JOHN CONWAY'S GAME OF LIFE

adapted for the
BALLY/ASTROCADE
Home Video Arcade

by RICHARD C. DEGLER with assistance from R & L

According to Martin Gardner in his MATHEMATICAL GAMES column (in SCIENTIFIC AMERICAN Oct '70), most of the work of John Horton Conway, a mathematician at Gonville and Caius College of the University of Cambridge, has been in pure mathematics. In addition to such serious work he also enjoys recreational mathematics. His latest brainchild (at the time) is a fantastic solitare pastime that he calls "LIFE". Because of its analogies with the rise, fall and alterations of a society of living organisms, it belongs to a growing class of what are called "simulation games" - games that resemble real-life processes.

Conway was fully aware of earlier games and it was with them in mind that he selected his recursive rules with great care to avoid two extremes: too many patterns that grow quickly without limit and too many that fade quickly. By striking a delicate balance he designed a game of surprising unpredictability and one that produced such remarkable figures as oscillators and moving spaceships.

LIFE can be played using a fairly large checkerboard and a plentiful supply of flat counters (as originally played) or by using this cartridge and a BALLY, or ASTROCADE, Home Video Arcade (which is a lot easier, faster and more colorful). In this version 64 rows of 128 pixels (the smallest picture elements) are used.

In the begining there is no life and all of the pixels in the center of the screen are off (black), except for a movable dark red spot. This cursor is controled by handle one and its speed can be set by the knob. By positioning the cursor and pulling in the trigger, a light blue cell will be generated (although it will appear bright green until the cursor is moved off of it) and the population counter will change accordingly. By moving the cursor to different locations and pulling the trigger each time, a video organism will be created. Any cell may be removed by placing the cursor on it and pulling the trigger again (turning the cursor from bright green back to a dark red). When the cursor is moved off, the pixel will be empty again.

Each pixel has eight neighbors (four adjacent orthogonally and four adjacent diagonally) and its birth or death depends upon the number of neighboring pixels that are light blue, which denotes live cells. Pixels along the left and right borders have each other as neighbors, as do the pixels along the top and bottom. You can see where these borders are by moving the cursor over the edge.

Once the starting organism is complete, pressing any key on the keypad will start the growth cycle from generation zero to the next generation, and on.

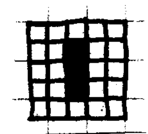
Births (depicted by a green pixel increasing in intensity) and deaths (a red pixel dimming to black) will occur simultaneously according to these rules:

1. every live cell with two or three neighboring live cells survives for the next generation
2. every live cell with only one live neighbor or none dies from isolation, and
   every live cell with four or more neighbors dies from overcrowding
3. each empty pixel adjacent to exactly three living cells
   - no more, no fewer -
   is a birth cell, becoming a live cell this generation.

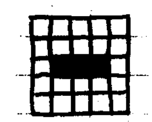
This cartridge not only displays the "life history" of your starting colony, but also displays the generation number, the number of births and deaths leading up to this generation and the current population. Holding the trigger in will cause the births and deaths to be displayed in solid colors and also at this time you can re-center the organism by pulling the joystick to the left or down. When you release the trigger, you can change any cells you wish as before, or continue with LIFE by pressing any key. The generation counter will be reset to Gen.#0 if any of the pixels were altered.

You will find the population constantly undergoing unusual, sometimes beautiful and always unexpected change. Patterns with no initial symmetry tend to become symmetrical. Once this happens the symmetry cannot be lost, although it may increase in richness. In a few cases the society eventually dies out (and the population becomes zero), although this may not happen until after a great many generations. Most starting patterns either reach stable figures - Conway calls them "still lifes" - that cannot change or patterns that oscillate forever. In most cases the generation counter will stop counting or will alternate between two numbers to signify that there are only two different configurations. This happens when the births are equal to the deaths for two or more generations.

