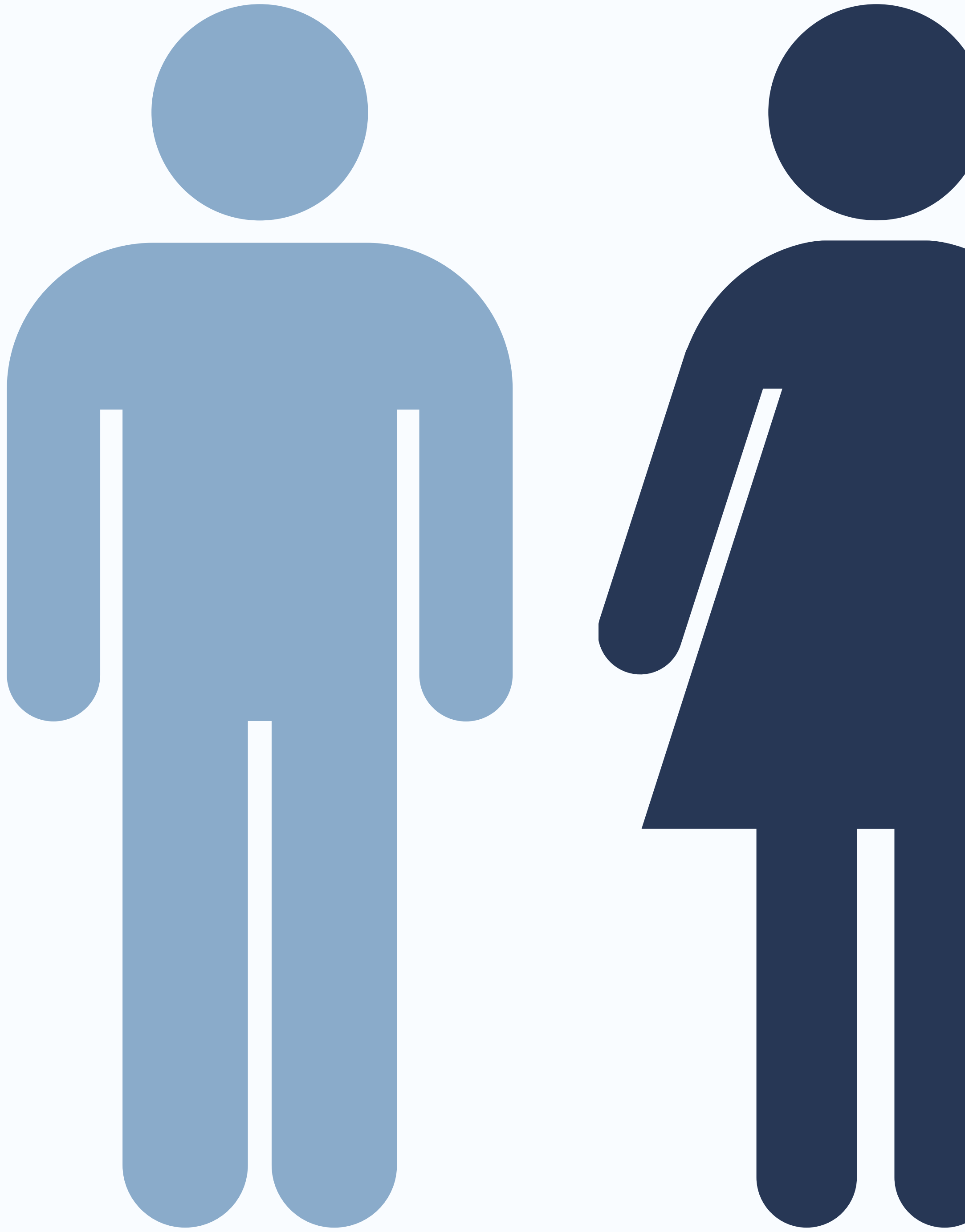
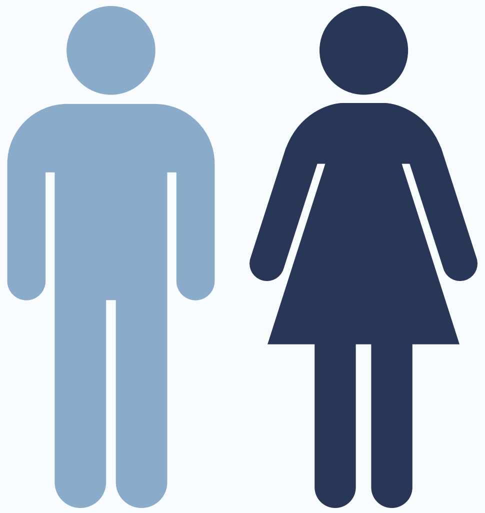
INSTRUCTIONS FOR JOHN CONWAY'S

The Game of Life

A presentation by Samuel Okoth Ogalo



Today's Discussion



OUTLINE OF TOPICS

Instructions for Game of Life
Rules for Conway's Game of Life
Starting Points: Single Cell, Two Cells & Three Live Cells
Example Patterns
Activity: Two Player Game of Life
Video: A Lesson on Conway's Game of Life by Samuel

GET INSPIRED

“You know, people think mathematics is complicated. Mathematics is the simple bit. It's the stuff we can understand. It's cats that are complicated. I mean, what is it in those little molecules and stuff that make one cat behave differently than another, or that make a cat? And how do you define a cat? I have no idea.”

