

Generalized Neighbor Designs in Circular Blocks

¹Munir Akhtar, ²Rashid Ahmed and ³Farrukh Shehzad

¹COMSATS Institute of Information Technology Wah Campus, Pakistan

²Department of Statistics The Islamia University of Bahawalpur, Pakistan

³ National College of Business Administration and Economics Lahore, Pakistan

Abstract: Neighbor balanced designs have their own importance in the experiments where the performance of a treatment is affected by the treatments applied to its adjacent plots. Unfortunately these designs satisfy fairly restrictive combinatorial constraints, therefore, most of these designs require large number of blocks. In such situations, generalized neighbor designs are recommended to avoid a large number of blocks. Generalized neighbor designs are useful in serology as well as in field experiments. In this article, generalized neighbor designs are presented for $3 \leq k \leq 10$ and $v \leq 50$. All these designs are binary and circular.

Key words: Neighbor designs • Generalized neighbor designs • Neighbor effects • Circular binary blocks

INTRODUCTION

Rees [1] introduced neighbor designs in serology and defined it as a collection of circular blocks in which any two distinct treatments appear as neighbors equally often. In agro forestry intercropping experiments, there also arises the design problem. As trees are much taller than the crop, there is a neighbor effect through interplant competition (see Monod [2]). Clearly, in this situation neighbor balance between the treatments must be looked for. Neighbor designs satisfy fairly restrictive combinatorial constraints, therefore, most of these designs require large number of blocks. In many field experiments such as agriculture, it is impossible to have as much replications as are needed for most of the neighbor designs. Wilkinson *et al.* [3] defined a design to be partially neighbor-balanced if each experimental treatment has other treatment as a neighbor, on either side, at most once. To make neighbor designs more useful and flexible. Misra *et al.* [4] suggested relaxing the condition of the constancy of λ' (number of times each pair of distinct treatments appears as neighbors) and proposed generalized neighbor designs. Azais *et al.* [5] considered designs in linear blocks with border plots in which a treatment may affect the response on the two adjacent plots. They also constructed partially neighbor-balanced designs in few complete blocks. Chaure and

Misra [6] constructed generalized neighbor designs for different cases. Mishra [7] constructed families of proper generalized neighbor designs. Kedia and Misra [8] constructed some series of generalized neighbor designs which are obtained by developing the initial blocks. They constructed GN_2 -designs for (i) $v = 3t+1$, $k = 4$, (ii) $v = 5t+1$, $k = 4$, (iii) $v = 6t+1$, $k = 4$, (iv) $v = 7t+1$, $k = 6$. They also constructed GN_2 -designs for (i) $v = 5t+1$, $k = 4$ and (ii) $v = 6t+1$, $k = 6$, where v is the number of treatments, k is block size and t is positive integer. Ahmed *et al.* [9] proposed the GN_2 -designs for (i) $v = 2t+1$, $k = t+i$, $t > i$, $1 \leq i \leq 3$ and (ii) $v = 2t$, $k = t+i$, $t > i+1$, $1 \leq i \leq 3$.

In this article, GN_2 -designs are constructed for v treatments in b circular blocks of k plots in which each treatment is a neighbor of every other treatment exactly 1 or 2 times. These designs are economical and thought to be closest to the neighbor balanced designs. Here, our main objective is to study the neighboring effects along with the main effects of the treatments. The list of these designs is very useful for practitioners to choose. In section 2, these GN_2 -designs are presented for v up to 50 with $3 \leq k \leq 10$. All our proposed designs are obtained by developing the initial block(s) cyclically mod v .

Generalized Neighbor Designs : In this section, GN_2 -designs are presented in circular binary blocks for $3 \leq k \leq 10$ which are economical.

GN₂-designs for k = 3

Example 2.1. Following is GN₂-design generated for v = 8 and k = 3 by developing two initial blocks (0,1,3) and (0,3,7) cyclically mod 8.