Let us look at the simplest of what Conway calls "flip-flops", oscillating figures of period 2. It is a "blinker" and it is simply three cells in a short vertical row as shown here:

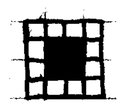


Checking the top cell for its neighbors, we can see that it only has one live one, so it will die from isolation in the next generation. The middle cell has two neighbors, the one above it and the one below it, so it will remain. The bottom one will die of loneliness since it only has one neighbor. Of the empty pixels, only the two directly next to the center cell have the proper amount of neighbors, three, so there will be births there (even though we know that two of their parents will die off). Using this information, we can see that the next generation will look like this:

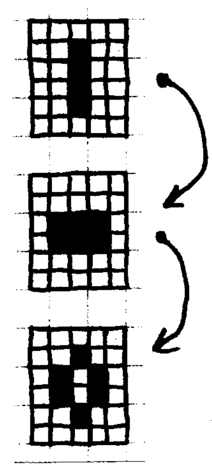


Checking the cells of this new generation to get the next one we see that it will be the same as the starting arrangement of three vertically stacked cells. Try it on your BALLY/ASTROCADE and notice that the generation counter oscillates and that it registers two births and two deaths each generation while the population counter remains at three.

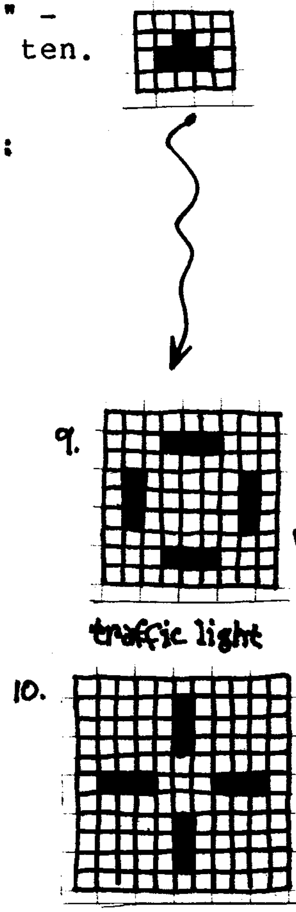
A common 2-by-2 block (called a "block") - has each live cell stable with three live neighbors, while there is no empty pixel with three neighbors to cause a birth. The Home Arcade will not get past generation zero, with no births and no deaths, and the population counter will stay at four.



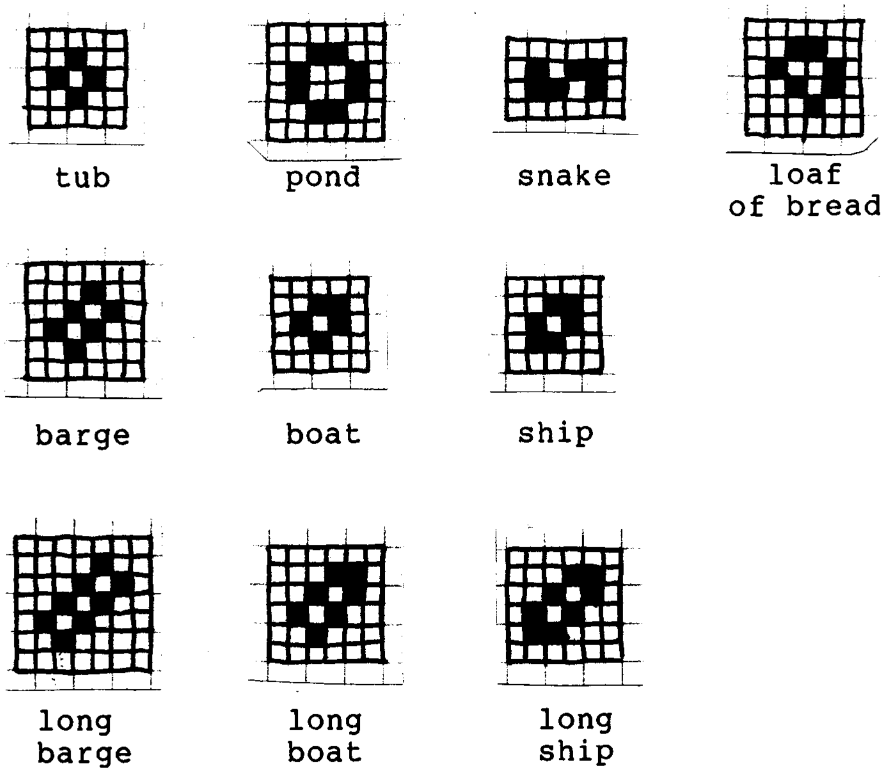
Four cells in a vertical row has the top and the bottom cells dying from lack of affection and the center two remaining. In addition, there will be births in four cells, resulting in this display: Now there are births at the top and bottom, the two live cells at the left and the two at the right side can each see three neighbors so they remain happy, and the center two each have five neighbors so they die. This results in a "beehive" - a stable colony since each live cell has two buddies and there are no more births.