- JOHN H. CONWAY

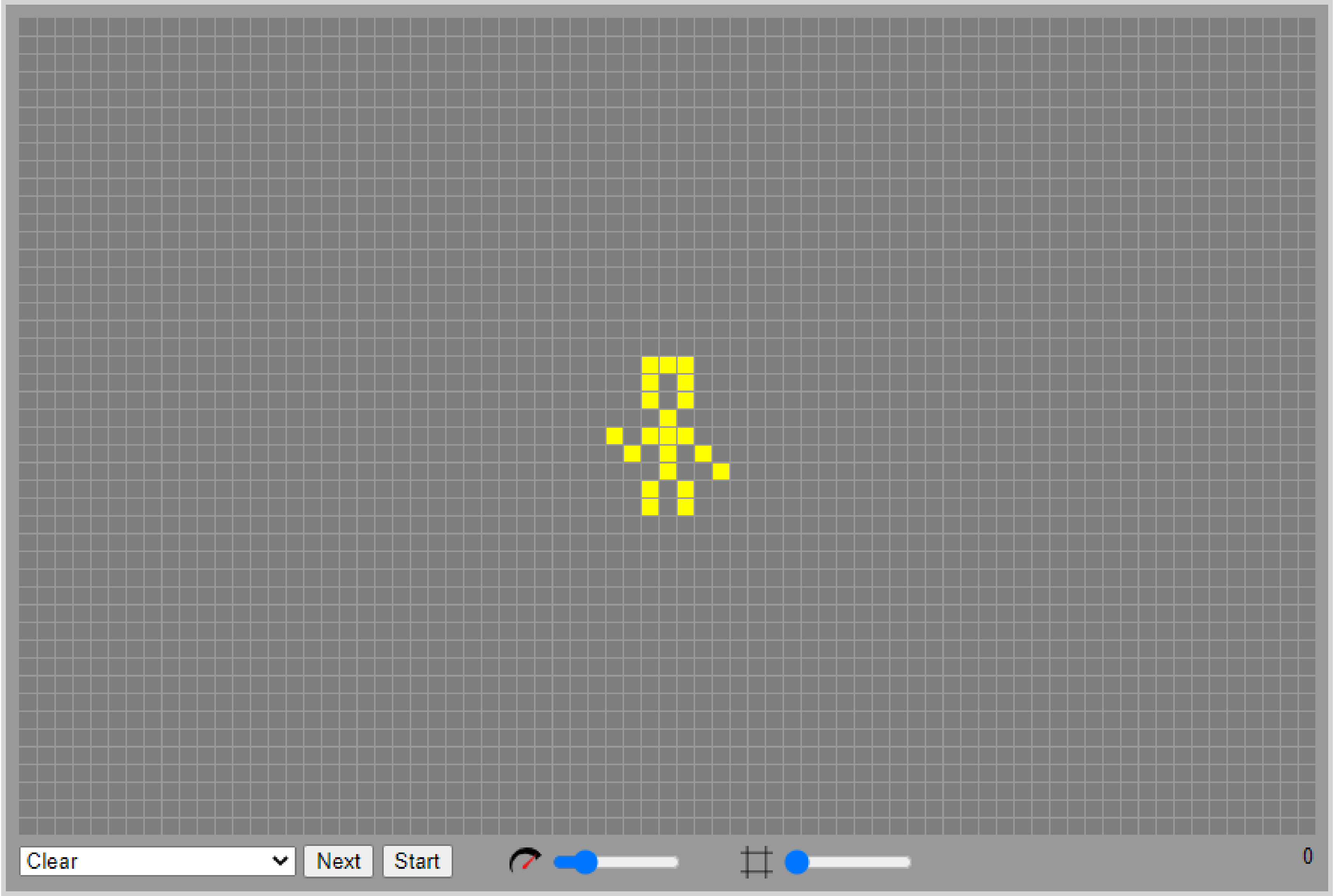
The Game

A BRIEF HISTORY

The Game of Life is not your typical computer game. It is a 'cellular automaton', and was invented by Cambridge mathematician John Conway.

This game became widely known when it was mentioned in an article published by Scientific American in 1970. It consists of a collection of cells which, based on a few mathematical rules, can live, die or multiply. Depending on the initial conditions, the cells form various patterns throughout the course of the game.

