

Program Title FORTRESS

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Program Description, Equations, Variables

YOU HAVE 7 TURNS TO INVADE A TRIANGULAR FORTRESS (SEE TRIANGLE WITH CORNERS 1,2,3, PAGE 2) AND CAPTURE ITS DEFENDER WITHOUT BEING CAPTURED THERE YOURSELF. A CAPTURE IS MADE BY MOVING FROM ONE NUMBERED POINT TO AN ADJACENT POINT OCCUPIED BY THE ENEMY. THE DEFENDER (YOUR CALCULATOR) IS CONFINED TO THE FORT AND MOVES FROM ONE CORNER TO ANOTHER ON EACH TURN. HE LEARNS FROM EVERY DEFEAT, YET IT IS ALWAYS POSSIBLE FOR YOU TO WIN. YOU START FROM POINT 6,7,8,9, OR 10, AND THEREAFTER MOVE TO ONE ADJACENT NUMBERED POINT ON EACH TURN. IF YOU CAPTURE THE DEFENDER, YOU WIN; IF NOT, HE WINS. YOU ALSO HAVE OPTIONS TO SPECIFY THE LEARNING RATE, R, OR ANY CONSTANT PROBABILITY OF ACCURATE PLAY FOR THE DEFENDER. R VARIES FROM 1 (SLOW) TO 7 (FAST), BUT IS AUTOMATICALLY 4 (AVERAGE) UNLESS CHANGED. NOTATION: P_1 AND P_7 ARE PROBABILITIES FOR DEFENDER TO MAKE AN ACCURATE MOVE AND TO FORCE A WIN IN 7 MOVES, RESPECTIVELY. EQUATION: $P_7 = (P_1)^7$.

Operating Limits and Warnings

"DEFENDER" DOES NOT CHECK ACCURACY OF INPUTS.

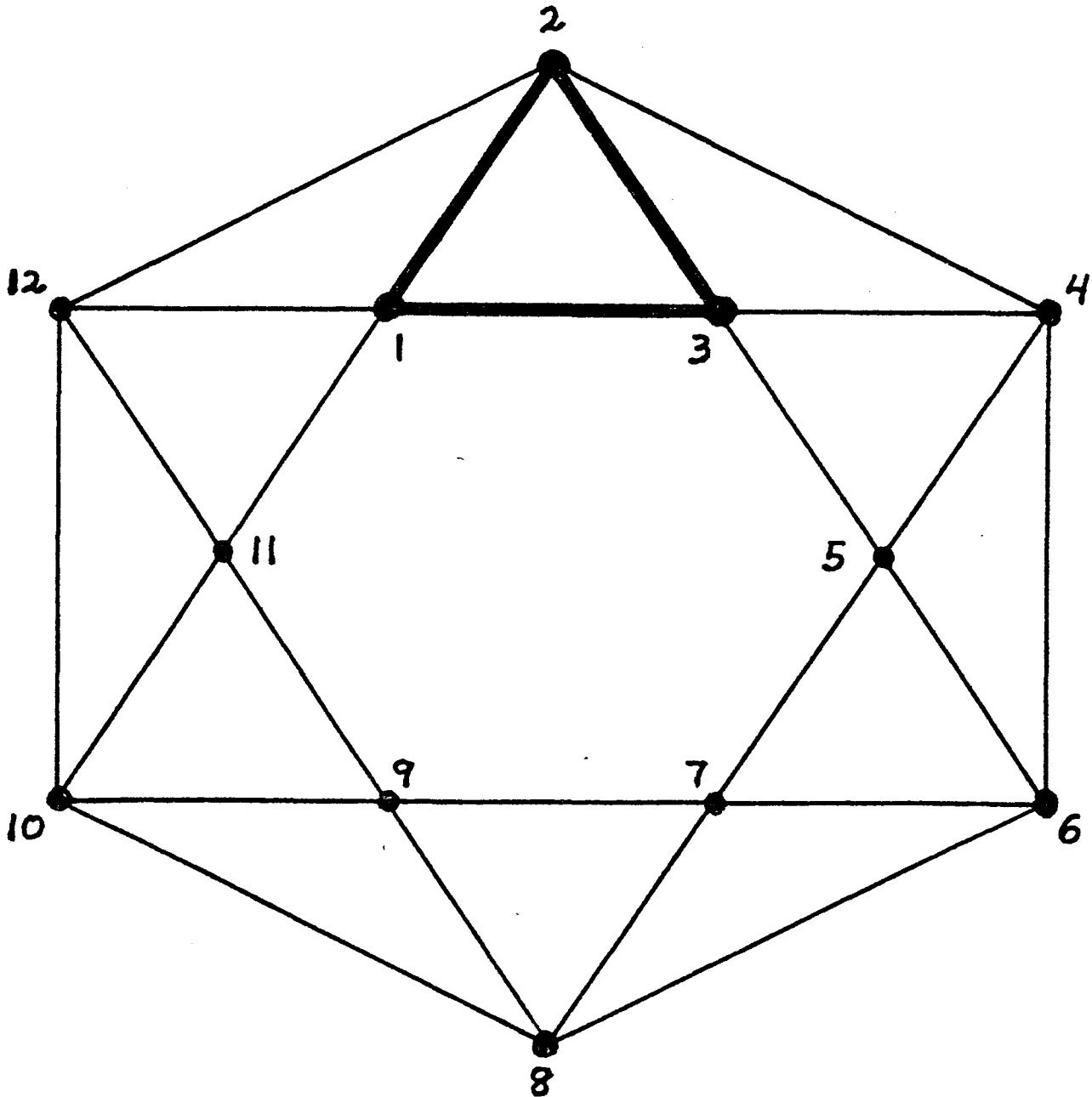
NOTE THAT FLAG 3 AFFECTS OPERATION OF STEPS 2,5, AND 9 TO 13.