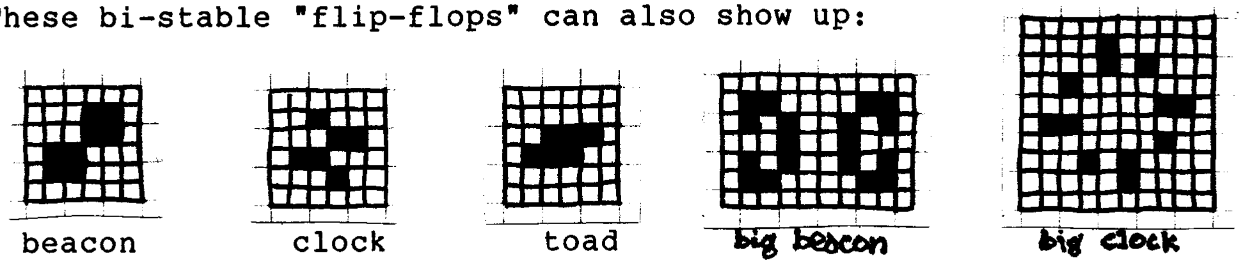
From this starting organism comes a "traffic light" - that will "flip-flop" between generations nine and ten. All of the above patterns can occur spontaneously within other larger organisms.



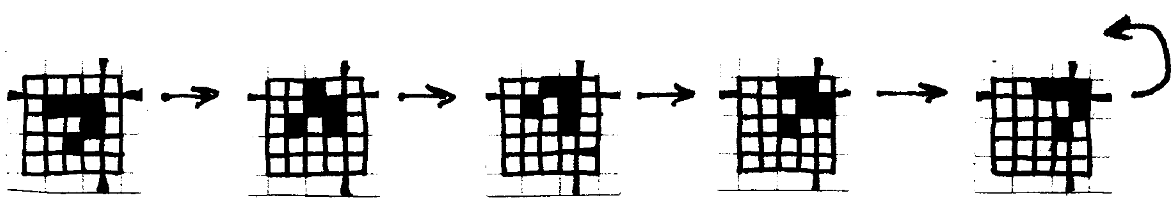
Here are ten stable patterns that you may also see:



These bi-stable "flip-flops" can also show up:

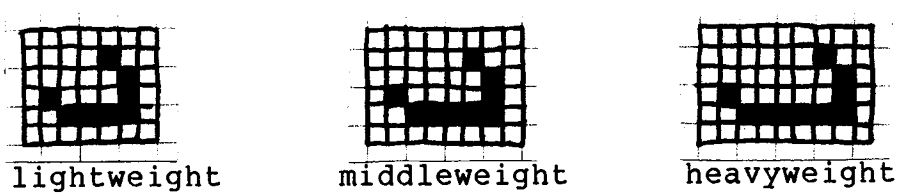


An remarkable pattern that often confuses the generation counter into signaling a stable configuration is a "glider". This colony regains its shape while moving diagonally across the screen and registers two births and two deaths per generation.



(which is the same as the first only up one and right one square)

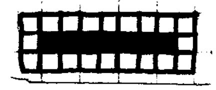
Horizontally moving "spaceships" rarely occur naturally, but you can enter a few of them and watch them move and crash.



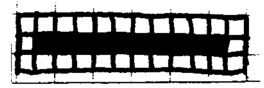
Larger "overweight spaceships" can be made, however they require smaller "escort" ships to remove the debris they leave behind.