The Simulation



THE CONTROLS

Choose a figure from the pull-down menu or make one yourself by clicking on the cells with a mouse. A new generation of cells (corresponding to one iteration of the rules) is initiated by the 'Next' button. The 'Start' button advances the game by several generations. Game speed is regulated by the speed dial and the size of the cells with the size dial.

Instructions for the Game of Life

Conway's Game of Life was originally played on a flat grid made up of square cells. These cells can be either live (with a token in it) or dead (no tokens in it). In computer versions, live cells are represented by one color, and dead cells by another color. In theory the size of the grid is infinite, but small boards will do for initial play.
This is a solitary game, or one with just one player, and the play of a typical game goes like this:

1

STARTING POINT

Player chooses an initial set up.

2

NEXT GENERATION

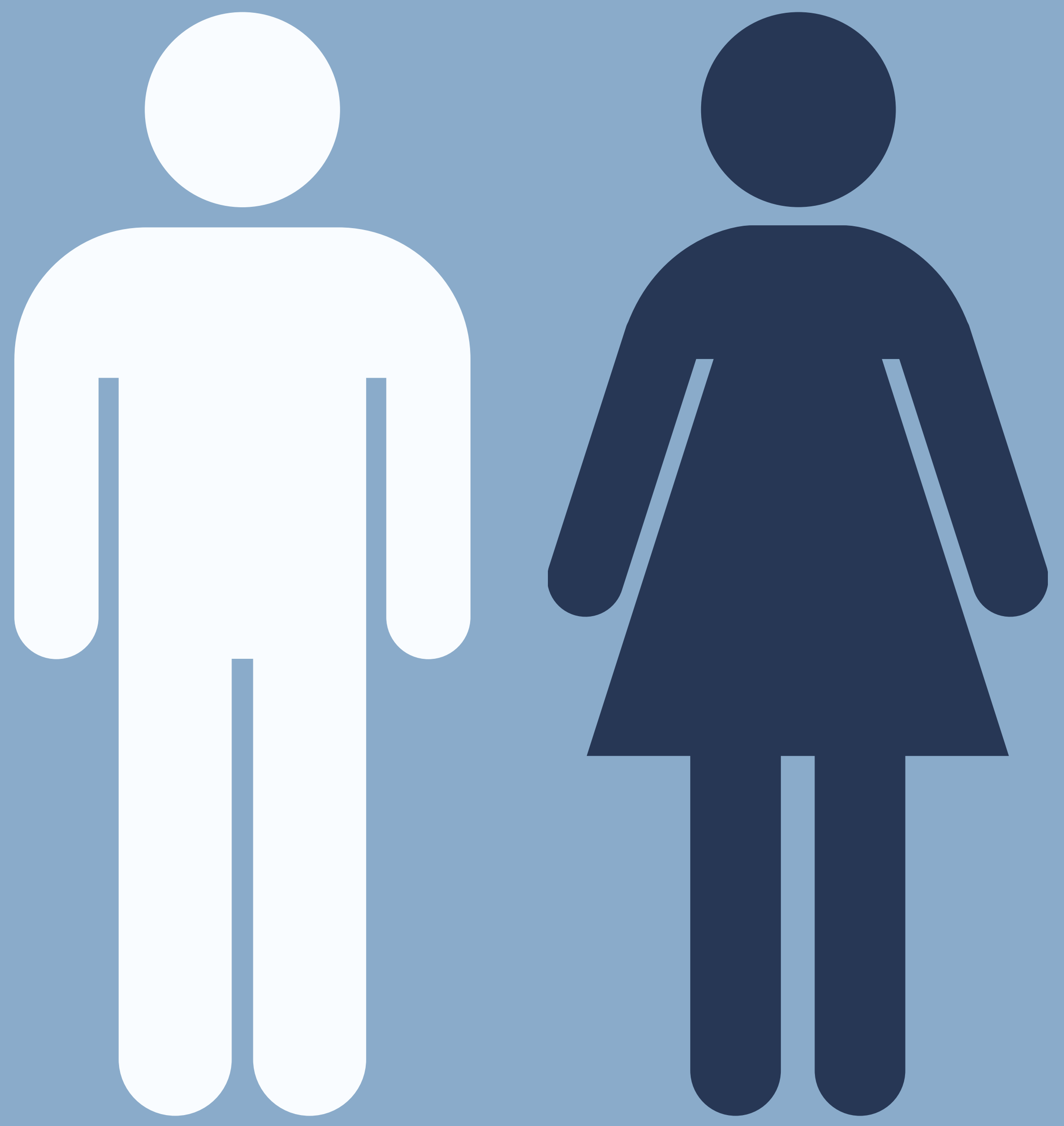
Rules are applied to see what happens in the next generation.

3

DETERMINANTS

Play continues until one of three things happens: all cells are dead, no cells change from one generation to the next, or the pattern flips back and forth between two or more positions.

