

01798D Program Description I

Program Title BRIDGE-IT

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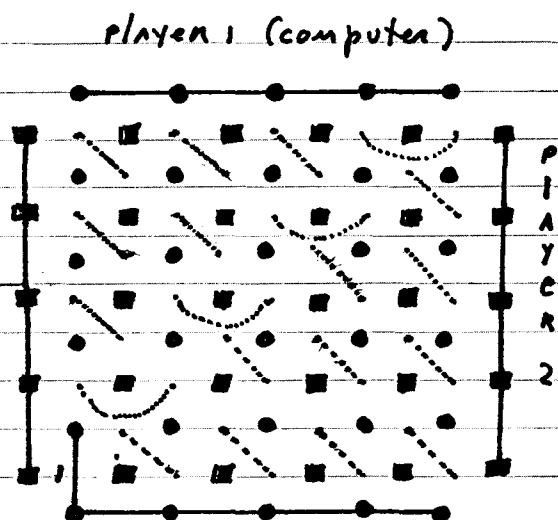
City Woodmere, L.I.

State N.Y.

Zip Code 11598

Program Description, Equations, Variables

Even without computer simulation, the game of BRIDGE-IT (see references) is fun to play, and a real game of skill. It is available commercially. Try playing it first against a human opponent to get a feel for its complexity and depth. Two players compete (use different colors) to build a rectilinear interconnected network between their respective posts (see example). Player 1 connects $\bullet + \bullet$. Player 2, $\blacksquare + \blacksquare$. No bridge may cross an opponent's.