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.

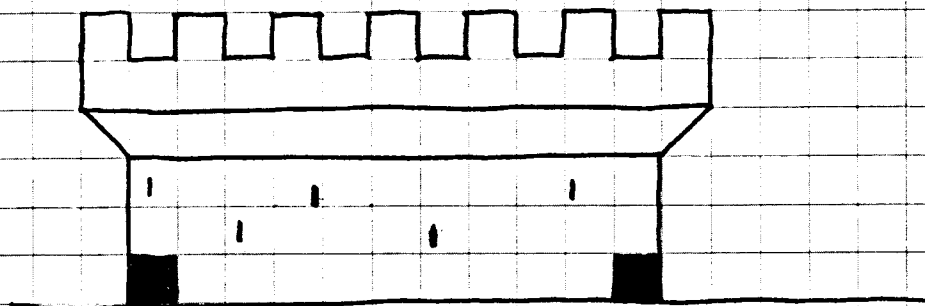
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Sketch(es)

PLAYING BOARD: FORTRESS



Sketch(es)



Sample Problem(s)

THESE TWO EXAMPLES, BELOW, SHOW FIRST A WIN THEN A LOSS (NOT FORCED) FOR THE ATTACKER AGAINST AN UNSKILLED DEFENDER.

(PARENTHESES INDICATE PAUSES.)

TWO DIFFERENT COINS MAY BE USED TO REPRESENT THE OPPONENTS ON THE PLAYING BOARD, PAGE 2.

Solution(s)

KEYSTROKES

.987654321 [A] → 0.00

10 [B] → (7.) N
→ 10.2 L_A.L_D

12 [C] → (6.) N
→ 12.1 L_A.L_D

1 [C] → 1.0 L_A.0

WIN

KEYSTROKES

7 [B] → (7.) N
→ 7.1 L_A.L_D

5 [C] → (6.) N
→ 5.2 L_A.L_D

3 [C] → (5.) N
→ 0.3 0.L_D

LOSS

Reference(s)

BASED ON A PROBLEM IN "RECREATION IN MATHEMATICS," BY R. SPRAGUE. LONDON, BLACKIE AND SON, (1963), 61 PP. SEE P. 20.

1

SEED

RATE

START

FORTRESS

MOVE

WINS? P₁, P₂?

2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	LOAD SIDES 1 AND 2.			
2	INPUT SEED, (ANY DECIMAL NUMBER).	SEED	A	0
3	OPTIONAL: SPECIFY LEARNING RATE, R, OF DEFENDER, FROM 1 (SLOW) TO 7 (FAST). OTHERWISE, R=4 (AVERAGE).	R	f B	R
4	PICK INITIAL LOCATION, L _A =6,7,8,9, or 10, NOTE TOTAL NUMBER OF TURNS, AND DEFENDERS LOCATION, L _D .	L _A	B	7
5	MOVE TO AN ADJACENT POINT, NOTE NUMBER OF MOVES LEFT, AND DEFENDER'S NEW LOCATION.	L _A	C	L _A ·L _D
6	REPEAT STEP 5 TO CONCLUSION. (L _A =0 OR L _D =0 MEANS ATTACKER OR DEFENDER HAS LOST.)			N
7	GO TO STEP 4 FOR NEXT GAME.			L _A ·L _D
	OPTIONAL:			
8	NOTE NUMBERS OF GAMES WON BY ATTACKER, G _A , AND DEFENDER, G _D .		D	G _A
9	NOTE CURRENT PROBABILITIES OF DEFENDER MAKING CORRECT MOVE, P ₁ , AND FORCING A WIN, P ₂ .		E	G _D
10	RECALL CURRENT LOCATIONS.			P ₁
11	FIX A CONSTANT PROBABILITY (DECIMAL) OF DEFENDER MAKING CORRECT MOVE.	P ₁	C	P ₂
12	CANCEL COMMAND IN STEP 11, RETURNING P ₁ TO ITS PREVIOUS VALUE.	0	E	L _A ·L _D
13	RESET G _A , G _D , P ₁ , AND P ₂ TO ZERO, AND R TO 4.			P ₁
			A	0
	NOTE: FOR VARIABLE P ₁ ,			
	$P_1 = \frac{m_1}{m_1 + m_2}, \quad m_1 = G_A, \quad m_2 = e^{4-R},$			
	$P_2 = P_1^7.$			

