

# Program Description I

Program Title JACK OF EAGLES (GAME)

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**Program Description, Equations, Variables** A guessing game. On each move the human enters a positive or negative number: the machine has already analysed the human's previous moves and anticipated his choice. If correct, the machine score goes up: if wrong, human score goes up. The number of plays can be set by the user. The game limit, if the human does not specify one, is 7: the maximum is 9. The program has some learning ability.

THEORY: See sheets labelled "Jack of Eagles: Theory"

**Operating Limits and Warnings**

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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# 00727D Program Description II

Sketch(es)

Sample Problem(s) Try to win

SOLUTION

KEYSTROKE	COMMENT	OUTPUT	COMMENT
LOAD SIDES 1 and 2 OF PROGRAM CARD			
A	Initialise	7.0 ***	Game limit
CHS, R/S	Select a negative number	-1.-01 ***	Machine selects -1. I lose
		0.1 ***	My score 0; machine's 1
CHS, R/S	Negative again	1.-01 ***	Machine selects 1. I win
		1.1 ***	Both scores are 1
R/S	Positive	1.+01 ***	Machine selects 1. I lose
		1.2 ***	
R/S	Positive	1.+01 ***	I lose again
		1.3 ***	
CHS, R/S	Will it get the sequence?	-1.-01 ***	Yes! I lose again
		1.4 ***	
R/S	Break the sequence	-1.+01 ***	I win
		2.4 ***	
CHS, R/S	Break again	-1.-01 ***	!! I lose
		2.5 ***	
CHS, R/S	Break new sequence	-1.-01 ***	!! Oh dear
		2.6 ***	Only 1 chance left
CHS, R/S	Never had 3 same signs	-1.-01 ***	!!
Display reads 0.BLISS (inverted). Machine has won.			

5, A	Another game	5.0 ***	Game limit is 5
ETC.			

 <b>1</b>	<b>JACK OF EAGLES</b>	<b>2</b>
 <b>NEW PLAYER</b> (A): GO		<b>OLD PLAYER</b> (A): GO

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	LOAD SIDES 1 and 2 OF PROGRAM CARD		<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
2	START Do ONE of 2a or 2b		<input type="text"/> <input type="text"/>	
2a	For game limit of 7		A <input type="text"/>	7.000 *
2b	For any other goal-score, A: Set A*	A	A <input type="text"/>	A  *
			<input type="text"/> <input type="text"/>	
3	MAKE MOVE Do ONE of 3a or 3b		<input type="text"/> <input type="text"/>	
3a	To select a positive number		R/S <input type="text"/>	M.H *
3b	To select a negative number		CHS R/S <input type="text"/>	M.H *
	M is machine's guess ( $\pm 1$ .), H is human's Selection ( $\pm 01$ ). If M=H, human has been outguessed. If human selected a positive (negative) number, H = +01 (-01)		<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
4	MACHINE MAKES NEW GUESS		<input type="text"/> <input type="text"/>	SH.SM *
	After the analysis of the human's previous moves, the scores are printed (SH is human's score, SM is the machine's).		<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
5	CONTINUE		<input type="text"/> <input type="text"/>	
	Return to 3 until SH or SM = A		<input type="text"/> <input type="text"/>	
	A message is displayed. Invert and read.		<input type="text"/> <input type="text"/>	MESSAGE
			<input type="text"/> <input type="text"/>	
6	FOR NEW GAME, SAME PLAYER		<input type="text"/> <input type="text"/>	
	Do ONE of 6a, 6b		<input type="text"/> <input type="text"/>	
	For goal-score of 7		E <input type="text"/>	7.000 *
	For any other goal-score. Set A*	A	E <input type="text"/>	A  *
	Go to 3		<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
7	FOR NEW GAME, NEW PLAYER		<input type="text"/> <input type="text"/>	
	Go to 2		<input type="text"/> <input type="text"/>	
*	If $ A  > 9$ , the word "Error" is displayed. Press and return to 2 or 7		CLR <input type="text"/>	
	NOTE: TO CHEAT ON ANY MOVE (STEP 3)		<input type="text"/> <input type="text"/>	
	Instead of 3a or 3b		RCL B <input type="text"/>	
			CHS R/S <input type="text"/>	
	This choice must win on the current play		<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	
			<input type="text"/> <input type="text"/>	