B ₁ = (0,1,3),	B ₂ = (1,2,4),	B ₃ = (2,3,5),	B ₄ = (3,4,6),
B ₅ = (4,5,7),	B ₆ = (5,6,0),	B ₇ = (6,7,1),	B ₈ = (7,0,2),
B ₉ = (0,3,7),	B ₁₀ = (1,4,0),	B ₁₁ = (2,5,1),	B ₁₂ = (3,6,2),
B ₁₃ = (4,7,3),	B ₁₄ = (5,0,4),	B ₁₅ = (6,1,5),	B ₁₆ = (7,2,6)
5	(0,1,3)		
6	(0,1,3)		
8	(0,1,3), (0,3,7)		
11	(0,1,3), (0,4,9)		
14	(0,1,3), (0,4,9), (0,6,13)		
17	(0,1,3), (0,4,9), (0,6,13)		
20	(0,1,3), (0,4,9), (0,6,13), (0,8,18)		
22	(0,1,3), (0,4,12), (0,5,11), (0,7,16)		
23	(0,1,3), (0,4,9), (0,6,13), (0,8,19)		
24	(0,1,3), (0,4,12), (0,6,13), (0,5,14)		
26	(0,1,3), (0,4,9), (0,6,13), (0,8,18), (0,11,23)		
28	(0,1,3), (0,4,14), (0,5,11), (0,7,15), (0,9,21)		
29	(0,1,3), (0,4,9), (0,6,13), (0,8,18), (0,12,26)		
30	(0,1,3), (0,5,14), (0,6,13), (0,4,15), (0,8,20)		
32	(0,1,3), (0,4,9), (0,6,16), (0,7,15), (0,11,23), (0,13,27)		
34	(0,1,3), (0,4,9), (0,6,17), (0,7,19), (0,8,18), (0,13,17)		
35	(0,1,3), (0,4,9), (0,6,13), (0,8,18), (0,2,14), (0,3,14)		
38	(0,1,3), (0,4,9), (0,6,19), (0,7,15), (0,10,21), (0,12,26), (0,16,34)		
40	(0,1,3), (0,4,9), (0,6,20), (0,7,15), (0,10,27), (0,12,23), (0,16,34)		
41	(0,1,10), (0,2,21), (0,3,20), (0,4,18), (0,5,16), (0,6,8), (0,19,34), (0,12,25)		
44	(0,1,10), (0,2,21), (0,3,20), (0,4,18), (0,5,16), (0,6,13), (0,8,23), (0,12,34)		
46	(0,1,10), (0,2,21), (0,3,20), (0,4,18), (0,5,16), (0,6,13), (0,8,23), (0,12,34)		
47	(0,1,10), (0,2,21), (0,3,20), (0,4,18), (0,5,16), (0,6,13), (0,8,23), (0,12,34)		
50	(0,4,9), (0,6,13), (0,8,25), (0,10,26), (0,11,18), (0,13,28), (0,2,14), (0,1,20), (0,3,23)		

2.2. GN₂-designs for k = 4

v	Initial Blocks
7	(0,1,3,6)
10	(0,1,3,6), (0,2,7,3)
11	(0,1,3,6), (0,4,10,7)
14	(0,1,3,6), (0,4,9,2)
15	(0,1,3,6), (0,4,9,1)
18	(0,1,3,6), (0,4,9,16), (0,8,17,3)
19	(0,1,3,6), (0,4,9,16), (0,8,17,7)
22	(0,1,3,6), (0,5,12,8), (0,9,19,8)
23	(0,1,3,6), (0,5,12,8), (0,9,19,7)
26	(0,1,3,6), (0,4,9,16), (0,8,17,2), (0,4,16,3)
27	(0,1,3,6), (0,4,9,16), (0,8,17,2), (0,1,11,24)
30	(0,1,3,6), (0,4,9,16), (0,8,28,9), (0,12,25,10)
31	(0,1,3,6), (0,4,9,16), (0,8,29,9), (0,12,25,8)
34	(0,1,3,6), (0,4,9,16), (0,8,32,9), (0,12,25,5), (0,4,19,2)
35	(0,1,3,6), (0,4,9,16), (0,8,33,9), (0,12,25,4), (0,6,21,3)
38	(0,1,3,6), (0,4,9,16), (0,8,36,9), (0,26,1,15), (0,17,35,16)
39	(0,1,3,6), (0,4,9,16), (0,8,37,9), (0,27,1,15), (0,17,35,15)
42	(0,1,3,6), (0,4,9,16), (0,8,40,9), (0,30,1,15), (0,17,35,12), (0,2,22,1)
43	(0,1,3,6), (0,4,9,16), (0,8,41,9), (0,31,1,15), (0,17,35,11), (0,3,23,1)
46	(0,1,3,6), (0,4,9,16), (0,8,44,8), (0,34,1,15), (0,29,1,20), (0,23,45,20)
47	(0,1,3,6), (0,4,9,16), (0,8,45,9), (0,35,1,15), (0,30,1,20), (0,23,45,19)
50	(0,1,3,6), (0,4,9,16), (0,8,48,9), (0,38,1,15), (0,33,41,10), (0,23,45,16), (0,24,49,22)

