Chapter 2
Conway's Game of Life: Early Personal Recollections

Robert Wainwright

When the October 1970 issue of Scientific American arrived, I had no idea the extent to which Martin Gardner's article in that issue would affect my life. As long as I can remember, my custom would be to seek out the Mathematical Games column in search for Gardner's latest topic with the usual reader challenges. My first reaction to that particular article introducing a new pastime titled "The fantastic combinations of John Conway's new solitaire game 'life"' was only mildly interesting. A couple of days later, still curious about the outcome of random patterns, I located an old checkerboard and a small jarful of pennies to investigate this new game.

The simplicity and unpredictability of Life was intriguing and I realized that using coins was too cumbersome and left no record of the succession of generations. At that time, as a systems analyst for a large firm in Manhattan, I had access to an IBM mainframe computer and the following week wrote a program to "play" Life. Gardner had posed several challenges in his column and I set about to check them. My primary interest, however, concerned tracking the outcome of large areas randomly populated with "bits".

Since these computer runs required significant mainframe capacity, they were submitted for overnight processing. Initially, the jobs were aborted by the operators who thought the output was some sort of program error. After a few weeks, a summary of these "random broth" runs formed the basis of my first correspondence to Gardner about Life.

Late in October, I was delighted to receive a response (my first ever) from Gardner. In his letter he thanked me for solving one of the challenges and was awaiting confirmation from other readers. He mentioned that this was a common strategy for verifying the validity of material from readers responding to his monthly challenges. I also learned that Gardner did not work in an office at Scientific American headquarters on Madison Avenue but rather out of his home in nearby Westchester County. The geographic proximity offered an opportunity to personally meet with him, and on several occasions we did so to discuss developments readers were sending.

During one of our meetings, he mentioned a telegram (Fig. 2.1) he had received from a William Gosper at MIT claiming to have solved the biggest challenge of all,

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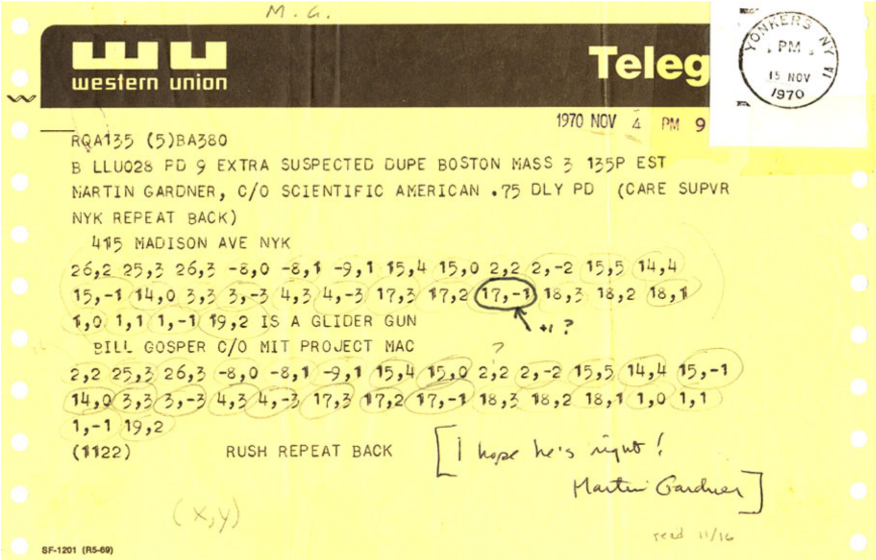
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B LLU028 PD 9 EXTRA SUSPECTED DUPE BOSTON MASS 3 135P EST
MARTIN GARDNER, C/O SCIENTIFIC AMERICAN .75 DLY PD (CARE SUPVR
NYK REPEAT BACK)
415 MADISON AVE NYK
26,2 25,3 26,3 -8,0 -8,1 -9,1 15,4 15,0 2,2 2,-2 15,5 14,4
15,-1 14,0 3,3 3,-3 4,3 4,-3 17,3 17,2 17,-1 18,3 18,2 18,1
1,0 1,1 1,-1 19,2 IS A GLIDER GUN
BILL GOSPER C/O MIT PROJECT MAC
2,2 25,3 26,3 -8,0 -8,1 -9,1 15,4 15,0 2,2 2,-2 15,5 14,4 15,-1
14,0 3,3 3,-3 4,3 4,-3 17,3 17,2 17,-1 18,3 18,2 18,1 1,0 1,1
1,-1 19,2
(1122) RUSH REPEAT BACK
[I hope he's right!
Martin Gardner]
(x,y)
SF-1201 (R5-69)

Fig. 2.1 Seminal telegram from Gosper to Gardner

finding a finite pattern that endlessly replicates. The telegram contained coordinates for a small set of starting "bits" which would evolve into a glider gun. Gardner had no way of knowing whether or not Gosper's claim was valid and asked if I could possibly verify this for him. Around mid-November, I input this starting configuration into the program which produced several dozen generations confirming that Gosper's claim was indeed true. This information pleased Gardner who in turn notified Conway of the discovery.