Rules for Conway's Game of Life



At the heart of this game are four rules that determine if a cell is live or dead. All depend on how many of that cell's neighbors are alive.

BIRTHS

Each dead cell adjacent to exactly three live neighbors will become live in the next generation.

DEATH BY ISOLATION

Each live cell with one or fewer live neighbors will die in the next generation.

DEATH BY OVERCROWDING

Each live cell with four or more live neighbors will die in the next generation.

SURVIVAL

Each live cell with either two or three live neighbors will remain alive for the next generation.

Note: All rules apply to all cells at the same time.

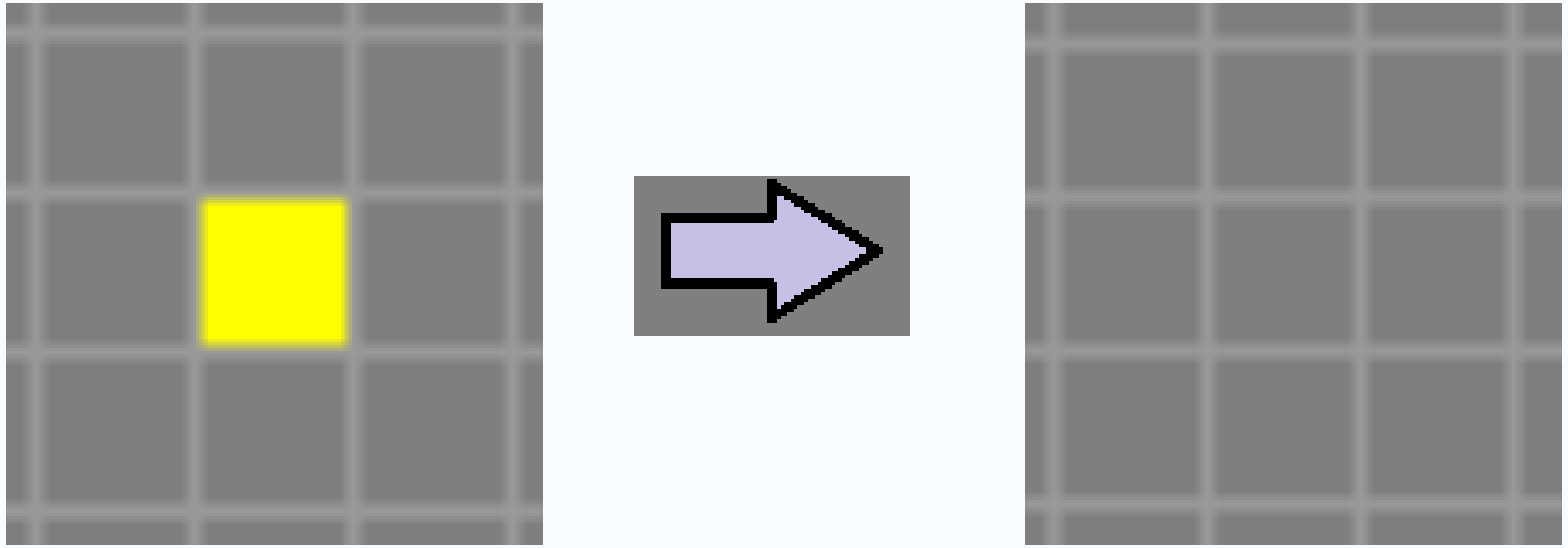
Starting Points

SINGLE CELL

What happens in the first generation if you start with a single cell that is alive?

Well, let's apply the rules to that single live cell. How many live neighbors does it have?