2.3. GN₂-designs for k = 5

v	Initial Blocks
12	(0,1,3,6,10), (0,1,4,10,5)
13	(0,1,3,6,10), (0,1,3,9,4)
14	(0,1,3,6,10), (0,1,6,12,5)
17	(0,1,3,6,10),(0,1,6,12,3)
18	(0,1,3,6,10),(0,5,11,2,9)
19	(0,1,3,6,10),(0,5,11,18,7)
22	(0,1,3,6,10),(0,5,1118,4),(0,9,19,8,9)
23	(0,1,3,6,10),(0,5,11,18,3),(0,9,19,7,8)
24	(0,1,3,6,10),(0,5,11,18,2),(0,9,19,6,18)
27	(0,1,3,6,10),(0,5,11,18,1),(0,9,20,5,18)
28	(0,1,3,6,10),(0,5,27,6,14),(0,9,20,4,17)
29	(0,1,3,6,10),(0,5,28,6,14),(0,9,20,3,16)
32	(0,1,3,6,10),(0,5,31,6,14),(0,9,20,1,16),(0,1,3,6,18)
33	(0,1,3,6,10),(0,5,32,6,14),(0,9,20,1,14),(0,1,4,19,2)
34	(0,1,3,6,10),(0,5,33,6,14),(0,9,20,2,15),(0,1,16,2,19)
37	(0,1,3,6,10),(0,5,36,6,14),(0,9,20,32,8),(0,15,31,11,29)
38	(0,1,3,6,10),(0,5,37,6,14),(0,9,20,32,19),(0,15,31,10,28)
39	(0,1,3,6,10),(0,5,38,6,14),(0,9,20,32,19),(0,15,31,9,27)
42	(0,1,3,6,10),(0,5,41,6,14),(0,9,20,8,21),(0,15,31,6,24),(0,2,5,24,2)
43	(0,1,3,6,10),(0,5,42,6,14),(0,9,20,8,21),(0,15,31,5,23),(0,1,3,6,25)
44	(0,1,3,6,10),(0,5,43,6,14),(0,9,20,8,21),(0,15,31,4,22),(0,6,9,28,4)
47	(0,1,3,6,10),(0,5,46,6,14),(0,9,20,8,21),(0,15,31,1,19),(0,1,21,43,19)
48	(0,1,3,6,10),(0,5,47,6,14),(0,9,20,8,21),(0,15,31,1,20),(0,17,39,14,38)
49	(0,1,3,6,10),(0,5,48,6,14),(0,9,20,8,21),(0,15,31,1,20),(0,20,42,16,40)

2.4. GN₂-designs for k = 6

v	Initial Blocks
11	(0,1,3,6,10,4)
14	(0,2,3,6,10,1),(0,6,13,1,4,8)
15	(0,1,3,6,10,2),(0,5,11,14,3,8)
16	(0,1,3,6,10,15),(0,6,13,5,7,10)
17	(0,1,3,6,10,15), (0,6,13,4,5,8)
20	(0,1,3,6,10,16), (0,5,12,1,9,19)
21	(0,1,3,6,10,16), (0,7,16,3,13,14)
22	(0,1,3,6,10,15), (0,6,15,1,13,2)
23	(0,1,3,6,10,15), (0,6,13,22,9,20)
26	(0,1,3,6,10,15), (0,6,13,21,4,14),(0,11,24,25,1,4)
27	(0,1,3,6,10,15), (0,6,14,21,3,13),(0,11,23,24,26,3)
28	(0,1,3,6,10,15), (0,6,14,21,2,12),(0,11,25,26,1,5)
29	(0,1,3,6,10,15), (0,6,14,21,1,11), (0,12,25,26,28,3)
32	(0,1,3,6,10,15), (0,6,14,21,30,8), (0,11,23,4,18,2)
33	(0,1,3,6,10,15), (0,6,14,21,30,7), (0,11,23,3,17,1)
34	(0,1,3,6,10,17), (0,6,14,19,28,18), (0,11,23,2,16,31)
35	(0,1,3,6,10,15), (0,6,14,21,12,22),(0,11,23,2,18,1)
38	(0,1,3,6,10,15), (0,8,14,21,12,22), (0,11,23,36,12,29), (0,18,37,1,2,5)
39	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,12,23,36,11,27), (0,18,37,38,1,4)
40	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,23,36,10,26), (0,17,36,16,18,19)
41	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,23,36,9,25), (0,18,35,14,15,17)
44	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,24,36,6,23), (0,16,34,9,29,30)
45	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,23,36,5,21), (0,17,35,9,29,30)
46	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,23,36,4,20), (0,17,35,8,29,6)
47	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,23,36,3,19), (0,17,35,8,29,5)
50	(0,1,3,6,10,15), (0,6,14,21,12,22), (0,11,23,36,2,19), (0,14,32,2,23,46), (0,24,49,1,4,8)

