

00325D

Program Description I

Program Title CYBERNETIC NIM GAME

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Program Description, Equations, Variables CYBERNETIC NIM IS A SUBTRACTION GAME THAT YOU PLAY AGAINST THE CALCULATOR. WHEN YOU BEGIN, THE CALCULATOR KNOWS ONLY THE RULES OF THE GAME. NO PLAYING STRATEGY IS PROGRAMMED. HOWEVER, EACH TIME YOU WIN, THE CALCULATOR REMEMBERS THE MOVE THAT CAUSED IT TO LOSE AND WILL NOT MAKE THAT SAME MOVE AGAIN. EVENTUALLY THE CALCULATOR WILL PLAY A PERFECT GAME. THE GAME IS PLAYED AS FOLLOWS: YOU BEGIN WITH A NUMBER FROM 5 TO 21. ON EACH TURN YOU OR THE CALCULATOR CAN SUBTRACT 1, 2, OR 3 FROM THE NUMBER. THIS CONTINUES UNTIL SOMEONE MUST TAKE THE LAST 1 AND MAKE THE NUMBER 0. WHOEVER HAS TO DO THIS LOSES. GRANTED, THIS IS A VERY SIMPLE GAME. HOWEVER, THE PURPOSE HERE IS TO DEMONSTRATE THE WAY A COMPUTER CAN BE PROGRAMMED TO 'LEARN'. THE FIRST TIME YOU PLAY CHOOSE A SMALL NUMBER SO THE LEARNING PROCESS IS SHORT AND IS IMMEDIATELY APPARENT. IT IS INTERESTING TO PLOT THE WON/LOST RECORD WHILE PLAYING DUMB AND THEN PLAY YOUR BEST. THE BETTER YOU PLAY, THE FASTER THE LEARNING PROCESS.

Operating Limits and Warnings STEPS 9 & 10 LIMIT THE STARTING VALUE TO A NUMBER OF 21 OR LESS. THE PROGRAM WILL FUNCTION WITH A VALUE NOT GREATER THAN 33 BUT THE LEARNING PROCESS IS VERY LONG (60+ GAMES MAYBE). IF YOU WOULD WANT TO CHANGE THESE STEPS, THE PROGRAM WILL RUN FINE.

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)

Sample Problem(s) IT IS IMPOSSIBLE TO DEMONSTRATE THE LEARNING PROCESS IN THIS MUCH SPACE. HOWEVER, A SAMPLE GAME IS SHOWN TO ILLUSTRATE THE OUTPUTS. A RANDOM NUMBER SEED IS NOT GENERATED SO THE SAMPLE CAN BE DUPLICATED. THE GAME WILL BE PLAYED WITH A STARTING VALUE OF 15. MAKE SURE REGISTER A IS ZERO (RANDOM NUMBER SEED).

Solution(s) 1) 15 $\rightarrow$ 15

2) YOU TAKE 2: 2 $\rightarrow$ 13, -1, 12 (LEAVING 13, CALC TAKES 1 LEAVING 12)

3) YOU TAKE 1: 1 $\rightarrow$ 11, -2, 9 (LEAVING 11, CALC TAKES 2 LEAVING 9)

4) YOU TAKE 3: 3 $\rightarrow$ 6, -3, 3 (LEAVING 6, CALC TAKES 3 LEAVING 3)

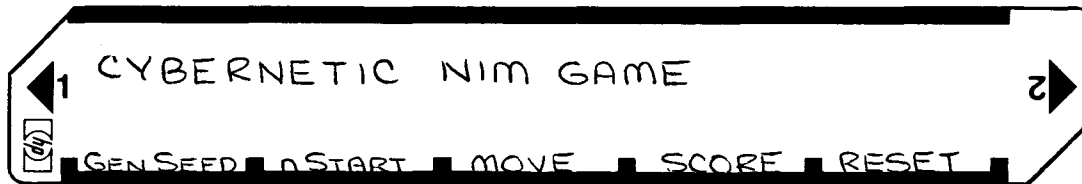
5) YOU TAKE 2: 2 $\rightarrow$ 1, -1, 0, 15 (LEAVING 1, CALC TAKES 1 LEAVING 0 AND LOSES. START AGAIN WITH 15)

6) PRINT SCORE: $\rightarrow$ 1, 0, 15 (YOU LEAD 1 TO 0. DISPLAY RETURNS TO 15)

Reference(s) 65 NOTES, VOL 2 NO 4 PUBLISHED BY HP-65 USERS CLUB, 2541 W. CAMDEN PLACE, SANTA ANA, CALIFORNIA 92704. CYBERNIM PROGRAM BY T. WIRTZ BASED ON HEXAPAWN PROGRAM BY J. RAUSCH.

