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Minimal Critical Set of a Room Square of order 7

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Abstract

A Room square R of order r is an $r \times r$ array each of whose cells may either be empty or contain an unordered pair of objects $0, 1, 2, \dots, r$, subject to the following conditions:

- (i) each of the objects $0, 1, 2, \dots, r$ occurs precisely once in each row of R and precisely once in each column of R , and
- (ii) every possible unordered pair of objects occurs precisely once in the whole array.

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Minimal Critical Set of a Room Square of order 7

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A *Room square* R of order r is an $r \times r$ array each of whose cells may either be empty or contain an unordered pair of objects $0, 1, 2, \dots, r$, subject to the following conditions :

- (i) each of the objects $0, 1, 2, \dots, r$ occurs precisely once in each row of R and precisely once in each column of R , and
- (ii) every possible unordered pair of objects occurs precisely once in the whole array.

A *critical set* $Q = [Q_1, Q_2, Q_3, \dots, Q_c]$, $|Q| = c$, in a Room square R of order r , is a set of quadruples $Q_a = [i, j; k, l]$ such that if any Q_a is removed from the set, it can no longer be uniquely completed. In Q_a , (i, j) shows the position of the pair (k, l) in the square. A *minimal critical set* (*min. cs*) of a Room square R of order r is a critical set of minimum cardinality.

Through computer search, we have found a critical set of size 10 for a Room square of order 7. We believe that critical set of size 10 given below is the minimal because critical set of size 9 could not be found. We also note that its size is less than $r^2/4$.

Example A minimal critical set in a Room square of order 7 and its completion.

0 7	**	3 4	5 6	**	**	**
**	1 7	**	**	**	**	3 5
**	**	2 7	**	**	**	**
**	**	**	**	1 5	**	**
**	0 3	**	**	**	**	**
**	**	**	2 4	0 6	**	**
**	**	**	**	**	**	**

0 7	--	3 4	5 6	--	--	1 2
4 6	1 7	--	--	--	0 2	3 5
--	4 5	2 7	0 1	--	3 6	--
--	2 6	--	3 7	1 5	--	0 4
2 5	0 3	1 6	--	4 7	--	--
1 3	--	--	2 4	0 6	5 7	--
--	--	0 5	--	2 3	1 4	6 7

where "*" shows the unknown pair positions and "--" shows empty positions in the Room square.

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