2.5.	GN ₂ -designs for k = 7
v	Initial Blocks
12	(0,1,4,6,10,3,9)
13	(0,1,4,6,10,2,8)
16	(0,1,4,6,10,15,5), (0,7,15,1,2,5,9)
17	(0,1,3,6,10,15,4), (0,7,15,16,1,4,9)
18	(0,1,4,6,10,15,3), (0,8,15,6,7,9,14)
19	(0,1,4,6,10,15,2), (0,7,15,5,6,9,13)
20	(0,3,4,6,10,15,1), (0,7,15,4,14,16,3)
23	(0,3,4,6,10,15,21), (0,7,15,1,11,22,4)
24	(0,3,4,6,10,15,21), (0,7,15,1,10,21,9)
25	(0,3,4,6,10,15,21), (0,8,15,24,9,20,7)
26	(0,3,4,6,10,15,9), (0,7,15,25,10,22,9)
27	(0,3,4,6,10,15,9), (0,8,15,25,9,21,7)
30	(0,1,3,6,10,15,21), (0,7,15,25,6,18,1), (0,14,29,1,4,8,13)
31	(0,1,3,6,10,15,21), (0,7,15,24,4,16,29), (0,14,29,1,3,7,12)
32	(0,1,3,6,10,15,21), (0,7,15,24,2,14,27), (0,14,29,13,15,18,22)
33	(0,1,3,6,10,15,21), (0,7,15,24,1,12,25), (0,14,29,12,15,17,21)
34	(0,1,3,6,10,15,21), (0,7,15,24,1,11,23), (0,14,29,11,28,31,33)
37	(0,1,3,6,10,15,21), (0,7,15,24,34,8,20), (0,13,28,5,23,24,27)
38	(0,1,3,6,10,15,21), (0,7,15,24,34,7,19), (0,13,28,4,20,2,3)
39	(0,1,3,6,10,15,21), (0,7,15,24,34,6,19), (0,12,27,2,18,35,36)
40	(0,1,3,6,10,15,21), (0,7,15,24,34,5,18), (0,12,27,1,17,34,14)
41	(0,1,3,6,10,15,21), (0,7,15,24,34,4,17), (0,15,27,2,16,34,12)
44	(0,1,3,6,10,15,21), (0,7,15,24,34,1,14), (0,12,27,43,16,34,9), (0,20,42,43,1,4,8)
45	(0,1,3,6,10,15,21), (0,7,15,24,34,2,13), (0,14,26,41,12,29,2), (0,19,39,16,17,20,24)
46	(0,1,3,6,10,15,21), (0,7,15,24,34,1,12), (0,14,29,45,16,34,7), (0,20,42,19,20,24,29)
47	(0,1,3,6,10,15,21), (0,8,17,27,38,4,11), (0,12,26,41,10,27,45), (0,19,39,14,37,38,42)
48	(0,1,3,6,10,15,21), (0,7,15,24,34,45,10), (0,12,27,41,9,26,44), (0,19,39,14,36,12,13)

