

A Magic Rook's Tour

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A *tour* of a chessboard by a given chess piece is a sequence of moves by that piece such that each square of the chessboard is occupied once and only once during the journey. The tour is said to be *reentrant* if the chess piece can move from the last square of the tour directly back to the first square of the tour. Tours are possible by the King, Queen, Rook, and Knight, but not by a Bishop.

When the occupied squares are successively numbered 1, 2, 3, 4, . . . , the tour is known as a *magic tour* if the resulting numbered array is a magic square. The tour is a *semi-magic tour* if the result is only a semi-magic square (rows and columns add up to the magic constant, but the two diagonals do not both add up to the magic constant.)

On the standard 8×8 chessboard, a reentrant magic king's tour is known [1]. This is also a reentrant magic queen's tour. No fully magic knight's tour is known, but there is a lot of literature on semi-magic knight tours [1-5].

We now round out our knowledge of magic tours by presenting a reentrant magic rook's tour (Figure 1), believed to be new. For the reader's convenience, we reproduce the reentrant magic king's tour in Figure 2, and a reentrant semi-magic knight's tour in Figure 3.

61	62	63	64	1	2	3	4
12	11	10	9	56	55	45	53
20	19	18	48	17	47	46	45
60	59	58	8	57	7	6	5
37	38	39	25	40	26	27	28
13	14	15	49	16	50	51	52
21	22	23	24	41	42	43	44
36	35	34	33	32	31	30	29

Figure 1: Magic Rook's Tour

61	62	63	64	1	2	3	4
60	11	58	57	8	7	54	5
12	59	10	9	56	55	6	53
13	14	15	16	49	50	51	52
20	19	18	17	48	47	46	45
21	38	23	24	41	42	27	44
37	22	39	40	25	26	43	28
36	35	34	33	32	31	30	29

Figure 2: Magic King's Tour

46	55	44	19	58	9	22	7
43	18	47	56	21	6	59	10
54	45	20	41	12	57	8	23
17	42	53	48	5	24	11	60
52	3	32	13	40	61	34	25
31	16	49	4	33	28	37	62
2	51	14	29	64	39	26	35
15	30	1	50	27	36	63	38

Figure 3: Semi-Magic Knight's Tour

References

- [1] W. W. Rouse Ball, *Mathematical Recreations and Essays*, 11th edition (with corrections). The Macmillan Company. New York: 1960.
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- [3] S. W. Golomb, "Of Knights and Cooks and the Game of Cheskers", *Journal of Recreational Mathematics*. **1.3**(1966)130–138.
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- [5] T. H. Willcocks, "Th Construction of Magic Knight Tours", *Journal of Recreational Mathematics*. **1.3**(1968)225–233.