REGISTERS									
0 $L_A \cdot L_D$	1 1,3,2	2 2,1,3	3 1,2,3	4 $m_1 \geq 0$	5 $m_2 = 1?$	6 $N \leq 7$	7	8 G_D	9 G_A
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
A R	B 10	C 7	D FIXED P ₁	E "RAND." NO.	F $L_D = 1,2,3$				

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
113	$\frac{1}{2}$	81	DEFENDER STRATEGY.	169	RTN	35 22	FIND AND DISPLAY P ₁ AND P ₂ .
114	FRAC	32 83		170	*LBL E	31 25 15	
115	3	03		171	F? 3	35 71 03	
116	X	71		172	GT 0 6 a	22 31 11	
117	DSP 0	23 00		173	RCL 4	34 04	
118	RND	31 24	DEFENDER'S MOVE OPTIONS.	174	RCL 5	34 05	ALTER LEARNING RATE.
119	X=0	31 51		175	RCL 4	34 04	
120	3	03		176	+	61	
121	ST 0 3	33 03		177	$\frac{1}{2}$	81	
122	RTN	35 22		178	DSP 2	23 02	
123	*LBL 1	31 25 01		179	F? 1	35 71 01	
124	2	02		180	RCL D	34 14	
125	ST 0 1	33 01		181	PAUSE	35 72	
126	3	03		182	7	07	
127	ST 0 2	33 02		183	4 ^x	35 63	
128	RTN	35 22	DISPLAY SCORES.	184	RTN	35 22	
129	*LBL 2	31 25 02		185	*LBL 6	32 25 12	
130	3	03		186	CF 3	35 61 03	
131	ST 0 1	33 01		187	ST 0 A	33 11	
132	1	01		188	CHS	42	
133	ST 0 2	33 02		189	4	04	
134	RTN	35 22		190	+	61	
135	*LBL 3	31 25 03		191	2 ^x	32 52	
136	1	01		192	ST 0 5	33 05	
137	ST 0 1	33 01	STORE SEED, INITIALIZE.	193	CLX	44	
138	2	02		194	ST 0 4	33 04	
139	ST 0 2	33 02		195	DSP 2	23 02	
140	RTN	35 22		196	RCL A	34 11	
141	*LBL D	31 25 14		197	RTN	35 22	
142	CF 3	35 61 03					
143	RCL 9	34 09					
144	DSP 0	23 00					
145	PAUSE	35 72					
146	RCL 8	34 08	INCORPORATE FIXED P ₁ .				
147	RTN	35 22					
148	*LBL A	31 25 11					
149	F? 3	35 71 03					
150	ST 0 E	33 15					
151	EEX	43					
152	1	01					
153	ST 0 B	33 12					
154	7	07					
155	ST 0 C	33 13					
156	1	01					
157	ST 0 5	33 05					
158	CLX	44					
159	ST 0 8	33 08					
160	ST 0 9	33 09					
161	ST 0 4	33 04					
162	RTN	35 22					
163	*LBL 6 a	32 25 11					
164	ST 0 D	33 14					
165	X ≠ 0	31 61					
166	SFI	35 51 01					
167	X=0	31 51					
168	CF 1	35 61 01					

LABELS					FLAGS	SET STATUS		
A INITIAL.	B SET UP	C MOVES	D SCORES	E P ₁ , P ₂	0 LOSS?	FLAGS	TRIG	DISP
a STORE P ₁	b SET R	c	d LOSS	e WIN	1 P ₁ FIXED	ON OFF		
0 "RAND." #	1 ST 0 2, 3	2 ST 0 3, 1	3 ST 0 1, 2	4	2 # < P ₁ ?	0 ☐ ☒	DEG ☒	FIX ☒
5	6	7 USED	8 USED	9 FIND P ₁	3 USED	1 ☐ ☒	GRAD ☐	SCI ☐
						2 ☐ ☒	RAD ☐	ENG ☐
						3 ☐ ☒		n <u>2</u>