

# Program Description I

Program Title

LIFE

Contributor's Name

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Program Description, Equations, Variables

LIFE IS PLAYED ON THE 10x10 ARRAY AS SHOWN TO THE RIGHT. A ZERO IS USED TO INDICATE AN EMPTY CELL AND A ONE IS USED TO INDICATE AN OCCUPIED CELL. A NEIGHBOR IS AN OCCUPIED CELL IN ANY OF THE EIGHT ADJACENT CELLS TO THAT OF THE CELL IN QUESTION. THE GENETIC LAWS ARE:

ROW 9

ROW 8

ROW 7

ROW 6

ROW 5

ROW 4

ROW 3

ROW 2

ROW 1

ROW 0

10 COLUMNS

0.0	0	0	0	0	0	0	0	0	0
0.0	0	0	0	0	0	0	0	0	0
0.0	0	0	0	0	0	0	0	0	0
0.0	0	1	0	0	1	0	0	0	0
0.0	0	1	1	1	1	0	0	0	0
0.0	1	0	0	0	0	1	0	0	0
0.0	1	0	1	1	0	1	0	0	0
0.0	1	0	0	0	0	1	0	0	0
0.0	0	1	1	1	1	0	0	0	0
0.0	0	0	0	0	0	0	0	0	0

"THE CHESHIRE CAT"

1) SURVIVALS: ANY OCCUPIED CELL WITH 2

OR 3 NEIGHBORS REMAINS OCCUPIED.

2) DEATHS: ANY OCCUPIED CELL WITH LESS

THAN 2 NEIGHBORS BECOMES EMPTY DUE TO

ISOLATION. ANY OCCUPIED CELL WITH MORE THAN 3 NEIGHBORS DIES DUE TO OVERPOPULATION

3) BIRTHS: ANY EMPTY CELL WITH EXACTLY 3 NEIGHBORS BECOMES OCCUPIED.

NO CHANGES ARE MADE IN THE ARRAY UNTIL ALL CELLS HAVE BEEN SUBJECTED TO THESE RULES. FOR FASTEST TIME BETWEEN GENERATIONS, PLACE THE INITIAL CONFIGURATION TOWARDS THE BOTTOM AND LEFT BUT ALLOW ROOM FOR PATTERN GROWTH. MINIMUM TIME BETWEEN GENERATIONS IS 2 MINUTES, MAXIMUM TIME IS 9 MINUTES, AND AVERAGE TIME IS 5 TO 6 MINUTES.

Operating Limits and Warnings

ANY PATTERN THAT GROWS BEYOND THE LEFT BOUNDARY WILL GIVE INVALID RESULTS.

HP-67 USERS SHOULD CHANGE THE FOLLOWING PROGRAM STEPS IN THE LISTING:

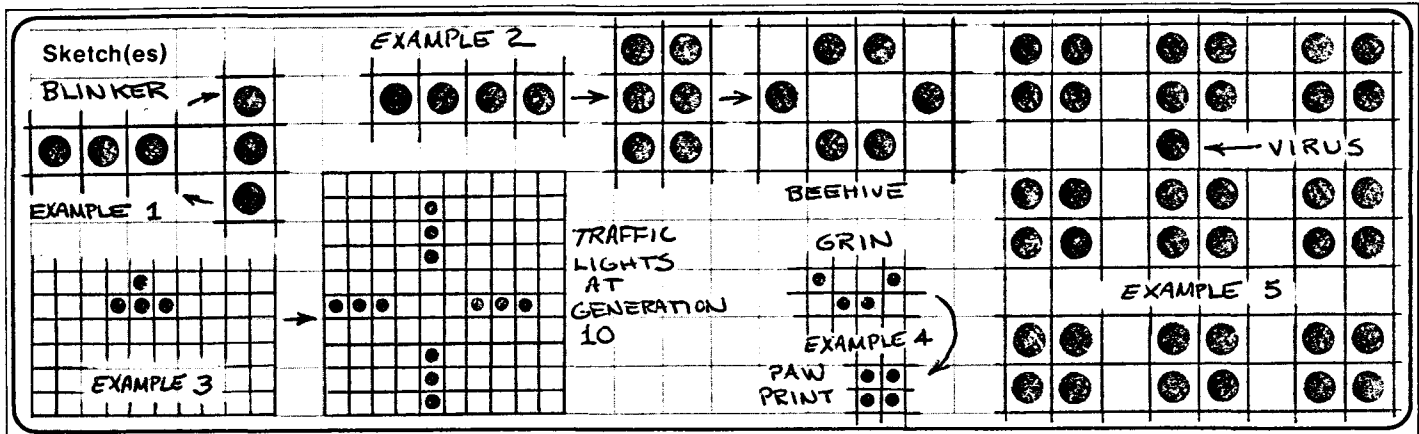
018 CHANGE -X- (PRINT X) 31 84 TO PAUSE 35 72

