaped patterns.
2. **Minesweeper**: A Python implementation of the classic Minesweeper game with a graphical user interface (GUI) using `Matplotlib` and `NumPy` . This project includes additional features like reset, hint, next, and undo buttons.

Both projects utilize basic Python libraries such as `NumPy` and `Matplotlib` , and are designed to run in a local environment. Enjoy exploring these projects and feel free to contribute to their development!

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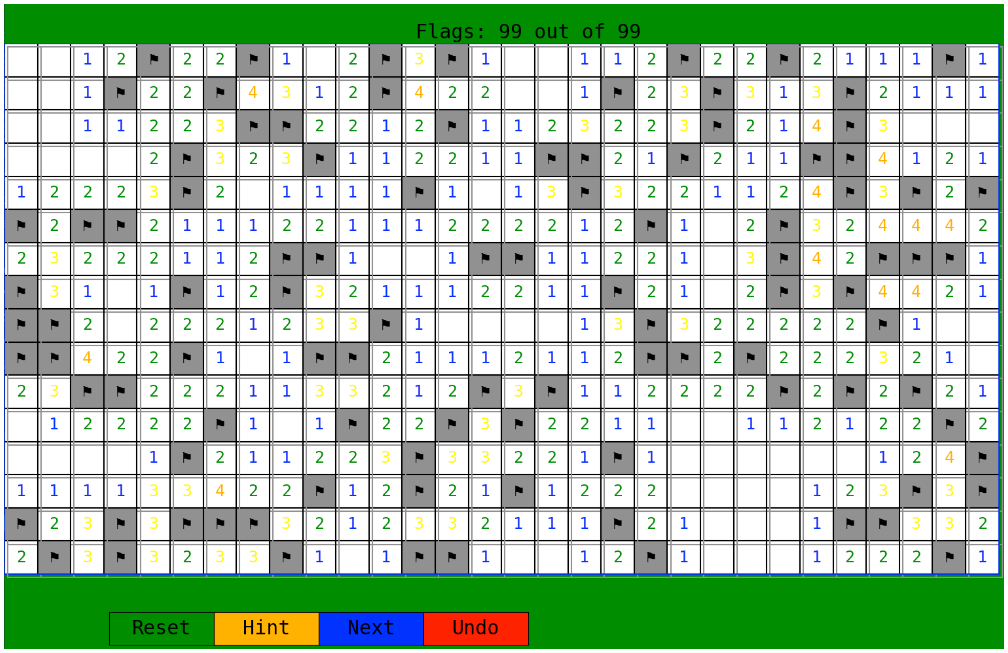
Minesweeper

A Python implementation of the classic Minesweeper game with a graphical user interface (GUI) using Matplotlib and NumPy. This project includes additional features like reset, hint, next, and undo buttons.



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Minesweeper Features

- **Classic Minesweeper Gameplay**: Inspired by the original Minesweeper game from Microsoft Windows.
- **Graphical User Interface (GUI)**: Built with Matplotlib for visual interaction.
- **Interactive Buttons**:
  - **Reset Button**: Resets the game.
  - **Hint Button**: Reveals a random hidden cell.
  - **Next Button**: Applies a custom rule set inspired by Conway's Game of Life to reveal hidden cells.
  - **Undo Button**: Undoes the last move.
- **Custom Rules**: Implements custom rules for the "Next" button to provide an enhanced gameplay experience.

- **Game Over and Win Conditions**: Game ends when a mine is hit or all non-mine cells are revealed.

Installation

1. **Clone the repository**:

   ```
   git clone https://github.com/Dor-sketch/CrossFinder
   cd CrossFinder
   ```

2. **Install the required packages**:

   ```
   pip install -r requirements.txt
   ```

Usage

1. **Run the Minesweeper game**:

   ```
   python3 mines.py
   ```

2. **Play the game using the GUI**:
   - Left-click to reveal a cell.
   - Right-click to flag a cell as a mine.