User Instructions

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STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	LOAD SIDE 1 AND SIDE 2			
2	GENERATE RANDOM NUMBER SEED. AFTER PRESSING [A] ALLOW THE PROGRAM TO RUN A FEW SECONDS, THEN PRESS [R]. YOU CAN OPTIONALLY STORE ANY NUMBER IN REGISTER A.	n	A R/S -OR- STO A	? n
3	SELECT A STARTING VALUE FROM 5 TO 21	5 TO 21	B	VALUE
4	MOVE. IF YOU WANT THE CALCULATOR TO MOVE FIRST JUST PRESS [C]. THIS IS PERMITTED ONLY ON THE FIRST MOVE OF A GAME. IF YOU WANT TO MOVE, ENTER 1, 2, OR 3 AND PRESS [C]. THE FOLLOWING WILL BE DISPLAYED: 1) THE RESULT OF YOUR MOVE. 2) THE CALCULATOR'S MOVE WITH A MINUS SIGN TO IDENTIFY IT. 3) THE RESULT OF THE CALCULATOR'S MOVE. IF EITHER YOU OR THE CALCULATOR TAKE THE LAST ONE, THE STARTING VALUE WILL BE DISPLAYED FOR A NEW GAME RIGHT AFTER THE ZERO RESULT. REPEAT STEP 4 ALL YOU WANT.	FIRST MOVE OF GAME ↓ NOTHING -OR- 1, 2, 3	C OR C	SEE TEXT
5	DISPLAY SCORE		D	YOUR WINS/LOSSES
6	RESET-- THIS ALLOWS YOU TO RE-ENTER A STARTING VALUE. NORMALLY [A] IS PROTECTED SO YOU WON'T WIPE OUT MEMORY.		E	
	NOTE: AFTER COMPLETING A GAME YOU CAN WRITE THE CONTENTS OF MEMORY TO A CARD AND START UP LATER WHERE YOU LEFT OFF. DO THE FOLLOWING: ISSUE A WRITE/DATA COMMAND FROM THE KEYBOARD, THEN WRITE A DATA CARD. TO RESTART: COMPLETE STEPS 1 THRU 3 USING THE SAME VALUE. READ IN THE DATA CARD.			