023 CHANGE -X- (PRINT X) 31 84 TO PAUSE 35 72

027 CHANGE -X- (PRINT X) 31 84 TO R/S 84

This program has been verified only with respect to the numerical example given in Program Description II. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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Sample Problem(s) (USE A SHEET OF GRAPH PAPER TO RECORD PATTERN CHANGES)

EXAMPLE 1: BLINKER CL REG, 0.111 STO 1, A

EXAMPLE 2: BEEHIVE CL REG, 0.1111 STO 1, A

EXAMPLE 3: TRAFFIC LIGHTS CL REG, 0.00111 STO 4, 0.0001 STO 5, A

EXAMPLE 4: CHESHIRE CAT CL REG, 0.001111 STO 1, STO 5

(SEE PAGE 1)

0.0100001 STO 2, STO 4

0.0101101 STO 3

0.001001 STO 6, A

EXAMPLE 5: VIRUS CL REG, 0.11011011 STO 1, STO 2, STO 4, STO 5, STO 7, STO 8

0.0001 STO 6, A

Solution(s)

EXAMPLE 1: THE PATTERN OSCILLATES BETWEEN 3 VERTICAL AND 3 HORIZONTAL CELLS.

EXAMPLE 2: THE PATTERN BECOMES A STABLE BEEHIVE AT GENERATION 2.

EXAMPLE 3: THE PATTERN BECOMES FOUR BLINKERS AT GENERATION 9.

EXAMPLE 4: THE CHESHIRE CAT FADES TO A GRIN AT GENERATION 6 AND

LEAVES A STABLE PAW PRINT AT GENERATION 7.

EXAMPLE 5: THE HOST IS KILLED OFF BY THE VIRUS UNTIL THE PATTERN

GROWS BEYOND THE ARRAY SIZE AT GENERATION 8.

Reference(s) MARTIN GARDNER, MATHEMATICAL GAMES, SCIENTIFIC  
AMERICAN, OCT 1970 AND FEB 1971.

# User Instructions

00626D



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	LOAD SIDE 1 AND SIDE 2.		<input type="text"/> <input type="text"/>	
2	CLEAR REGISTERS.		<input type="text"/> f <input type="text"/> Q REG	0
3	INPUT INITIAL CONFIGURATION, X=0,1:		<input type="text"/> <input type="text"/>	
	ROW 0 X.XXXXXXXXXX	ROW 0	<input type="text"/> STO <input type="text"/> 0	ROW 0
	ROW 1 X.XXXXXXXXXX	ROW 1	<input type="text"/> STO <input type="text"/> 1	ROW 1
	ROW 2 X.XXXXXXXXXX	ROW 2	<input type="text"/> STO <input type="text"/> 2	ROW 2
	ROW 3 X.XXXXXXXXXX	ROW 3	<input type="text"/> STO <input type="text"/> 3	ROW 3
	ROW 4 X.XXXXXXXXXX	ROW 4	<input type="text"/> STO <input type="text"/> 4	ROW 4
	ROW 5 X.XXXXXXXXXX	ROW 5	<input type="text"/> STO <input type="text"/> 5	ROW 5
	ROW 6 X.XXXXXXXXXX	ROW 6	<input type="text"/> STO <input type="text"/> 6	ROW 6
	ROW 7 X.XXXXXXXXXX	ROW 7	<input type="text"/> STO <input type="text"/> 7	ROW 7
	ROW 8 X.XXXXXXXXXX	ROW 8	<input type="text"/> STO <input type="text"/> 8	ROW 8
	ROW 9 X.XXXXXXXXXX	ROW 9	<input type="text"/> STO <input type="text"/> 9	ROW 9
	(NEED NOT INPUT TRAILING ZEROS OR ALL ZERO ROWS).		<input type="text"/> <input type="text"/>	
4	START.		<input type="text"/> A <input type="text"/>	
97	THE HP-97 WILL NOW SUCCESSIVELY PRINT:		<input type="text"/> <input type="text"/>	
	GENERATION NUMBER,		<input type="text"/> <input type="text"/>	GEN
	10 X 10 ARRAY (ROW 9 AT TOP).		<input type="text"/> <input type="text"/>	ARRAY
67	THE HP-67 WILL PAUSE TO DISPLAY THE FOLLOWING:		<input type="text"/> <input type="text"/>	
	GENERATION NUMBER,		<input type="text"/> <input type="text"/>	GEN
	ROW 9, ROW 8, ..., ROW 2, ROW 1,		<input type="text"/> <input type="text"/>	ROW
	AND WILL STOP WITH ROW 0 IN THE DISPLAY.		<input type="text"/> <input type="text"/>	ROW 0
5	TO DISPLAY THE ROWS SEPARATELY: (ANY ORDER)		<input type="text"/> <input type="text"/>	
	ROW 0		<input type="text"/> RCL <input type="text"/> 0	ROW 0
	ROW 1		<input type="text"/> RCL <input type="text"/> 1	ROW 1
	ROW 2		<input type="text"/> RCL <input type="text"/> 2	ROW 2
	ROW 3		<input type="text"/> RCL <input type="text"/> 3	ROW 3
	ROW 4		<input type="text"/> RCL <input type="text"/> 4	ROW 4
	ROW 5		<input type="text"/> RCL <input type="text"/> 5	ROW 5
	ROW 6		<input type="text"/> RCL <input type="text"/> 6	ROW 6
	ROW 7		<input type="text"/> RCL <input type="text"/> 7	ROW 7
	ROW 8		<input type="text"/> RCL <input type="text"/> 8	ROW 8
	ROW 9		<input type="text"/> RCL <input type="text"/> 9	ROW 9
6	COMPUTE NEXT GENERATION		<input type="text"/> R/S <input type="text"/>	
	GO TO STEP 67		<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
	FOR A NEW INITIAL CONFIGURATION, GO TO		<input type="text"/> <input type="text"/>	
	STEP 2.		<input type="text"/> <input type="text"/>	