Gameplay Demo

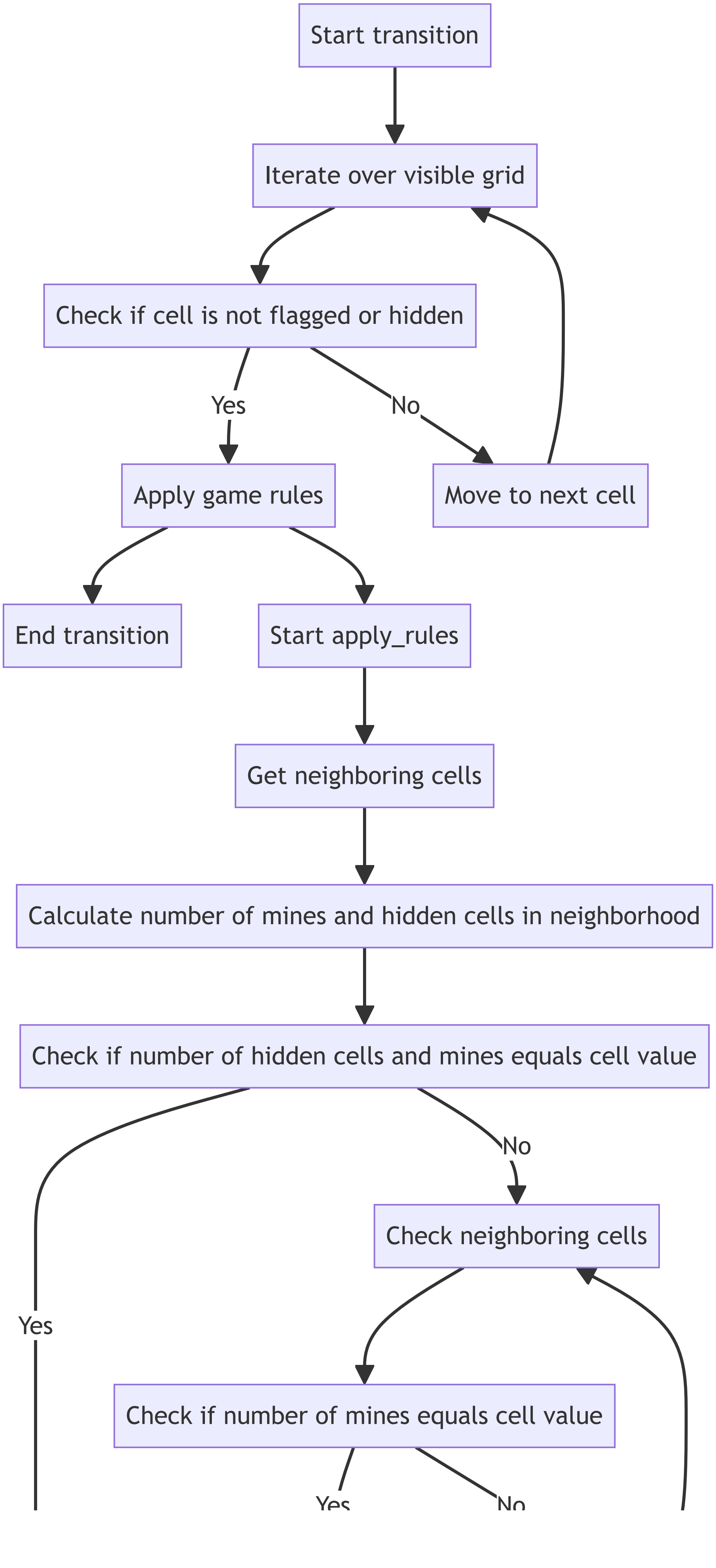
Watch the video here

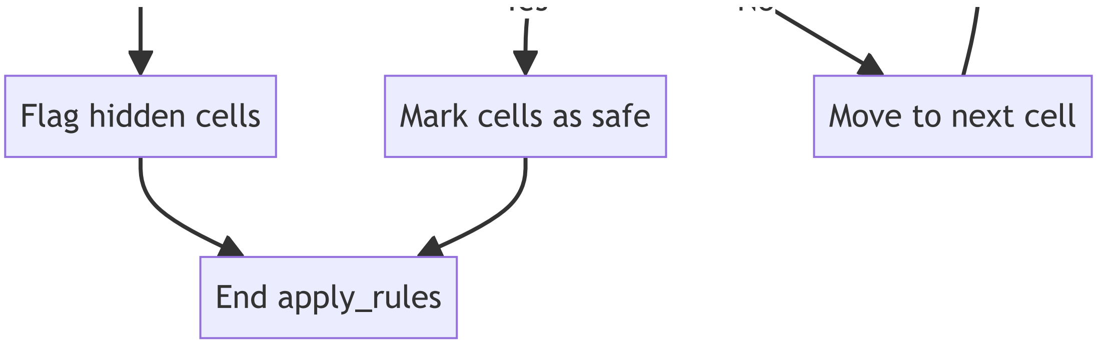
Gameplay Instructions

- **Objective**: Reveal all non-mine cells without hitting a mine.
- **Cells**:
  - Hidden Cell: A cell that has not been revealed.
  - Revealed Cell: A cell that has been revealed, showing either a number or a mine.
  - Flagged Cell: A cell flagged as a potential mine.
- **Buttons**:
  - Reset: Starts a new game.
  - Hint: Reveals a random hidden cell.
  - Next: Applies custom rules to reveal hidden cells.
  - Undo: Reverts the last move.

How the Minesweeper Solver Works

The states of each cell are reduced to three categories: hidden, flagged, or revealed. The solver iterates over the visible grid, applies game rules, and reveals cells based on the rules. The solver uses a custom rule set inspired by Conway's Game of Life to reveal hidden cells.


Start transition
Iterate over visible grid
Check if cell is not flagged or hidden
Yes
No
Apply game rules
Move to next cell
End transition
Start apply_rules
Get neighboring cells
Calculate number of mines and hidden cells in neighborhood
Check if number of hidden cells and mines equals cell value
No
Yes
Check neighboring cells
Check if number of mines equals cell value
Yes
No



> **Note**: The solver might wont be proceed without revealing more cells that might be mines.

Contributing

Contributions are welcome! Please open an issue or submit a pull request with any improvements or bug fixes.

Here are some ways you can contribute:

Enhancement Category	Description	Status
Add new features to the game	e.g., timer, high scores, custom grid sizes. Create a new game mode or difficulty level.	Not Started
GUI enhancements	Implement additional buttons or functionalities to enhance the gameplay experience. Modified `matplotlib` default toolbar to include additional buttons for game controls.	Not Started
Algorithm improvements	Optimize the game logic or implement new rules for revealing cells.	Not Started
Probabilistic solver	Develop a solver that uses probability to determine the best move. This is particularly useful in cases where no safe moves are available. This can be implemented using a Monte Carlo simulation or other probabilistic methods, such as Bayesian inference or Markov chains.	Not Started
Image recognition solver	Create a solver that uses image recognition techniques to analyze game boards as an input image and determine the best move. This can be implemented using computer vision libraries such as `OpenCV` or `TensorFlow`.	Not Started