Gardner also said that this particular column had generated an unprecedented volume of reader response including many discoveries of which some were new to Conway himself. He felt that a second column would soon be necessary and had to convince the magazine editors to agree to this. About this time, I suggested possibly starting a newsletter to serve as a clearing house to handle the large number of inquiries. Both Gardner and Conway agreed to this idea. In February 1971, Gardner wrote a column about cellular automata which presented more of the technical background upon which Life was based.

In March 1971, with Gardner's encouragement including a list of about 150 reader names and addresses, LIFELINE, a quarterly newsletter for enthusiasts of John Conway's Game of Life, was initiated (Fig. 2.2). This was mentioned in the April column along with details for an annual subscription of one dollar. Over the first year, a growing base of readers sent in more discoveries which provided new material for the newsletter (Fig. 2.3). Toward the end of 1971, during a weekend trip to Boston, I met Gosper and a few others including Ed Fredkin who headed the AI Lab there. The lab's computing capability which included a large circular CRT display was truly amazing. This was the first time I observed Life patterns rapidly

A QUARTERLY NEWSLETTER FOR ENTHUSIASTS OF JOHN CONWAY'S GAME OF LIFE

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0      00000 00000 00000 0       00000 0    0 00000
0        0   0     0     0         0   00   0 0
0        0   000   000   0         0   0 0  0 000
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NUMBER 1 MARCH 1971

· Editor and Publisher - Robert T. Wainwright ·

What you are now reading is the prototype issue of LIFELINE, a newsletter for enthusiasts of John Horton Conway's game of 'Life'. Scientific American having already devoted two full Mathematical Games columns to this subject can not, obviously, continue to provide the space required to report adequately on all the new developments still occurring. Many readers (the writer included) have expressed an interest to have some means by which they may continue to exchange new developments. My own prior investment of time and effort motivates me to establish this newsletter and I will maintain it in proportion to the degree of interest expressed by you, the 150 correspondents of Martin Gardner's October 1970 and February 1971 columns.

This first newsletter is compiled from information contained in your letters to Martin Gardner and from experiments conducted by the writer. Subsequent newsletters will necessarily depend upon the extent of your response to LIFELINE. A subscription form is provided for you and anyone you choose who would be interested in keeping abreast of new Life developments. I will attempt to provide an interesting mix of information in a free format and solicit your comments and suggestions on how this could best be done.

John Conway first presented his game of Life to Martin Gardner early last year. At that time he had followed the life histories of all but one of the pentominoes, all but one of the hexominoes, and all but seven of the heptominoes. By now we all know the fate of the notorious R-pentomino which, in its first generation, becomes a hexomino (the one who's fate was unknown to Conway). This apparently confused a number of readers who wondered how Conway could have known about all the hexominoes as stated on page 122 of the October column.

This leaves us with the seven 'unknown' heptominoes shown here which Conway arbitrarily labeled B, C, D, E, F, H, and I.