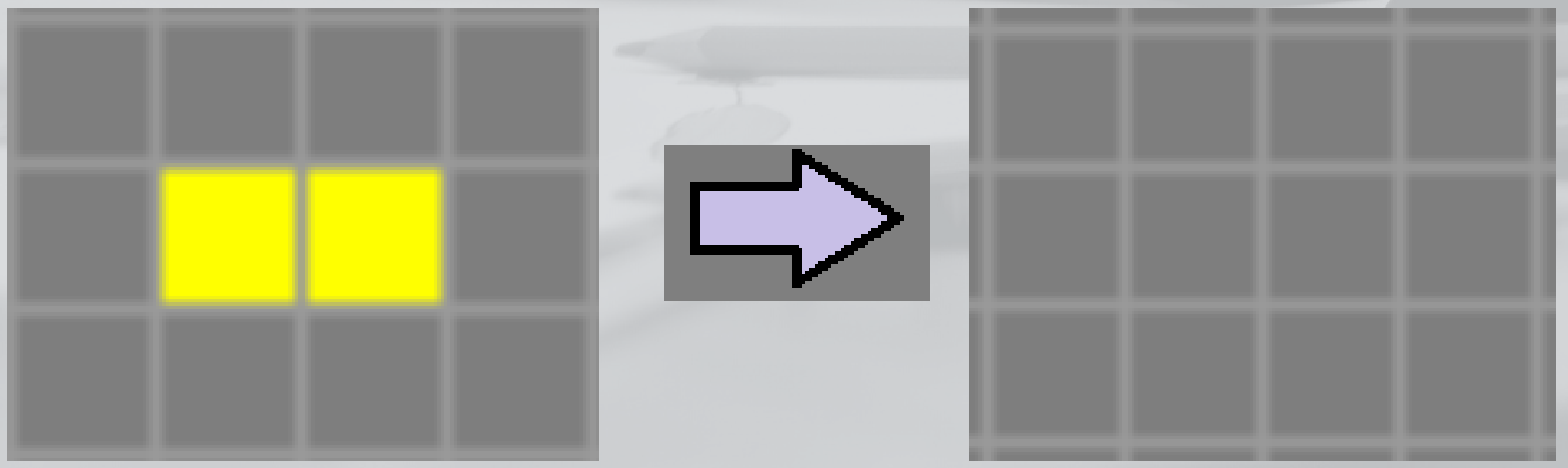
Because it is the only live cell on the board, it has zero live neighbors and the rules say it will die due to isolation. Since there are no dead cells that could possibly have three live neighbors, there will be no births. So, all starting configurations with only a single live cell will only contain dead cells in the next generation.



Two Cells

WHAT HAPPENS IN THE NEXT GENERATION?

The same thing happens when you start with only two live cells. In that case, each cell will only have a maximum of one live neighbor and will die of isolation. There will be no births, since there are fewer than three live cells. So, all initial configurations die in the first generation.



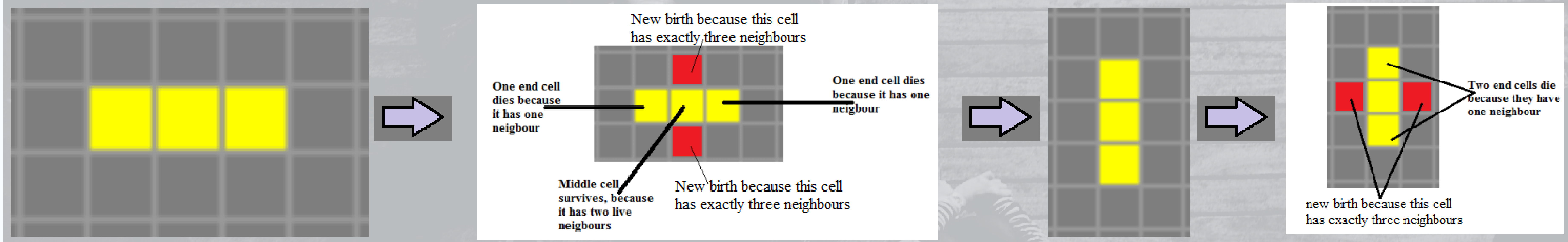
THREE LIVE CELLS

Things start to get more interesting with three live cells. Most configurations will be far enough apart that they will also die out in one or two generations, but there are two exceptions to this rule. The first is a line of three live cells.

The two end cells will die, because they each have one neighbor. The middle cell will survive, because it has two live neighbors, and there will be two births.

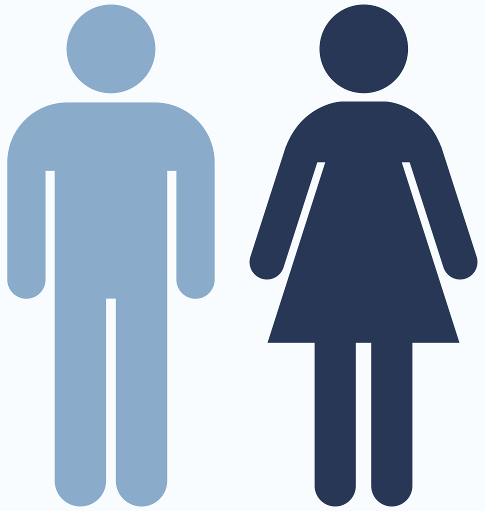
The births occur in the two cells next to the surviving cell that were dead because each of those positions is next to all three live starting positions.

If we started with a vertical line of three, the first generation will be a horizontal line of three. This pattern will repeat every second generation and was named a blinker by Conway.