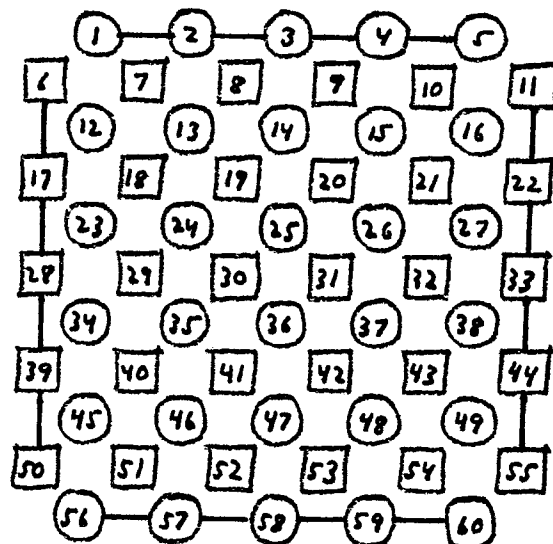
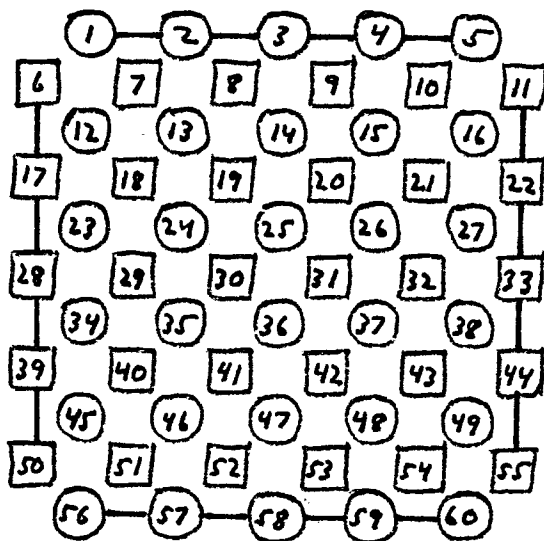
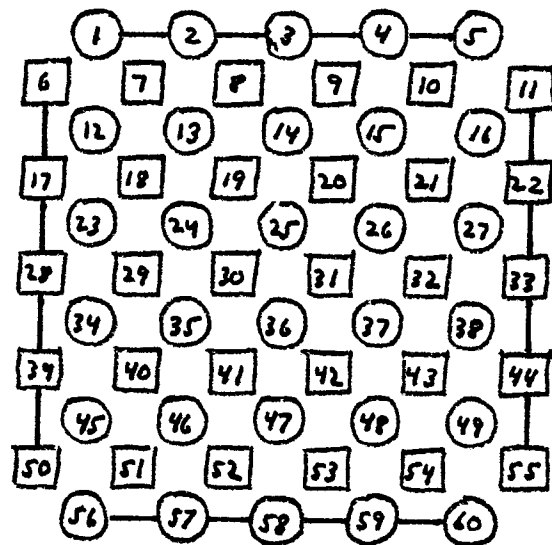
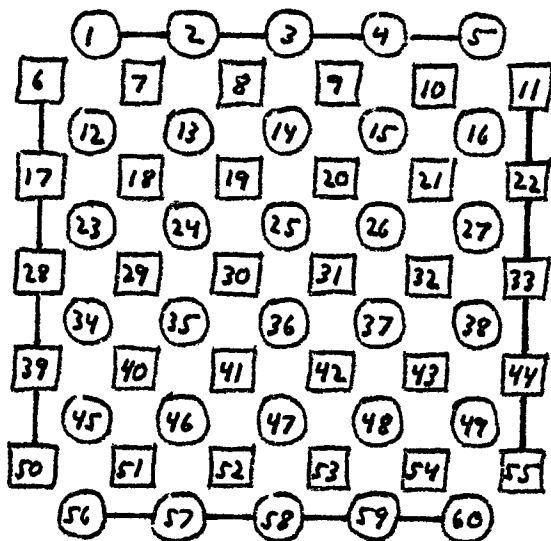
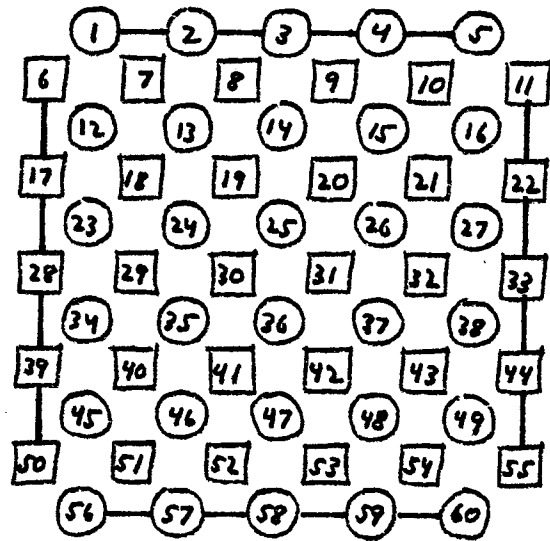
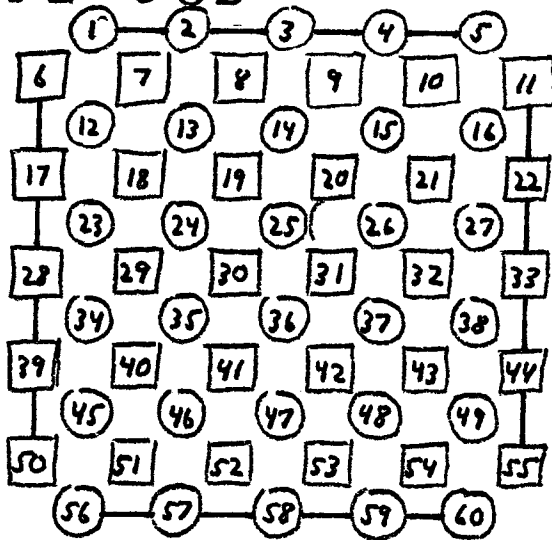
Surprisingly, this apparently complex game was found, by Oliver Gross, a year after its introduction, to have a completely defined and clearly stated strategy forcing a win for player 1. After his initial move (shown), each opponent move is answered by connecting two circles such that the opposite end of the appropriate dotted line bisects the bridge.

Operating Limits and Warnings The program implements this far-from-obvious winning strategy using no arithmetic numbering of the squares and circles. It further encompasses all symmetric variations so that the 6797 has a choice of opening moves and a corresponding variation in response to specific player moves. Play your best and observe the computer strategy - it is most instructive and entertaining. When desired, up to 19 moves may be reviewed.

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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01798D Program Description II BRIDG-IT

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Sketch(es)	<u>SAMPLE GAME OF BRIDG-IT</u> (NO RNG INITIATING)				
16.05					Moves are listed vertically starting with computer's first move 16.05
21.22	41.42	31.20	51.40	19.30	
26.15	46.35	25.14	45.34	24.13	
21.10	29.30	8.09	40.29	7.08	
15.04	26.35	15.14	34.23	14.13	
				END	Each player's move and computer response is then shown.
31.32	21.32	51.52	17.18		
36.25	38.27	56.45	24.23		