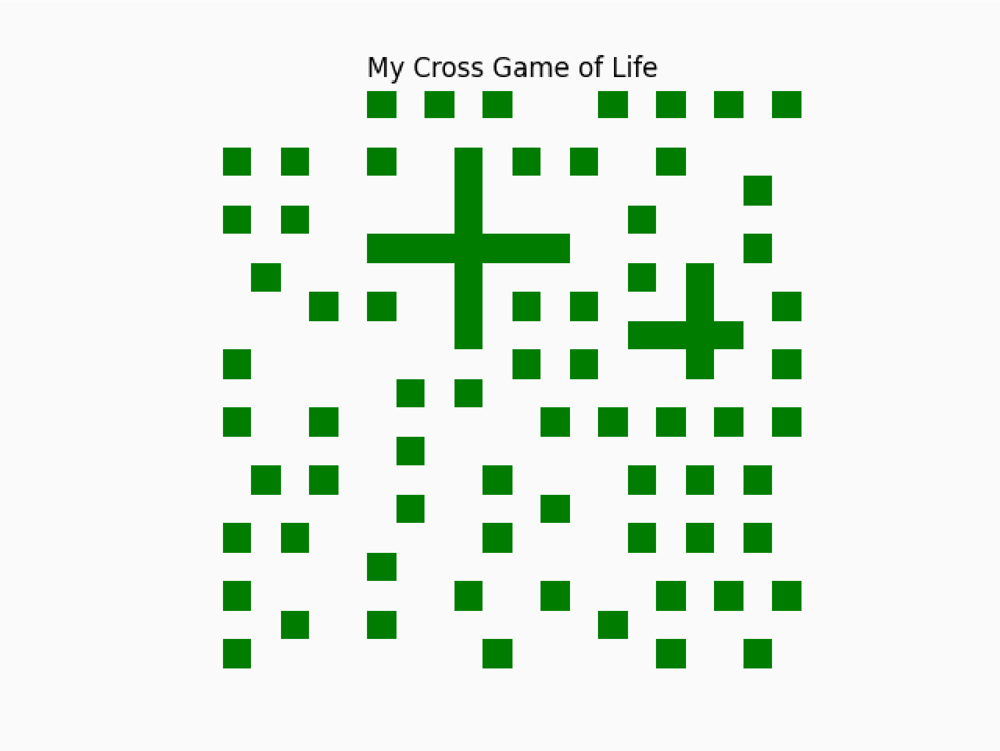
Acknowledgements

- Inspired by the classic Minesweeper game from Microsoft Windows.
- Built using Matplotlib and NumPy.

CrossFinder

CrossFinder is an innovative variant of Conway's Game of Life, meticulously engineered to detect and manipulate cross shapes within a grid environment. Diverging from the conventional Game of Life, CrossFinder integrates additional states and tailor-made rules aimed at pinpointing and transforming cross-shaped patterns.

This ingenious program was conceived as a response to problem 28 in the seminal book **Biological Computation** by Ehud Lamm and Ron Unger. It was developed as a key component of the "Biological Computation" course at the Open University of Israel. The solution, amalgamated with another program (simulationEarth), was submitted and acclaimed with a perfect score of 100.

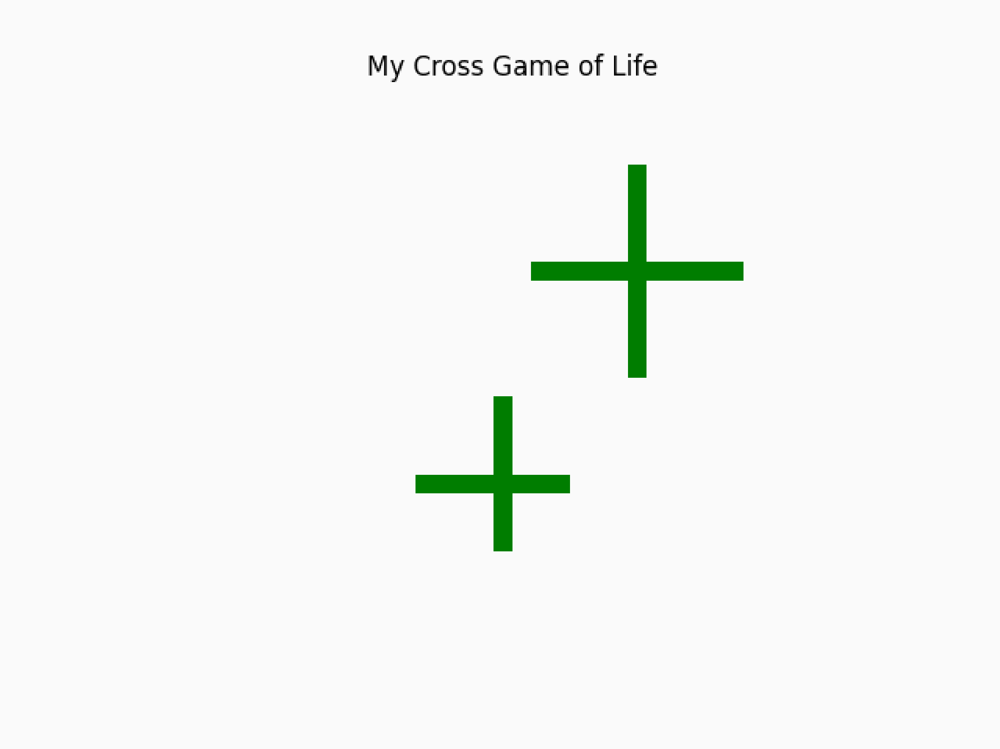


Algorithm identify target '+' shape

Finder Features

- Grid-based simulation where each cell can be in one of four states:
  - `0` : Dead
  - `1` : Alive
  - `2` : Red, marking cells that are part of a cross or interact with cross shapes
  - `3` : Blue, indicating the propagation of a wave from the edges of a cross towards its center
- Custom rules to detect and highlight cross shapes within the grid
- Functionality to visualize the detection and processing of crosses in real-time