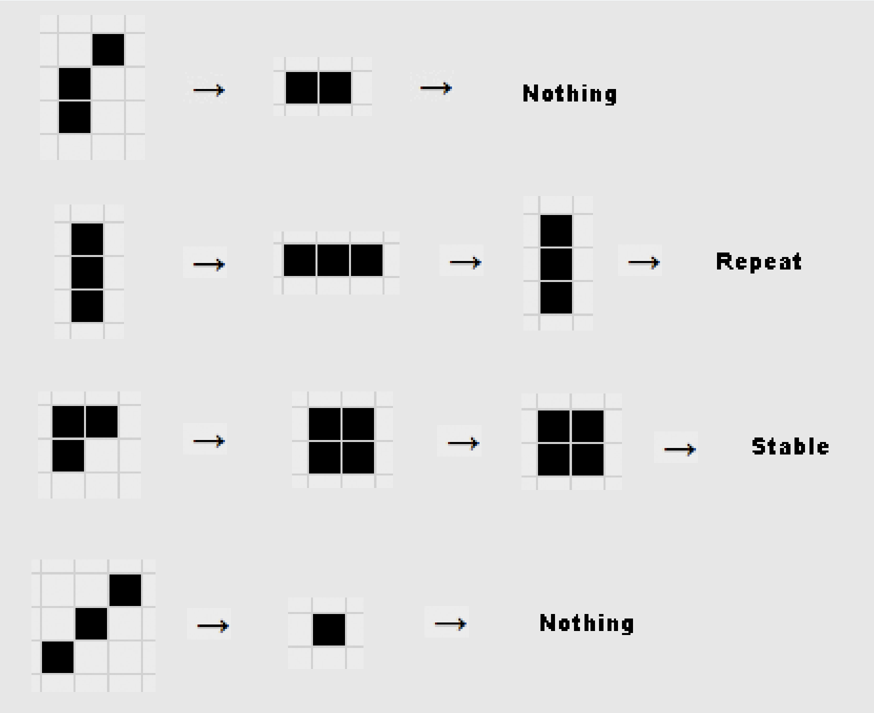
This pattern repeats from horizontal line of three to vertical line of three. The pattern is called **blinker**

Example Patterns

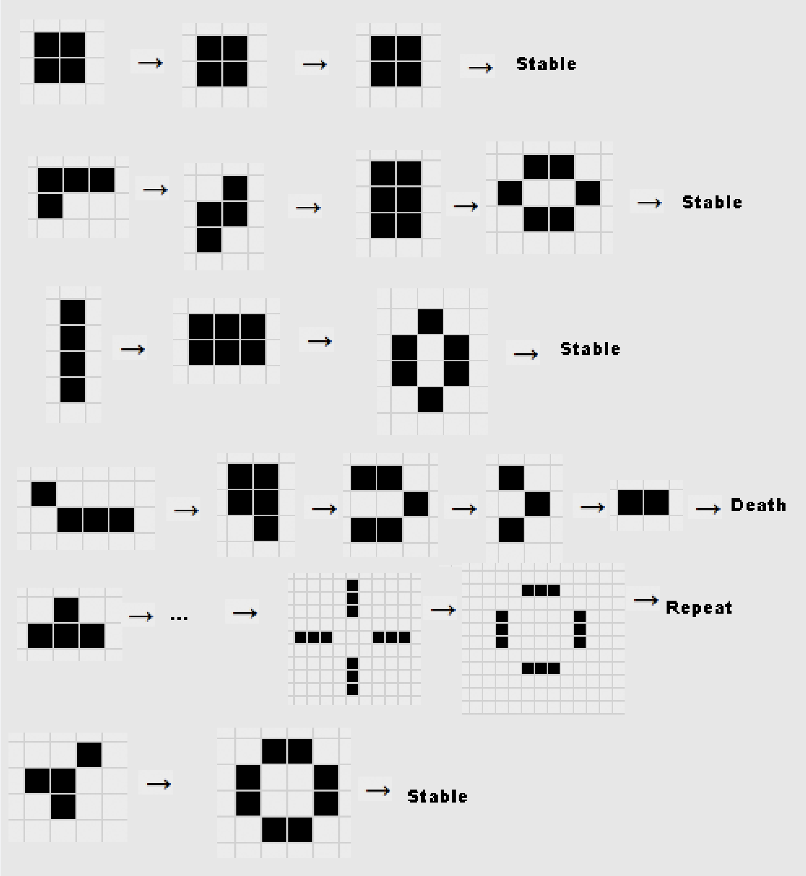


SOME POSSIBLE PATTERNS (AND THEIR EVOLUTION) TO CHECK:

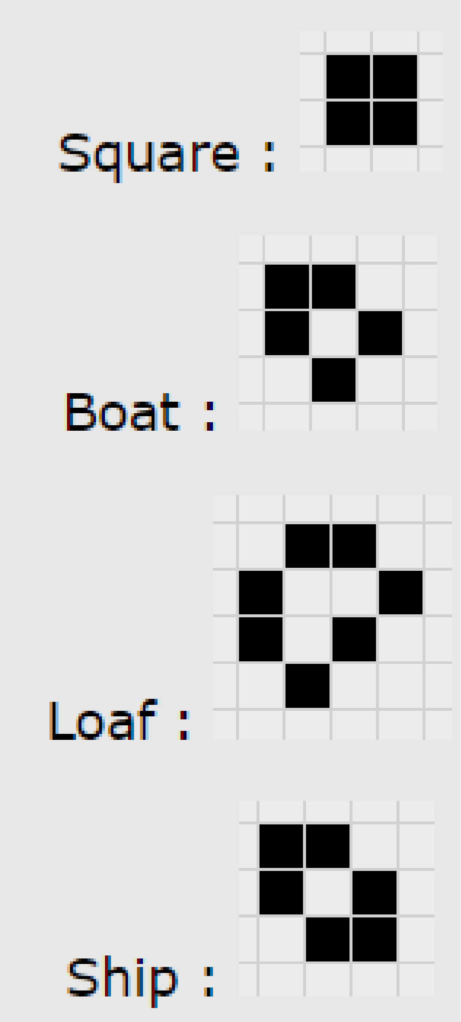
TRIOMINO PATTERNS

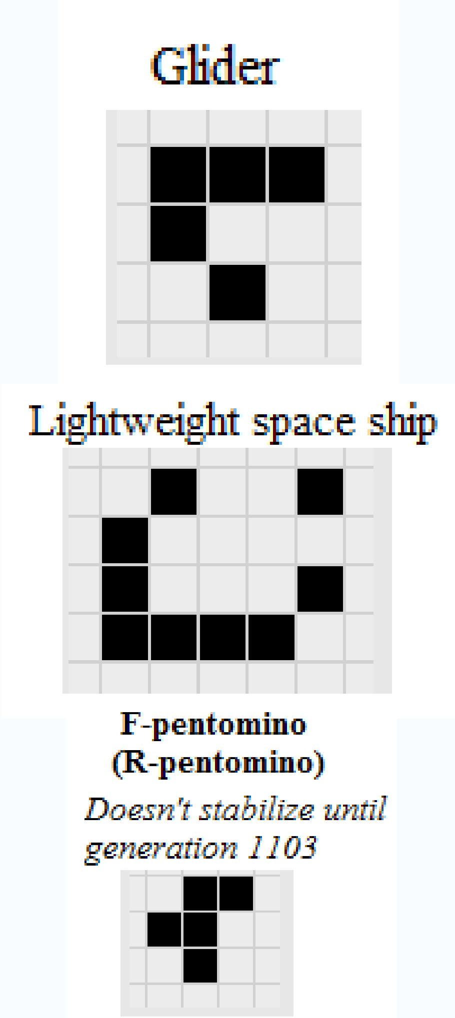


TETROMINO PATTERNS



OTHER EXAMPLES

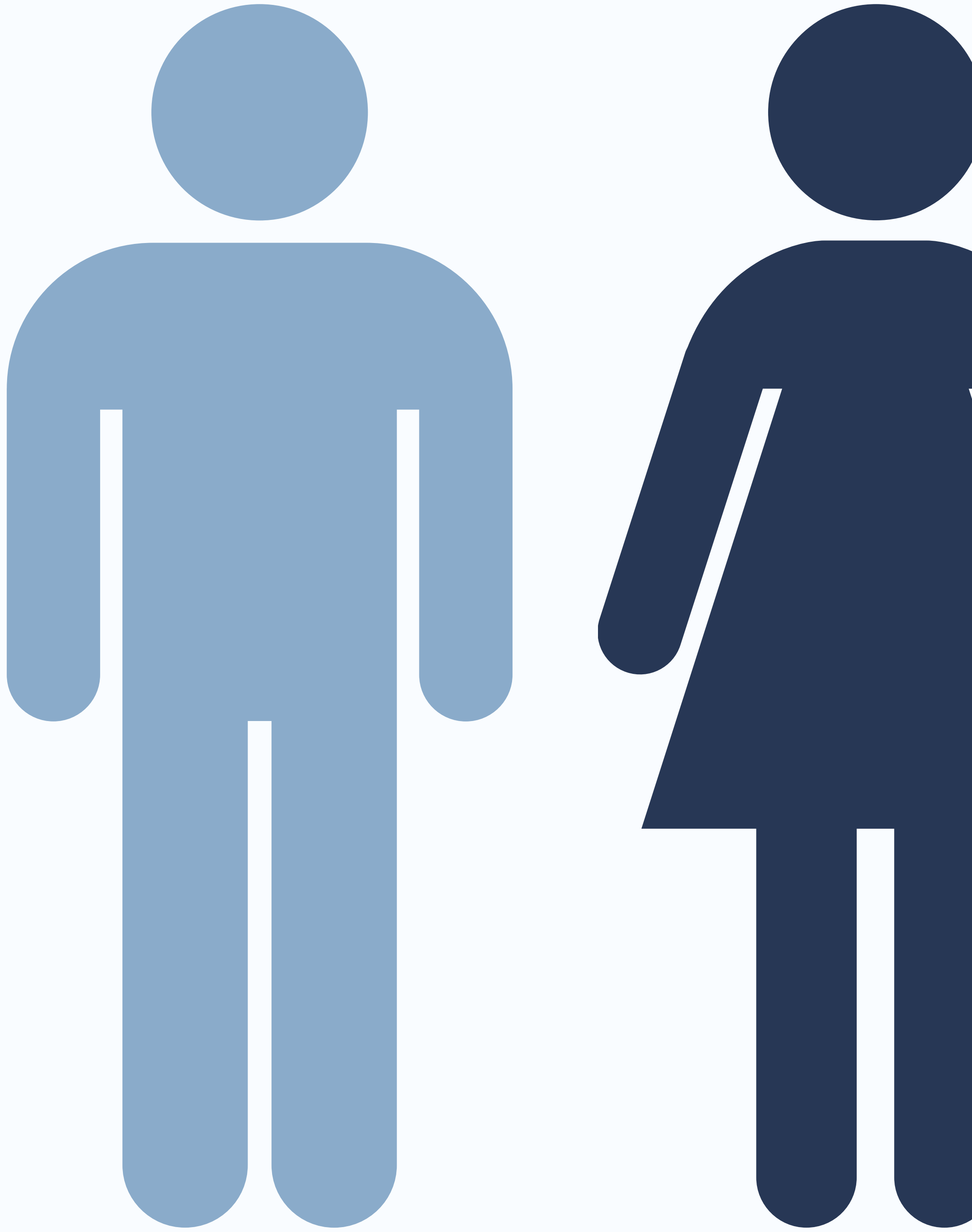




Activity

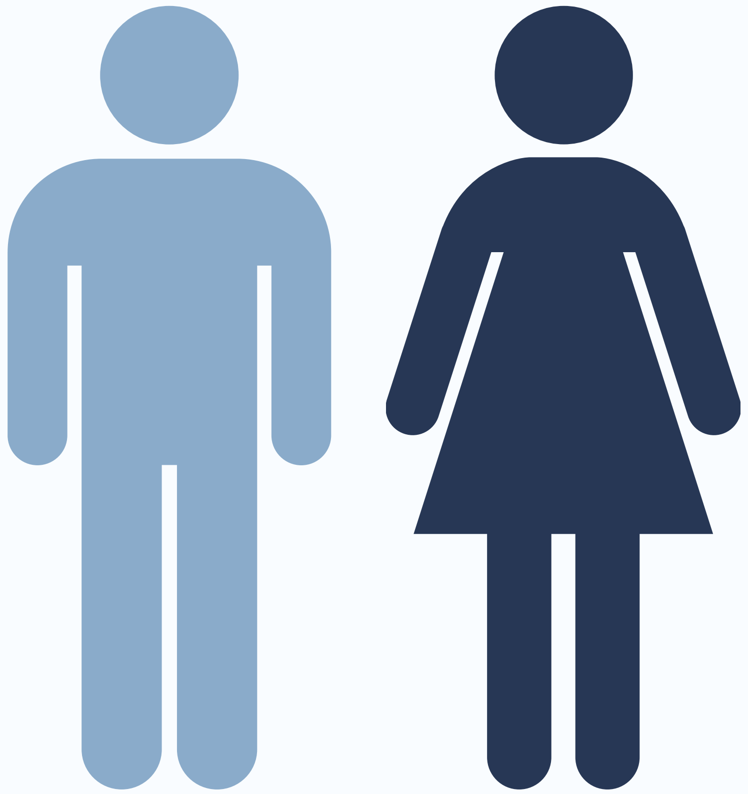
TWO PLAYER GAME OF LIFE

To call Conway's Game of Life a game is to stretch the meaning of the word "game", but there is a fun adaptation that can produce a competitive and strategic activity for multiple players.
The modification made is that now the live cells come in two colors (one associated with each player). When a new cell comes to life, the cell takes on the color of the majority of its neighbors. (Since there must be three neighbors in order for a cell to come to life, there cannot be a tie. There must be a majority)
Players alternate turns. On a player's turn, he or she **must** kill one enemy cell and **must** change one empty cell to a cell of their own color. They are allowed to create a new cell at the location in which they killed an enemy cell.
After a player's turn, the Life cells go through one generation, and the play moves to the next player. There is always exactly one generation of evolution between separate players' actions.
The initial board configuration should be decided beforehand and be symmetric. A player is eliminated when they have no cells remaining of their color.
This variant of life can well be adapted to multiple players. However, with more than two players, it is possible that a newborn cell will have three neighbors belonging to three separate players. In that case, the newborn cell is neutral, and does not belong to anyone.



A Lesson on Conway's Game of Life by Samuel

Watch this lesson on Game of life introduction here.
You can also play here



References

CORNELL MATH EXPLORERS' CLUB
Chaos and Fractals

Conway's Game of Life

JOHN CONWAYS GAME OF LIFE

Play here

LYCEE FRANCAIS SAMI MATHS CLUB

The Game of Life