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBL A	31 25 11	START		ISZ	31 34	
	PZS	31 42			GTO 2	22 02	
	CL REG	31 43			*LBL 3	31 25 03	BUILD LAST ROW
	DSZ	31 33			RCL O	34 00	SHOWING VERTICAL
	*LBL O	31 25 00	SET UP ROW COUNTER		+	61	NEIGHBORS AND
	PZS	31 42			RC I	35 34	UPDATE ROW
	1	01			CL REG	31 43	COUNTER
	0	00			9	09	
	RC I	35 34			PZS	31 42	
010	+	61			+	61	
	ST I	35 33			ST I	35 33	
	FRAC	32 83	EXTRACT AND PRINT		R↓	35 53	
	EEX	43	GENERATION		STO O	33 00	
	5	05	NUMBER	070	1	01	
	X	71			STO E	33 15	
HP-67	SPACE	35 84			*LBL 4	31 25 04	BEGIN TESTING
↓	DSP O	23 00			RCL A	34 11	TO COUNT TOTAL
PAUSE	-X-	31 84			STO B	33 12	NEIGHBORS TO
	DSP 9	23 09	PRINT ARRAY		RCL C	34 13	APPLY GENETIC
020	SPACE	35 84	STARTING WITH		STO A	33 11	RULES FOR EACH
HP-67	*LBL 1	31 25 01	ROW 9		RCL (i)	34 24	ROW A CELL AT
↓	RCL (i)	34 24			F? O	35 71 00	A TIME
PAUSE	-X-	31 84			CF 1	35 61 01	
	DSZ	31 33		080	X=O	31 51	
HP-67	GTO 1	22 01			SF O	35 51 00	
↓	RCL O	34 00			INT	31 83	
R/S	-X-	31 84			STO C	33 13	
	RC I	35 34	UPDATE ROW		LST X	35 82	
	9	09	COUNTER		FRAC	32 83	
030	+	61			1	01	
	EEX	43	INCREMENT		0	00	
	CHS	42	GENERATION		X	71	
	5	05	NUMBER		STO (i)	33 24	
	+	61		090	0	00	
	ST I	35 33			STO D	33 14	
	RCL 8	34 08	REBUILD EACH		RCL C	34 13	ROUTINE TO
	2	02	ROW SO THAT IT		X=O	31 51	DETERMINE
	X	71	CONTAINS INFORMATION		GTO 5	22 05	SURVIVAL
	*LBL 2	31 25 02	SHOWING HOW MANY		3	03	
040	RCL (i)	34 24	VERTICAL NEIGHBORS		X>Y	32 81	
	+	61	IT HAS		GTO 6	22 06	
	PZS	31 42			CLX	44	
	STO (i)	33 24			5	05	
	PZS	31 42		100	X=Y	32 51	
	RCL (i)	34 24			GTO 7	22 07	
	2	02			RCL D	34 14	
	X	71			2	02	
	DSZ	31 33			+	61	
050	X<O	31 71			STO D	33 14	
	GTO 3	22 03			GTO 5	22 05	
	DSZ	31 33			*LBL 6	31 25 06	
	DEG	35 41			RCL D	34 14	
	RCL (i)	34 24			1	01	
	2	02		110	+	61	
	X	71			STO D	33 14	
	+	61			GTO 5	22 05	