How the CrossFinder Works



Visualization of the CrossFinder simulation waves

The CrossFinder program operates on a grid where cells can transition between states based on their neighbors. The primary focus is on identifying and marking cross shapes. A cross is defined as a vertical and horizontal line intersecting at a central cell, all of which are alive (`1`). When a cross is detected, the cells constituting the cross transition to the state `2` (red), signifying the first wave of detection.

Rules Overview

- The first wave (`2` state) targets cells that form the cross structure. When a pattern matching a part of the cross is found, those cells transition to the red state.

- The second wave (`3` state) begins at the edges of the cross and moves towards the center, marking the progression of the detection process.

How to Run the CrossFinder

The program was tested on python `3.11` and requires the following packages:

- `numpy` : For grid manipulation and operations
- `matplotlib` : For visualization

Use the following command to run the program:

```
python3 cross_game.py
```

If more than one python version is installed, try use the following command:

```
python3.11 cross_game.py
```

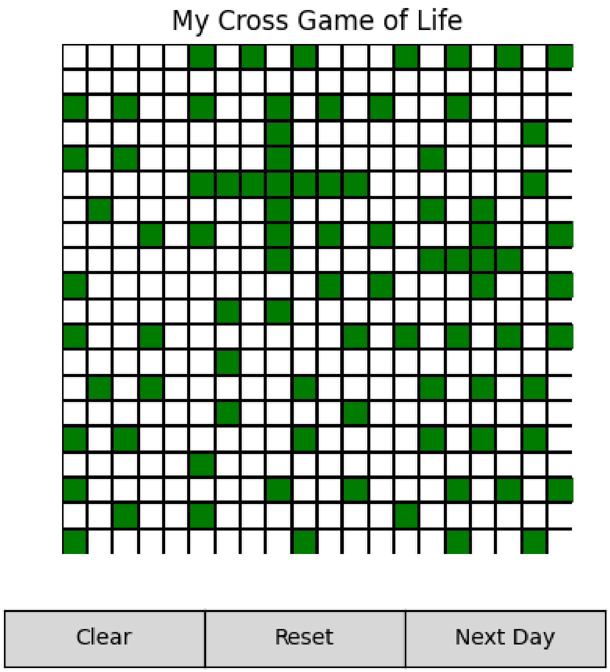
Crossfinder Demo

Watch the video here

CrossFinder GUI

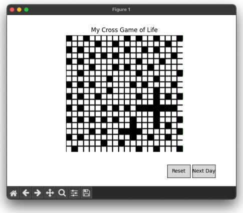
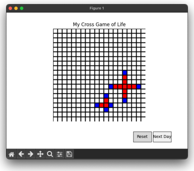
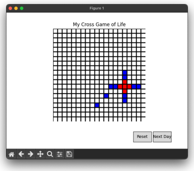
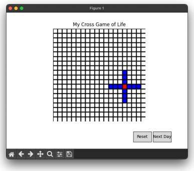
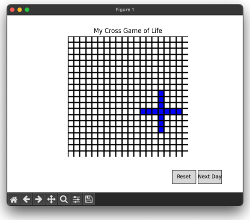
The program support both randomized initial states (press `reset` button) and user interactive controls (press the matrix cells to change their state).

For the next generation, press `next Day` button.



