

A Chessboard Journey on the TI-59 Programmable Calculator

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KTTOUR-59 (see listing 1) is a program for the Texas Instruments TI-59 that finds *Knight tours* on an 8 by 8 board. (A Knight tour is a journey on a chessboard where the Knight lands on each square exactly once.)

To begin, partition the calculator memory locations into 320 program lines and 90 addressable memory locations by pressing 9, *Op, 17. Then enter the program and press B. This initializes values in registers 00 thru 89 as shown in figure 1. The actual chessboard is represented by registers 11 thru 18, 21 thru 28, . . . 81 thru 88. After setting up this initial configuration, the program returns with the display value 0. Enter the initial square number and press C. The program will then move the Knight at

the approximate rate of one move every 33 seconds according to the Rule of Warnsdorf. That is, it will always move the Knight to a square having, at that point in the tour, a minimal number of entrances.

Execution stops with the display value 0 as soon as no additional moves can be found. Pressing D causes the program to flash each move in the format "square.move" (eg: "13.07" means the seventh move was made on square number 13). This allows the user to write down the complete tour on graph paper. If used in conjunction with the Texas Instruments PC-100A printer, a hard copy of the tour is produced using the same format. Then for a dif-

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Listing 1: KTTOUR-59, written for the Texas Instruments TI-59.

Loc.	Keys	Comments
000	9 STO 50	Start with 9 exits.
003	8 STO 09	Prepare to test 8 jumps.
006	RCL *IND 09 SUM 10	Put KT on test square.
010	SUB 0 91 INV *x=t 0 61	Test for legal move.
017	8 STO 00	Prepare to count exits.
020	1 STO 89	One exit has been found.
023	RCL *IND 00 SUM 10	Put KT on potential exit.
027	SUB 0 91 INV *x=t 0 37	Test for legal exit.
034	1 SUM 89	Increase exit count.
037	*DSZ 0 0 23	Next potential exit.

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Listing 1 continued:

041		2	1	+/-	SUM	10				Return KT to test square.
046		RCL	50	$x \geq t$	RCL	89	$*x \geq t$	0	60	Test for new minimum.
054		STO	50	RCL	10	STO	20			New minimum and position.
060		*CP								
061		*DSZ	9	0	06					Next test square.
065		2	1	+/-	SUM	10				Return KT to last square.
070		RCL	10	-	RCL	20	=	$*x = t$	2	10
079		RCL	*IND	10	STO	*IND	20	RCL	20	Stop if no move possible.
		STO	10	1	SUM	*IND	10			Move knight.
090	RST									Look for further moves.
091	RCL	10	$x \geq t$	1	0	$*x \geq t$	1	07		
		8	9	$x \geq t$	$*x \geq t$	1	07			Test for correct range.
105	RCL	*IND	10	*CP	INV	SUB				Return 0 for legal move.
109	*LBL	B								Prepare board for tour.
		*CMS	8	0	STO	00	8	+/-		
		STO	*IND	00	*Op	30	STO	*IND		
		00	SUM	00	*DSZ	0	1	18		Fill border squares.
130		2	STO	01	STO	07	4	STO	03	
		STO	05	x^2	STO	04	7	STO	02	
		STO	06	2	1	+/-	STO	08		Load jump increments.
153	CLR	R/S								
155	*LBL	C								Make first move.
		STO	10	STO	20	1	STO	*IND	10	RST
										Begin search.
165	*LBL	D	*Fix	2						Display Routine.
169		8	STO	00						Prepare row index.
172		8	STO	09						Prepare column index.
175		RCL	00	\times	1	0	+	RCL	09	
		=	STO	89	+	RCL	*IND	89	\div	
		1	0	0	=	Pause	Pause	Pause	*Prt	Display "square.move".
198		*DSZ	9	1	75	*Adv				Next column.
203		*DSZ	0	1	72					Next row.
207	CLR	INV	*Fix	R/S						

Desk-Top Wonders

00	01	02	03	04	05	06	07	08	09
0	2	7	4	16	4	7	2	-21	-8
10	-8	0	0	0	0	0	0	0	-8
20	-8	0	0	0	0	0	0	0	-8
30	-8	0	0	0	0	0	0	0	-8
40	-8	0	0	0	0	0	0	0	-8
50	-8	0	0	0	0	0	0	0	-8
60	-8	0	0	0	0	0	0	0	-8
70	-8	0	0	0	0	0	0	0	-8
80	-8	0	0	0	0	0	0	0	0

Figure 1: Register initialization assignments. The values are assigned as shown for an 8 by 8 playing area. Usable squares are identified by a zero value; the board size can be reduced by manually assigning nonzero values to eliminate squares.

11	12	13	14	15
1	20	9	14	3
21	22	23	24	25
10	15	2	19	24
31	32	33	34	35
21	8	23	4	13
41	42	43	44	45
16	11	6	25	18
51	52	53	54	55
7	22	17	12	5

Figure 2: Example of a reduced-size board. The Knight tour shown here is the result of KTTour-59's version of the Rule of Warnsdorf applied to a starting position of 11.

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ferent tour, press B, enter a new starting position, and proceed as before.

The program execution can be modified to find tours on subsets of the 8 by 8 board. Press B as before. Then enter a nonzero value (say 1) into any square you wish to eliminate before entering the initial square and pressing C. This works since the Knight is not allowed to move to squares containing a nonzero value. For example, press B and then store the value 1 into registers 16, 17, 26, 27, 36, 37, 46, 47, 56, 57, 61 thru 67, and 71 thru 77. Enter the initial position of 11 and press C. The result will be the 5 by 5 tour shown in figure 2. ■

Acknowledgments

M Kraitchik, *le Probleme du Cavalier*, Gauthiers-Villars et C^{ie}, Paris, 1927.

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