## REGISTERS

0 ROW 0	1 ROW 1	2 ROW 2	3 ROW 3	4 ROW 4	5 ROW 5	6 ROW 6	7 ROW 7	8 ROW 8	9 ROW 9
S0 ROW 0'	S1 ROW 1'	S2 ROW 2'	S3 ROW 3'	S4 ROW 4'	S5 ROW 5'	S6 ROW 6'	S7 ROW 7'	S8 ROW 8'	S9 ROW 9'
A USED	B USED	C USED	D USED	E USED	I USED				

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	*LBL 7	31 25 07			3	03	
	RCL D	34 14		170	+	61	
	3	03			STD D	33 14	
	+	61			*LBL b	32 25 12	-----
	STD D	33 14			RCL A	34 11	TEST TO
	*LBL 5	31 25 05			2	02	DETERMINE IF
	RCL A	34 11			÷	81	CELL IS TO BE
120	X=0	31 51			FRAC	32 83	OCCUPIED DUE TO
	GTO 8	22 08			X=0	31 51	BIRTH
	3	03			GTO e	22 31 15	
	X>Y	32 81			4	04	
	GTO 9	22 09		180	RCL D	34 14	
	CLX	44			X=Y	32 51	
	5	05			SF 2	35 51 02	-----
	X=Y	32 51			*LBL e	32 25 15	DECIDE IF CELL
	GTO a	22 31 11			3	03	IS TO BE EMPTY
	RCL D	34 14			RCL D	34 14	(0) OR OCCUPIED (1)
130	2	02			X=Y	32 51	
	+	61			SF 2	35 51 02	
	STD D	33 14			0	00	
	GTO 8	22 08			F? 2	35 71 02	
	*LBL 9	31 25 09		190	1	01	-----
	RCL D	34 14			PZS	31 42	ADD CONDITION OF
	1	01			1	01	TESTED CELL TO
	+	61			0	00	THE END OF THE
	STD D	33 14			STD X (i)	33 71 24	CURRENT ROW
	GTO 8	22 08			XZ Y	35 52	BEING
140	*LBL a	32 25 11			STD + (i)	33 61 24	CONSTRUCTED
	RCL D	34 14			PZS	31 42	-----
	3	03			R↓	35 53	KEEP TRACK OF
	+	61			RCL E	34 15	DECIMAL POINT IN
	STD D	33 14		200	X	71	ROW BEING
	*LBL 8	31 25 08			STD E	33 15	CONSTRUCTED
	RCL B	34 12			F? 1	35 71 01	-----
	X=0	31 51			GTO 4	22 04	IF NOT LAST CELL,
	GTO b	22 31 12			PZS	31 42	GO TO STEP 4
	3	03			RCL (i)	34 24	-----
150	X>Y	32 81			RCL E	34 15	POSITION DECIMAL
	GTO c	22 31 13			÷	81	POINT IN ROW
	CLX	44			EEX	43	WHICH HAS JUST
	5	05			2	02	BEEN FINISHED
	X=Y	32 51			X	71	ACCORDING TO THE
	GTO d	22 31 14		210	STD (i)	33 24	GENETIC RULES
	RCL D	34 14			PZS	31 42	-----
	2	02			CF 0	35 61 00	SET INITIAL
	+	61			SF 1	35 51 01	CONDITIONS
	STD D	33 14			DSZ	31 33	-----
160	GTO b	22 31 12			RC I	35 34	TEST TO SEE IF
	*LBL c	32 25 13			RC I	35 34	THIS IS THE LAST
	RCL D	34 14			X<0	31 71	ROW OF THE ARRAY,
	1	01			GTO 0	22 00	IF SO, GO TO THE
	+	61			0	00	PRINT ROUTINE
	STD D	33 14		220	STD B	33 12	-----
	GTO b	22 31 12			1	01	ELSE, GO TO LBL 4
	*LBL d	32 25 14			STD E	33 15	TO BEGIN GENETIC
	RCL D	34 14			GTO 4	22 04	TESTING OF NEXT
							ROW

-----  
ROUTINE TO  
DETERMINE  
BIRTH

LABELS					FLAGS		SET STATUS		
A	B	C	D	E	0	USED	FLAGS	TRIG	DISP
a	USED	USED	USED	USED	1	USED	ON OFF	DEG <input checked="" type="checkbox"/>	FIX <input checked="" type="checkbox"/>
0	USED	USED	USED	USED	2	USED	0 <input type="checkbox"/> <input checked="" type="checkbox"/>	GRAD <input type="checkbox"/>	SCI <input type="checkbox"/>
5	USED	USED	USED	USED	3		1 <input checked="" type="checkbox"/> <input type="checkbox"/>	RAD <input type="checkbox"/>	ENG <input type="checkbox"/>
							2 <input type="checkbox"/> <input checked="" type="checkbox"/>		n 9
							3 <input type="checkbox"/> <input checked="" type="checkbox"/>		