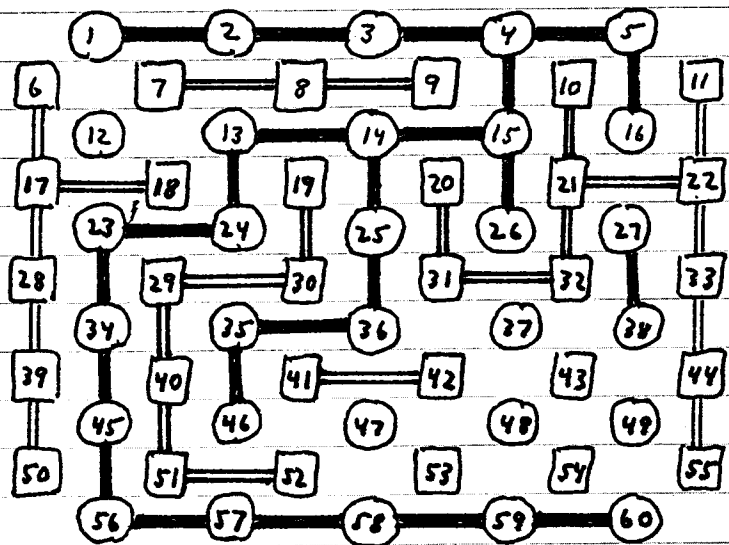
Sample Problem(s)

- (1) Press A to start.
→ 16.05

Computer constructs a bridge between
(5) and (16)

- (2) Player then connects
[21] and [22] and HP-67/97
responds with (26) + (15)
[21.22 C → 26.15]

- (3) Game continues as shown
above + in diagram.



Final position. HP-67/97 (—) wins.

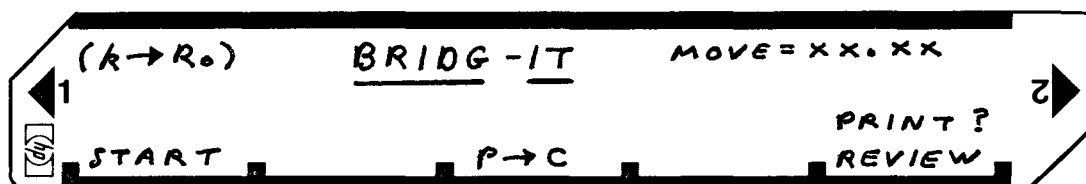
Solution(s)

Move 13 (38.27) is not the best computer response to player's preceding move. The 67/97 plays only as good as it has to to win, generally playing stronger against stronger opposition. Note how the computer eventually forces a winning connection despite strong opposition.

At move 19 you may press E to review the entire game. After this move, only the last 19 moves will be displayed.

Reference(s) Bridg-It was introduced in Scientific American, Oct. 1958 by Martin Gardner as "the game of GALE", and subsequently developed further in his New Mathematical Diversions from Scientific American (Simon & Schuster, 1966). The game was created by DAVID GALE, a mathematician at Brown University.

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter both sides of program card + (optionally) initial RAND	$0 \leq k < 1$			
			STO	0	
2	Choose display mode (alternate presses $\rightarrow 1+0$)				
			f	e	1 = PRINT 0 = NO PRINT
3	START $\rightarrow$ computer's first move			A	C_0
4	Player moves + computer replies	p_i		C	p_i, c_i
	Moves are entered by indicating — in either order — the two ends of the bridge (DSP 2 format). Eg., either 7.18 or 18.07 (NOT <u>18.7</u>) designates a bridge between squares 7 and 18. Computer responses are in the same format. The HP-97 will print/format all moves if print mode was chosen.				C_i only is displayed if print mode was not chosen
5	Repeat 4 until a winner is determined.				
	The 67/97 does not reject illegal moves or announce a win, but adjusts its level of play to its opponent's strength.				
6	At any time, review the 1st up-to-19 moves if desired.			E	$c, p, c, \dots$
	Output is in pause/print mode, but is most useful on the HP-67. The first move displayed is always C_i , and subsequent moves appear in the order played.				
7	For a new game, go to 2 or 3.				