Program Listing I

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	* LBL A	2111	LOOP TO GENERATE RANDOM NUMBER SEED.		PRINT X	-14	CALCULATORS MOVE. IF NOT FIRST MOVE IN GAME, ERROR. INDICATE NOT FIRST MOVE. GENERATE RANDOM MOVE FROM 1 TO 3. SET LOOP FOR 3 ITERATIONS
	f π	16-24			f X=0	16-43	
	+	-55			GTO 5	2205	
	STO A	3511		060	STO 0	3500	
	GTO A	2211			GTO 2	2202	
	* LBL B	2112			* LBL 1	2101	
	f F? 0	162300			f F? 1	162301	
	GTO fe	221615			GTO fe	221615	
	2	02			* LBL 2	2102	
010	2	02			f STE 1	162101	
	f X≤Y	16-35	START. VALIDATES STARTING VALUE. ESTABLISHES MOVE CUES BY RAISING 2 TO THE POWER OF THE STARTING VALUE AND REMOVING THE MOVES THAT ARE NOT PERMITTED FOR A GIVEN VALUE. FOR EXAMPLE, YOU CAN'T TAKE 2 WHEN THERE IS ONLY ONE LEFT.		RCL A	3611	CALCULATORS MOVE. IF NOT FIRST MOVE IN GAME, ERROR. INDICATE NOT FIRST MOVE. GENERATE RANDOM MOVE FROM 1 TO 3. SET LOOP FOR 3 ITERATIONS
	GTO e	221615			f π	16-24	
	CLX	-51			+	-55	
	S	05		070	X2	53	
	f X>Y	16-34			f FRAC	1644	
	GTO e	221615			STO A	3511	
	f STE 0	162100			3	03	
	f CL REG	16-53			X	-35	
	CLX	-51			f INT	1634	
020	2	02			1	01	
	XZY	-41	MOVE. IF DATA FLAG IS NOT ON, GO TO CALCULATORS MOVE. VALIDATE MOVE. THEN SUBTRACT FROM VALUE AND PRINT RESULT. IF 0, GO TO LOSE.		+	-55	LOOP. WILL TRY ALL THREE POSSIBILITIES. 2 IS RAISED TO THE POWER OF THE CURRENT VALUE AND DIVIDED INTO THE CUES FOR THE MOVE. IF THE RESULT HAS A FRACTIONAL PART ≥ .5 THE MOVE HAS NOT PREVIOUSLY CAUSED A LOSS AND IT IS MADE. IF NO MOVES ARE FOUND THAT WON'T CAUSE A LOSS, THE PRIOR MOVE THAT PUT THINGS HERE IS REMOVED FROM ITS CUE, AND THE MOVE IS MADE 1 FOR NOW.
	STO B	3512			STO 4	3504	
	Y*	31			2	02	
	2	02		080	RCL 0	3600	
	-	-45			Y*	31	
	STO 1	3501			STO 5	3505	
	2	02			3	03	
	-	-45			STO I	3546	
	STO 2	3502			* LBL 3	2103	
030	4	04			3	03	
	-	-45	MOVE. IF DATA FLAG IS NOT ON, GO TO CALCULATORS MOVE. VALIDATE MOVE. THEN SUBTRACT FROM VALUE AND PRINT RESULT. IF 0, GO TO LOSE.		RCL 4	3604	LOOP. WILL TRY ALL THREE POSSIBILITIES. 2 IS RAISED TO THE POWER OF THE CURRENT VALUE AND DIVIDED INTO THE CUES FOR THE MOVE. IF THE RESULT HAS A FRACTIONAL PART ≥ .5 THE MOVE HAS NOT PREVIOUSLY CAUSED A LOSS AND IT IS MADE. IF NO MOVES ARE FOUND THAT WON'T CAUSE A LOSS, THE PRIOR MOVE THAT PUT THINGS HERE IS REMOVED FROM ITS CUE, AND THE MOVE IS MADE 1 FOR NOW.
	STO 3	3503			1	01	
	* LBL 0	2100			+	-55	
	f CLF 1	162201		090	f X>Y	16-34	
	f CLF 3	162203			1	01	
	RCL B	3612			STO 4	3504	
	STO 0	3500			f XZT	16-41	
	f SPACE	16-11			RCL (i)	3545	
	PRINT X	-14			XZY	-41	
040	RTN	24			f XZT	16-41	
	* LBL C	2113	MOVE. IF DATA FLAG IS NOT ON, GO TO CALCULATORS MOVE. VALIDATE MOVE. THEN SUBTRACT FROM VALUE AND PRINT RESULT. IF 0, GO TO LOSE.		XZY	-41	LOOP. WILL TRY ALL THREE POSSIBILITIES. 2 IS RAISED TO THE POWER OF THE CURRENT VALUE AND DIVIDED INTO THE CUES FOR THE MOVE. IF THE RESULT HAS A FRACTIONAL PART ≥ .5 THE MOVE HAS NOT PREVIOUSLY CAUSED A LOSS AND IT IS MADE. IF NO MOVES ARE FOUND THAT WON'T CAUSE A LOSS, THE PRIOR MOVE THAT PUT THINGS HERE IS REMOVED FROM ITS CUE, AND THE MOVE IS MADE 1 FOR NOW.
	f F? 3	162303			RCL 5	3605	
	f F? 3	162303			÷	-24	
	GTO 1	2201		100	f FRAC	1644	
	f X>0	16-44			.	-62	
	f X=0	16-43			S	05	
	GTO fe	221615			f X≤Y	16-35	
	3	03			GTO 4	2204	
	XZY	-41			f DSZ I	162546	
050	f X>Y	16-35			GTO 3	2203	
	GTO fe	221615	MOVE. IF DATA FLAG IS NOT ON, GO TO CALCULATORS MOVE. VALIDATE MOVE. THEN SUBTRACT FROM VALUE AND PRINT RESULT. IF 0, GO TO LOSE.		RCL 6	3606	LOOP. WILL TRY ALL THREE POSSIBILITIES. 2 IS RAISED TO THE POWER OF THE CURRENT VALUE AND DIVIDED INTO THE CUES FOR THE MOVE. IF THE RESULT HAS A FRACTIONAL PART ≥ .5 THE MOVE HAS NOT PREVIOUSLY CAUSED A LOSS AND IT IS MADE. IF NO MOVES ARE FOUND THAT WON'T CAUSE A LOSS, THE PRIOR MOVE THAT PUT THINGS HERE IS REMOVED FROM ITS CUE, AND THE MOVE IS MADE 1 FOR NOW.
	RCL 0	3600			STO I	3546	
	XZY	-41			RCL 7	3607	
	f X>Y	16-35		110	2	02	
	GTO fe	221615			÷	-24	
	-	-45			STO-(i)	35-4545	

REGISTERS

CURRENT VALUE	1 CUES FOR MOVE 1	2 CUES FOR MOVE 2	3 CUES FOR MOVE 3	4 CURRENT MOVE	5 CURRENT 2 VALUE	6 PRIOR MOVE	7 PRIOR 2 VALUE	8 YOUR WINS	9 YOUR LOSSES
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
A RANDOM NUMBER SEED	B VALUE			C	D	E	I USED		

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STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
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LABELS					FLAGS	SET STATUS		
A GEN SEED	B n START	C MOVE	D SCORE	E RESET	0 ON-NO START			
a	b	c	d	e "error"	1 ON-NOT 1ST MOVE	ON OFF	DEG ☒	FIX ☒
0 START GAME	1 CALC FIRST	2 CALC MOVE	3 MOVE LOOP	4 MAKE MOVE	2	0 ☐ ☒	GRAD ☐	SCI ☐
5 LOSE	6	7	8	9	3 DATA ENTRY	1 ☐ ☒	RAD ☐	ENG ☐
						2 ☐ ☒		n <u>0</u>
						3 ☐ ☒		