Conway's seven 'unknown' heptominoes

```
 B        C        D        E        F        H        I

0 00     000      0        000      00       00       00
000      000      000     00        0        0        0
0        0        0 0      00       0        000      00
                    0               000      0         00
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Heptomino B whose first generation appears in the 29th generation of the R-pentomino eventually becomes three blocks, one ship, and two gliders after 148 generations - so its history is known. This was confirmed by Mr. Hugh W. Thompson of Lefrak City, New York.

Fig. 2.2 First issue of LIFELINE

A QUARTERLY NEWSLETTER FOR ENTHUSIASTS OF JOHN CONWAY'S GAME OF LIFE

LIFELINE

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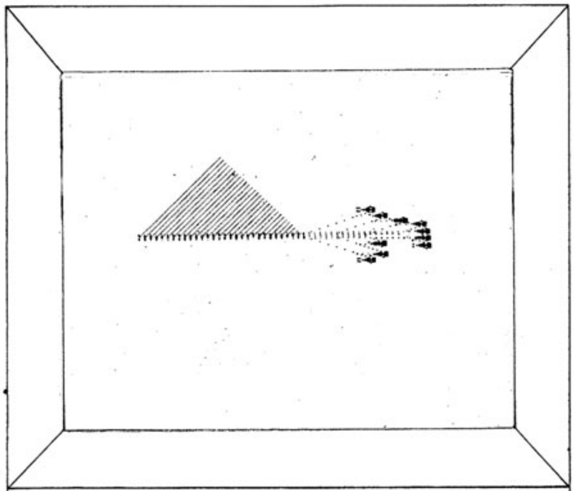
New inquiries to LIFELINE are still coming in but (fortunately) the rate is decreasing. With the readership base almost established at more than 500, I can afford to devote more attention to the many new developments which are occurring at a rate very nearly proportional to time (since October 1970) squared. In order to maintain some degree of continuity in these series of newsletters, I will continue to follow the general outline of previous issues. While doing so I will point out new and the more interesting developments as well as answer (and pose) some new questions about this incredible game.

When I first outlined this issue in late August, it appeared that well over two-thirds of the new developments were in the area of Life dealing with transfinite objects. In early September, I received some information from the group at the M.I.T. Artificial Intelligence Laboratory (Gosper, et.al.) which convinced me there are still many surprises in the finite kingdom of Life. After reading this issue, I am sure you will agree that LIFELINE Number Three will very likely be remembered for the extraordinary achievements reported.



THE BREEDER

In this issue I will cover first, the area of Life dealing with finite objects and events, then activity associated with one-dimensionally infinite objects ('wicks') which includes fuses, next activity associated with two-dimensionally infinite objects (agars), and finally developments in other selected areas of cellular automina.

The expanded classification system for finite Life objects makes it more convenient to identify and place new discoveries. However, Class V which includes Life events needs some further refinement. I will go thru each subclass in turn discussing new developments. These are definitely not in any order of significance.

Fig. 2.3 Number 3 of LIFELINE

AN EXPANDED CLASSIFICATION SYSTEM FOR FINITE LIFE OBJECTS					
Primary Class	Subclassified According To:		Subclass	Example*	Size
I-Still Lifes	Degree of symmetry	2-way orthogonal, 2-way diagonal, 90° rotational	I.A	block	4
		2-way orthogonal, 180° rotational	I.B.1	beehive	6
		2-way diagonal, 180° rotational	I.B.2	ship	6
		90° rotational	I.B.3	spiral	20
		1-way orthogonal	I.C.1	hat	9
		1-way diagonal	I.C.2	boat	5
		180° rotational	I.C.3	snake	6
		none	I.D	fishhook	7
II-Oscillators	Type of periodic activity	flip-flops (all period two)	II.A	blinker	3
		billiard table configurations	II.B	pinwheel	35
		inductors	II.C	tumbler	16
		pulsators	II.D	pentadecthalon	12
		shuttles	II.E	queen bee	20
		miscellaneous	II.F	M.I.T. osc.	18
III-Spaceships	Motion of spaceship	orthogonal	III.A	lt.wt.s.s.	8
		diagonal	III.B	glider	5
IV-Propagators	Nature of activity	spaceship guns	IV.A	the Gun	36
		puffer trains	IV.B	?	?
V-{Unstable (all objects not in above)}	Final census	dies (θ)	V.A	bit	1
		Class I	V.B	latent block	3
		Class II	V.C	blinker pred.	4
		Class III	V.D.1	R-pentomino	5
		Class III (only)	V.D.2	glider pred.	5
		Class IV	V.E	Gun pred.	26
		unknown	V.F	acorn**	7
* smallest known object (for Classes II, III, IV-minimum phase)					
** 'apparently' unknown - see text page six					

Fig. 2.4 An early classification system

evolving rather than manually paging through mainframe output one page (generation) at a time. Fredkin suggested that Life might actually be the basis for a model describing how subatomic particles behaved.

Around the middle of 1972, Conway came to New York to meet with Gardner. During his visit, I had the fortunate opportunity to meet him and hear first-hand about how his idea for Life developed. He said that he was excited to learn of Gosper's discovery and could not believe the amount of interest Gardner's columns had generated. At that time, he posed a second challenge called The Grandfather Problem which asked: "Is there a configuration which has a father but no grandfather?". This challenge along with an offer of another $50 prize was included in the newsletter. Conway's second prize generated even more interest in LIFELINE, which by then had grown to nearly one thousand subscribers.

The initial society of Life enthusiasts were like a group of taxonomists, giving names to the wide variety of forms that were tumbling out of the S32/B3 rule (Fig. 2.4). This is just the opposite of what goes on in science. Ordinarily one starts off with a set of data and then attempts to determine what underlying principles or laws control these results. Life players had the underlying principle already (Conway's rule); they sought to discover the universe it implied.

Late in 1973, near the end of its third year, LIFELINE ceased publication. It had become too great a burden and time consuming to continue due to priorities of family, career, and other personal matters which had been long neglected.

Like many others at that time, I wondered if Life was just a superficial game or was there something of real significance implied in its deceptively simple rules. Gardner, in an earlier Scientific American article,[1] wrote the following concerning simplicity in nature:

> A closely related question is whether the natural laws themselves are simple or complicated. Most biologists, particularly those working with the brain and nervous system, are impressed by the complexity of life. In contrast, although quantum theory has become enormously more complicated with the discovery of weird new particles and interactions, most physicists retain a strong faith in the ultimate simplicity of basic laws. This was especially true of Albert Einstein who wrote: 'Our experience justifies us in believing that nature is the realization of the simplest conceivable mathematical ideas'.

It is remarkable how such a simple system of genetic rules can lead to such complex results. It may even be argued as Fredkin suggested earlier that the configurations so far examined correspond roughly to the subatomic level in the real universe. If a two-state cellular automaton can produce such varied and esoteric phenomena from these simple rules, how much more so in our own universe?

[1] Gardner, Martin, Mathematical Games. Scientific American, August 1969.

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