# Program Listing I

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLR	21 11		057	X	-35	
002	RCL6	36 06		058	SCI	-12	
003	CLRG	16-53		059	DSP0	-63 00	
004	P2S	16-51		060	PRTX	-14	
005	CLRG	16-53		061	FIX	-11	
006	ST06	35 06		062	DSP1	-63 01	
007	ST01	22 01		063	RCLB	36 12	
008	*LBLR	21 15		064	RCLA	36 11	
009	0	00		065	X	-35	
010	ST07	35 07		066	SF0	16 21 00	
011	ST08	35 08		067	X<0?	16-45	
012	ST09	35 09		068	CF0	16 22 00	
013	*LBL1	21 01		069	8	00	
014	R4	-31		070	ST01	35 46	
015	7	07		071	F0?	16 23 00	
016	F3?	16 23 03		072	ISZI	16 26 46	
017	X2Y	-41		073	ISZ1	16 26 45	
018	ABS	16 31		074	0	00	
019	ST07	35 07		075	ST0B	35 12	
020	÷	-24		076	RCL8	36 08	
021	9	09		077	RCL7	36 07	
022	RCL7	36 07		078	X>Y?	16-34	
023	X>Y?	16-34		079	ST08	22 08	
024	SINH	16 41		080	7	07	
025	1	01		081	7	07	
026	0	00		082	3	03	
027	ST0E	35 15		083	4	04	
028	ST06	22 06		084	RTN	24	
029	*LBL0	21 00		085	*LBL8	21 00	
030	ST0B	35 12		086	RCL9	36 09	
031	RCL8	36 08		087	X2Y	-41	
032	RCL9	36 09		088	X>Y?	16-34	
033	RCL5	36 15		089	ST08	22 08	
034	÷	-24		090	5	05	
035	+	-55		091	5	05	
036	X=0?	16-43		092	1	01	
037	RCL7	36 07		093	7	07	
038	PRTX	-14		094	8	08	
039	R/S	51		095	RTN	24	
040	CF3	16 22 03		096	*LBL8	21 00	
041	X=0?	16-43		097	RCLA	36 11	
042	1	01		098	RCL0	36 00	
043	GSBC	23 13		099	X#0?	16-42	
044	RCLA	36 11		100	GSBC	23 13	
045	X2Y	-41		101	X	-35	
046	ST0A	35 11		102	ST+2	35-55 02	
047	X	-35		103	RCLA	36 11	
048	4	04		104	RCL1	36 01	
049	ST01	35 46		105	X#0?	16-42	
050	R4	-31		106	GSBC	23 13	
051	F0?	16 23 00		107	A	-35	
052	DSZI	16 25 46		108	ST+5	35-55 05	
053	ST+1	35-55 45		109	P2S	16-51	
054	RCLB	36 12		110	RCL8	36 08	
055	RCLA	36 11		111	ST09	35 09	
056	10*	16 37		112	RCL7	36 07	

## REGISTERS

0 G <sub>E</sub>	1 G <sub>s</sub>	2 S <sub>E</sub>	3 a-b	4 d-c	5 S <sub>s</sub>	6 RANDOM #	7 GAME LIMIT	8 HUMAN SCORE	9 MACHINE SCORE
S0	S1	S2	S3	S4 LAST TEN	S5 HUMAN PLAYS	S6	S7	S8	S9
A CURRENT HUMAN CHOICE		B FINAL GUESS		C Q		D P		E 10	
								I USED	

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## Program Listing II

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
113	ST08	35 08		169	RCLC	36 13	
114	RCL6	36 06		170	X <sup>2</sup>	53	
115	ST07	35 07		171	X	-35	
116	RCL5	36 05		172	RCLB	36 12	
117	ST06	35 06		173	+	-55	
118	RCL4	36 04		174	ST08	35 12	
119	ST05	35 05		175	*LBL8	21 08	
120	RCL3	36 03		176	RCLD	36 14	
121	ST04	35 04		177	1	01	
122	RCL2	36 02		178	+	-55	
123	ST03	35 03		179	ST00	35 14	
124	RCL1	36 01		180	9	09	
125	ST02	35 02		181	X>Y?	16-34	
126	RCL0	36 00		182	GT02	22 02	
127	ST01	35 01		183	P <sup>2</sup> S	16-51	
128	RCLA	36 11		184	RCLB	36 12	
129	ST00	35 00		185	ST00	35 00	
130	1	01		186	RCL4	36 04	
131	ST00	35 14		187	F0?	16 23 00	
132	*LBL2	21 02		188	RCL3	36 03	
133	RCLD	36 14		189	RCLA	36 11	
134	ST01	35 46		190	X	-35	
135	RCL1	36 45		191	ST01	35 01	
136	RCL0	36 00		192	RCL2	36 02	
137	X*Y?	16-32		193	RCL0	36 00	
138	GT08	22 08		194	X	-35	
139	1	01		195	X#0?	16-42	
140	ST0C	35 13		196	GT07	22 07	
141	*LBL3	21 03		197	RCL1	36 01	
142	RCLC	36 13		198	RCL5	36 05	
143	ST01	35 46		199	X	-35	
144	RCL1	36 45		200	*LBL7	21 07	
145	X <sup>2</sup> I	16-41		201	ST0B	35 12	
146	RCLD	36 14		202	*LBL6	21 06	
147	+	-55		203	RCLB	36 12	
148	X <sup>2</sup> I	16-41		204	X=0?	16-43	
149	RCL1	36 45		205	GSBB	23 12	
150	X*Y?	16-32		206	GSBC	23 13	
151	GT07	22 07		207	GT00	22 00	
152	RCLD	36 14		208	*LBLB	21 12	
153	RCLC	36 13		209	RCL6	36 06	
154	X=Y?	16-33		210	Pi	16-24	
155	GT07	22 07		211	+	-55	
156	1	01		212	5	05	
157	+	-55		213	Y*	31	
158	ST0C	35 13		214	FRC	16 44	
159	+	-55		215	ST06	35 06	
160	RCLC	36 13		216	.	-62	
161	X>Y?	16-34		217	5	05	
162	GT03	22 03		218	-	-45	
163	*LBL7	21 07		219	RTN	24	
164	RCLD	36 14		220	*LBLC	21 13	
165	1	01		221	ABS	16 31	
166	-	-45		222	LSTX	16-63	
167	ST01	35 46		223	÷	-24	
168	RCL1	36 45		224	RTN	24	