Some starting patterns you will want to watch include:

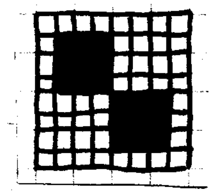
a horizontal row of seven cells - which grows into a "honey farm" with four stable "beehives"



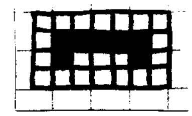
a repeating pattern of period 15 resulting from a line of ten cells -



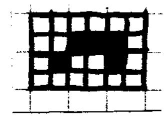
two three-by-three boxes that touch - at their corners, forming a "figure eight" that repeats every eight generations, and



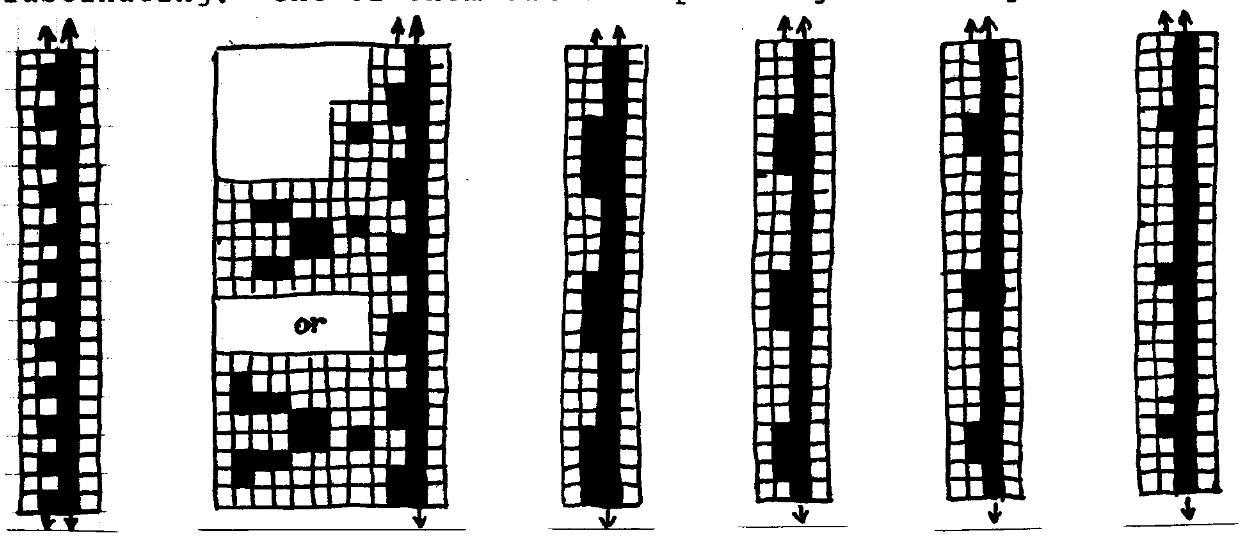
seven cells with five in a row and one cell under each of the end cells - This last pattern results in what is called "Pulsar 48-56-72" at generation 32 with a period of three, which can also be formed by two lines of five counters seperated by a empty pixel. The generation counter will not stop for any of these repeating patterns.



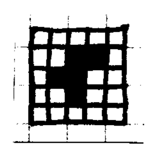
A pattern that stabilizes after 175 generations is grown from this seed: Watch especially for generation 79.



Since the right side of the playfield is adjacent to the left side and the bottom is connected to the top, a line reaching all the way from one side to the other is effectively infinite in lenth. Running this results in a rapidly expanding series of lines until they run into themselves coming from the other direction and the whole screen suffers a "sudden death". The outside lines move one row per generation. This is the maximum speed that any pattern can grow and is known as "the speed of life". Spaceships can move at only one-half of the speed of life. Diagonal lines will decay at their ends at the speed of life, but will remain unchanged if they have no ends, that is - "infinite". Two or more crossed infinite lines will result in very interesting displays. "Walking walls", while tedious to set up, are also fascinating. One of them can even pull objects along with it.



And one last pattern, the "R-pentomino": a long-lived, glider throwing, blotchy colony that takes hours to stabilize.



Enjoy the Game of LIFE - by: Richard C. Degler