BRIDG-17

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	F LBLA	31 25 11	START		S	05	Retain p move
	RCL 0	34 00	Zero all registers		h STI	35 33	+ perform save
	F C/Rg	31 43	EXCEPT RAND.	060	F LBL6	31 25 06	cycle to preserve
	F P=5	31 42			F DSZ	31 33	a maximum of 19
	F C/Rg	31 43			F DSZ	31 33	game moves.
	STO 0	33 00	clear symmetry		F DSZ	31 33	
	h CFO	35 61 00	flags Fo + Fi		S	05	
	h CF1	35 61 01			h RCI	35 34	
010	F GSB0	31 22 00	then reposition		g 7=4	32 51	Decompose +
	F 7=0	31 51	the symmetry flags		GTO 7	22 07	input p = [ap] [bp]
	h SFO	35 51 00	randomly.		RCL 6	34 24	into R1 + R2 +
	F GSB0	31 22 00			F ISZ	31 34	evolve a response.
	F 7=0	31 51		070	F ISZ	31 34	
	h SF1	35 51 01			STO 6	33 24	
	4	04			GTO 6	22 06	
	5	05	Obtain trans-		F LBL7	31 25 07	TRANSFORM RESPONSE TRANSFORM
	STO 1	33 01	formed basal		RCL 4	34 04	{ [ap] } TRUE
	5	05	move = computer's		STO 7	33 07	p move
	6	06	first move.		ENTER ↑	41	{ [bp] } move
020	STO 2	33 02			F INT	31 83	in
	F 6	32 22 12			STO 1	33 01	basal
	g LBLd	32 25 14			-	51	{ [ap] } response
	RCL 1	34 01	OUTPUT	080	EEX	43	in
	RCL 2	34 02	Form (ac) . (bc) =		2	02	basal
	EEX	43	computer move.		X	71	{ [bc] } response
	2	02			STO 2	33 02	{ [ac] } TRUE
	÷	81			F 6	32 22 12	c response
	+	61			F c	32 22 13	
	STO 6	33 06	Pause/print		F 6	32 22 12	
030	h F?2	35 71 02	p = [ap] . [bp]		GTO fd	22 31 14	Then output
	GTO 5	22 05	c = (ac) . (bc)	090	g LBLb	32 25 12	TRANSFORM
	h RTN	35 22	if print mode		h F?0	35 71 00	Symmetry trans-
	F LBL5	31 25 05	was selected.		GTO 1	22 01	formation as per
	h SF2	35 51 02	otherwise just		6	06	Fo + Fi coding.
	RCL 7	34 07	output c's move.		1	01	61-a → a
	h SPACE	35 84			RCL 1	34 01	61-b → b
	F 7=0	31 61			-	51	for center-point
	F -7-	31 84			STO 1	33 01	symmetry.
	h 7=	35 52			6	06	
040	F -7-	31 84			1	01	
	h RTN	35 22			RCL 2	34 02	
	F LBL0	31 25 00	RAND		-	51	
	RCL 0	34 00	Ra = fract. part	100	STO 2	33 02	
	h π	35 73	(Ra-1 + π)²		F LBL1	31 25 01	Horizontal line
	+	61			h F?1	35 71 01	symmetry
	g 7²	32 54			h RTN	35 22	
	g fract	32 83			RCL 1	34 01	
	STO 0	33 00	Output = 0 on 1		F a	32 22 11	f-a → a
	2	02	to determine		STO 1	33 01	f-b → b
050	X	71	Fo + Fi settings.		RCL 2	34 02	f = transposition
	F INT	31 83			F a	32 22 11	factor
	h RTN	35 22		110	STO 2	33 02	
	F LBLC	31 25 13			h RTN	35 22	
	h CF3	35 61 03			g LBLa	32 25 11	
	STO 4	33 04			STO 4	33 04	FACTOR f
	2	02			1	01	

REGISTERS									
0 RAND	1 EVOLVING a's	2 EVOLVING b's	3 m _f	4 hold a's mod 10	5 -	6 (a _c) (b _c)	7 [a _p] [b _p]	8 c	9 p
S0 c	S1 p	S2 c	S3 p	S4 c	S5 p	S6 c	S7 p	S8 c	S9 p
A c	B p	C c	D p	E c	I index				