LABELS				FLAGS		SET STATUS		
A NEW PLAYER GO	B RANDOM # GENERATOR	C GET ±1	D	E OLD PLAYER GO	OFF FOR BAD MACHINE CHOICE	FLAGS	TRIG	DISP
a	b	c	d	e	1	ON OFF	DEG <input type="checkbox"/>	FIX <input type="checkbox"/>
0 JUMP	1 JUMP	2 LOOP	3 LOOP	4	2	0 <input type="checkbox"/> <input checked="" type="checkbox"/>	GRAD <input type="checkbox"/>	SCI <input type="checkbox"/>
5	6 JUMP	7 JUMP	8 JUMP	9	3 GAME LIMIT	1 <input type="checkbox"/> <input checked="" type="checkbox"/>	RAD <input type="checkbox"/>	ENG <input type="checkbox"/>
					INPUT?	2 <input type="checkbox"/> <input checked="" type="checkbox"/>		n 0
						3 <input type="checkbox"/> <input checked="" type="checkbox"/>		

## JACK OF EAGLES: THEORY

\*\*\* WARNING! READING THIS MAY SPOIL  
YOUR ENJOYMENT OF THIS GAME.  
READ ONLY TO UNDERSTAND THE  
PROGRAM \*\*\*

The human's choice is converted to -1 if it was negative, and to 1 if it was positive. His most likely next choice is then determined by an analysis of his previous moves and by his "psychology" which the machine attempts to learn during the game. The analysis is based on (a) a "Sequence Extrapolator", described below, which analyses the last 10 human choices and finds all completed and uncompleted patterns of 1 through 5 digits, extrapolates these patterns one digit on, and takes, in effect, a weighted mean of these extrapolations: and on (b) whether the human switches, or keeps to, his last choice on a win/loss: this is the "Switch/Keep Algorithm", also described below. The "psychology" is deduced by keeping track of the success/failure of these analysis schemes - a positive value means more success than failure for the particular scheme. Call these "success scores"  $S_E$  for the extrapolator and  $S_S$  for the switch/keep algorithm.

The final guess is formed as follows.

1. Use the Sequence Extrapolator to get a guess  $G_E$
2. Use the Switch/Keep Algorithm to get a guess  $G_S$
3. Then 3a If  $G_E.S_E \neq 0$ , the guess is  $G_E.S_E = G$   
           3b If  $G_E.S_E = 0$  and  $G_S.S_S \neq 0$ , the guess is  $G_S.S_S = G$   
           3c If  $G_E.S_E = G_S.S_S = 0$ , the guess is random = G
4. Only the sign of the guess is of importance, so the final guess is  $G/|G|$

Switch/Keep Algorithm

Let a be the number of times the human keeps	his choice when that choice won
" b " " " " " " " switches	" " " " " "
" c " " " " " " " "	" " " " " lost
" d " " " " " " " keeps	" " " " " "

Then if the last choice won, the guess is  $G_S = D_0$  (a-b)

" " " " " lost, " " "  $G_S = D_0$  (d-c)

Sequence Extrapolator Algorithm

Let  $P$  be a scan of the last 10 moves, and let  $Q$  be the length of any pattern found. Call the current human choice  $D_0$ , the penultimate one  $D_1$ , etc. The algorithm is:

- a. Set  $G_e = 0$
- b. Set  $P = 1$
- c. Extract  $D_P$
- d. If  $D_0 \neq D_P$ , go to n
- e. Set  $Q = 1$
- f. Extract  $D_Q$
- g. Extract  $D_{P+Q}$
- h. If  $D_Q \neq D_{P+Q}$ , go to 1
- i. If  $Q = P$ , go to 1
- j.  $Q = Q + 1$
- k. If  $(P + Q) < 10$ , go to f
- l.  $G = Q^2 \cdot D_{P-1}$
- m.  $G_e = G_e + G$
- n.  $P = P + 1$
- o. If  $P < N - 1$ , go to c
- p.  $G_e$  is the guess. (But see step 4 above).

No pattern starting at  $P$  exists

Find pength of pattern starting at  $P$

The pattern ends

(The pattern cannot be longer than  $P$  digits)

Increase the length-of-pattern search

Only the last 10 choices are scanned

$G$  is the current extrapolated guess ( $G = \pm 1$ ),  
weighted for the length of the pattern found ( $Q$ ).

Increase choice scan

Continue scan of last 10 choices