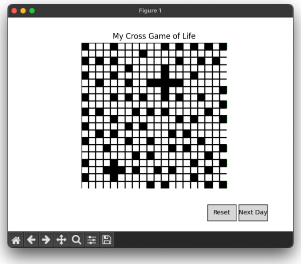
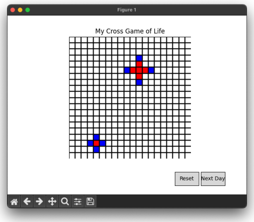
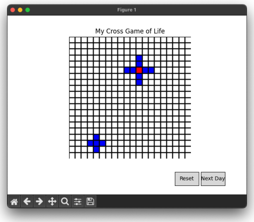
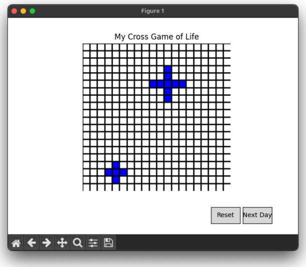
Runing Examples

Example 1

Initial state	2	3	4	*Finale state*
				

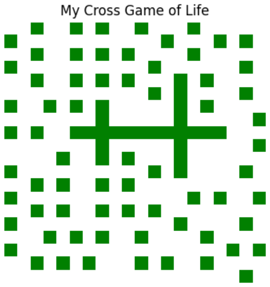
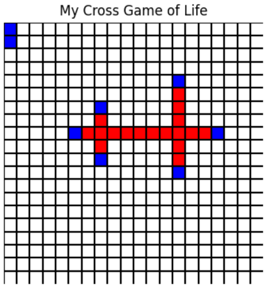
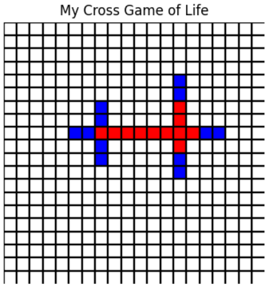
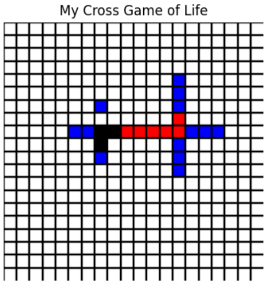
Example 2

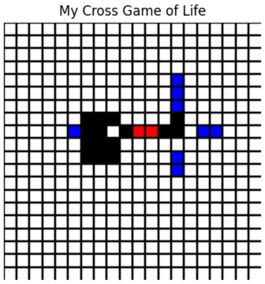
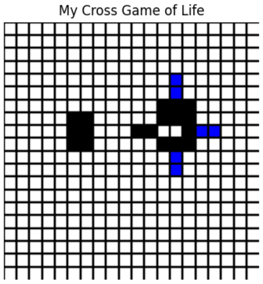
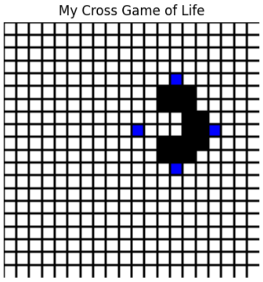
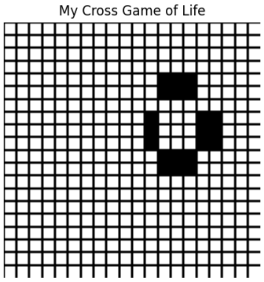
Initial state - 2nd example: 2 valid crosses in different sizes

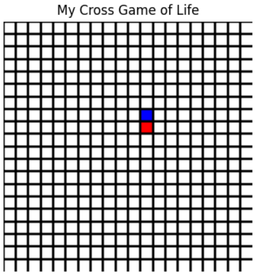
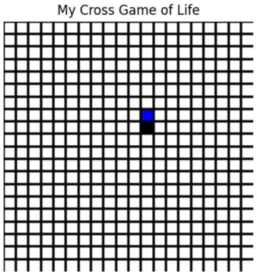
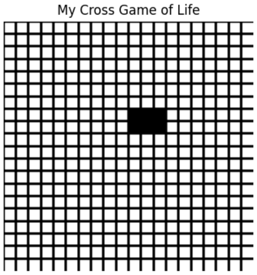
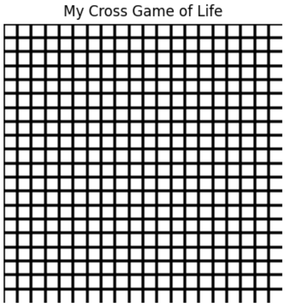
Initial state	2	3	*Finale state*
			

Example 3

Complex destruction exmp - no valid crosses

1	2	3	4
			

5	6	7	8
			

10	11	12	*Finale state*
			

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