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	1	01	First obtain + store m_f $m_f = a \text{ mod. } 11$ but $m_f + 11 \rightarrow m_f$ if orig. $m_f = 0$ make sure m_f is integral.	170	g x=y	32 71	if $(b_p - a_p) = 1$ do horizontal move analysis (LBL 2): $R_4 = 0 \rightarrow \text{LBL 3}$ $R_4 = 9 \rightarrow \text{LBL 4}$ but if $a_p \text{ mod. } 10$ $\neq 0 + \neq 9$ $a_p \pm 6 \rightarrow a_c$ $b_p \pm 6 \rightarrow b_c$ as per actual mod. value.
	$\div$	81			CHS	42	
	g FRACT	32 83			STO + 1	33 61 01	
	1	01			STO + 2	33 61 02	
	1	01			h RTN	35 22	
	x	71			<u>f LBL 2</u>	31 25 02	
	f RND	31 24			9	09	
120	1	01			RCL 4	34 04	
	1	01			f x=0	31 51	
	h $\equiv$	35 52			GTO 3	22 03	
	f x $\neq$ 0	31 61	----- $(m_f \leq 5) \rightarrow$ $f = 55 + 2m_f$ $(m_f > 5) \rightarrow$ $f = 44 + 2m_f$ Then f is used for $f - a \rightarrow a$ $f - b \rightarrow b$ in horiz. symmetry (f=61 for point symm.)	180	g x=y	32 51	ap mod. 10 = 0 $\rightarrow$ $a_p - 6 \rightarrow a_c$ $b_p + 4 \rightarrow b_c$ ap mod. 10 = 9 $\rightarrow$ $a_p - 4 \rightarrow a_c$ $b_p + 6 \rightarrow b_c$
	0	00			<u>g GTO 4</u>	22 04	
	+	61			6	06	
	STO 3	33 03			g x$\neq$y	32 81	
	5	05			CHS	42	
	h $\equiv$	35 52			STO + 1	33 61 01	
	g x$\neq$y	32 71			STO + 2	33 61 02	
130	h SF 3	35 51 03			h RTN	35 22	
	4	04			<u>f LBL 3</u>	31 25 03	
	h F? 3	35 71 03			6	06	
	5	05	RESPONSE First order $a_p + b_p$ so that $a_p < b_p$ ----- Then obtain + store $a_p \text{ mod. } 10$ + use it for ...	190	STO - 1	33 51 01	REVIEW Pause/print the game — up to 19 moves if $n > 19$, the last 19 moves are outputted. First move shown is always c/a.
	ENTER P	41			4	04	
	1	01			STO + 2	33 61 02	
	1	01			h RTN	35 22	
	x	71			<u>f LBL 4</u>	31 25 04	
	RCL 3	34 03			4	04	
140	2	02			STO - 1	33 51 01	
	x	71			6	06	
	+	61			STO + 2	33 61 02	
	RCL 4	34 04			h RTN	35 22	
	-	51	VERTICAL MOVE ANALYSIS: $a_p \pm 6 \rightarrow a_c$ $b_p \pm 6 \rightarrow b_c$	200	<u>f LBL 5</u>	31 25 15	PRINT? $F_{\text{on}} \rightarrow 1 = \text{print}$ $F_{\text{off}} \rightarrow 0 = \text{no}$ 1 + 0 alternate.
	h RTN	35 22			h SPACE	35 84	
	<u>g LBL 5</u>	32 25 13			2	02	
	ORCL 1	34 01			4	04	
	RCL 2	34 02			h STI	35 33	
	g x$\neq$y	32 71			<u>f LBL 8</u>	31 25 08	
150	h $\equiv$	35 52			RCL 4	34 04	
	STO 2	33 02			f x $\neq$ 0	31 61	
	h $\div$	35 53			f x-	31 84	
	STO 1	33 01			f DSZ	31 33	
	1	01	Labels	210	6	06	Flags
	0	00			h RCI	35 34	
	$\div$	81			g x$\neq$y	32 61	
	g FRACT	32 83			g GTO 8	22 08	
	1	01			RCL 6	34 06	
	0	00			f -x-	31 84	
	x	71			h RTN	35 22	
160	STO 4	33 04			<u>g LBL 6</u>	32 25 15	
	RCL 2	34 02			h F? 2	35 71 02	
	RCL 1	34 01			GTO 5	22 05	
	-	51	SET STATUS		h SF 2	35 51 02	ON OFF
	1	01		220	1	01	
	g x$\neq$y	32 51			h RTN	35 22	
	g GTO 2	22 02			<u>f LBL 5</u>	31 25 05	
	RCL 4	34 04			0	00	
	6	06			h RTN	35 22	

LABELS					FLAGS		SET STATUS		
A START	B -	C P $\rightarrow$ C	D -	E REVIEW	0 SYMMETRY		FLAGS	TRIG	DISP
a FACTOR	b TRANSFORM	c RESPOND	d OUTPUT	e PRINT ?	1 VARIANTS		ON OFF		
0 RAND	1 LINE SYMMETRY	2 HORIZ. MOVE	3 $m = 0$	4 $m = 9$	2 PRINT		☐ ☒	DEG ☒	FIX ☒
5 PRINT (MULTIPLE)	6 SAVE CYCLE	7 INPUT	8 REVIEW CYCLE	9 -	3 m_f value		☐ ☒	GRAD ☐	SCI ☐
							☐ ☒	RAD ☐	ENG ☐
							☐ ☒		n 2