2.6.	GN ₂ -designs for k = 8
v	Initial Blocks
18	(0,2,5,6,11,15,3,10), (0,9,17,1,2,5,10,6)
19	(0,1,4,6,13,17,3,12), (0,9,10,12,15,1,5,11)
20	(0,1,3,6,11,15,2,10), (0,9,10,12,15,1,6,14)
21	(0,2,3,6,10,15,1,9), (0,6,16,17,19,1,5,10)
22	(0,1,3,7,10,15,21,6), (0,8,17,5,16,18,19,4)
23	(0,1,3,6,10,15,21,5), (0,8,17,5,15,16,18,4)
26	(0,1,3,6,10,15,21,2), (0,8,17,1,13,24,11,12)
27	(0,2,3,6,10,15,21,1), (0,8,17,1,13,23,9,11)
28	(0,2,3,6,10,15,21,1), (0,7,1,26,9,21,6,20)
29	(0,1,3,6,10,15,21,28), (0,8,17,27,9,21,5,19)
30	(0,1,3,6,10,15,21,28), (0,9,17,27,8,20,3,18)
31	(0,1,3,6,10,15,21,14), (0,8,17,27,7,19,1,16)
34	(0,1,3,6,10,15,21,28), (0,8,17,27,4,16,29,9), (0,16,31,14,15,17,20,24)
35	(0,1,3,6,10,15,21,28), (0,9,26,18,21,1,29,2), (0,30,9,21,34,14,32,19)
36	(0,1,3,6,10,15,21,28), (0,10,21,30,6,19,33,12), (0,17,33,15,16,18,21,25)
37	(0,1,3,6,10,15,21,28), (0,8,18,29,4,17,31,10), (0,15,32,13,14,16,19,23)
38	(0,1,3,6,10,15,21,28), (0,8,17,28,2,15,29,6), (0,16,34,13,32,33,35,4)
39	(0,1,3,6,10,15,21,28), (0,8,21,30,3,17,32,9), (0,16,33,12,31,32,34,5)
42	(0,1,3,6,10,15,21,28), (0,9,17,27,38,8,21,36), (0,16,33,9,28,6,27,29)
43	(0,1,3,6,10,15,21,28), (0,8,17,27,38,7,20,34), (0,16,33,8,27,4,25,26)
44	(0,1,2,3,4,5,6,7), (0,8,17,27,38,6,19,33), (0,15,32,6,25,1,24,2)
45	(0,1,3,6,10,15,21,28), (0,37,1,11,22,34,2,16), (0,15,33,7,27,3,25,26)
46	(0,1,3,6,10,15,21,28), (0,8,18,27,38,4,17,31), (0,16,33,6,26,1,25,2)
47	(0,1,3,6,10,15,21,28), (0,8,17,27,38,3,16,30), (0,15,31,2,22,43,18,41)
50	(0,1,3,6,10,15,21,28), (0,8,17,28,38,1,13,27), (0,15,31,48,16,35,5,26), (0,22,46,19,44,45,47,3)

2.7.	GN ₂ -designs for k = 9
v	Initial Blocks
11	(0,1,3,6,10,4,9,5,2)
17	(0,1,3,6,10,15,4,11,2)
20	(0,2,3,6,10,15,1,8,16), (0,2,11,1,4,5,10,16,9)
21	(0,2,3,6,10,17,1,7,15), (0,9,19,20,1,4,8,3,10)
22	(0,2,3,7,10,15,21,6,14), (0,10,19,8,9,11,14,18,7)
23	(0,1,3,6,10,15,21,5,13), (0,9,20,21,1,3,7,2,8)
24	(0,1,3,6,10,15,21,4,12), (0,10,19,6,7,9,12,16,11)
25	(0,1,4,6,10,15,21,3,11), (0,10,19,6,7,9,12,17,13)
26	(0,1,3,6,11,15,21,2,10), (0,9,22,7,19,20,22,25,7)
29	(0,1,3,6,10,15,21,28,7), (0,9,19,1,13,26,11,12,14)
30	(0,1,3,7,10,15,21,28,6), (0,10,19,1,12,26,9,24,25)
31	(0,1,3,6,10,15,21,28,5), (0,9,19,30,11,24,7,22,23)
32	(0,1,3,6,10,15,21,28,4), (0,9,19,30,10,23,5,22,6)
33	(0,1,4,6,10,15,21,28,3), (0,11,20,30,9,22,3,18,1)
34	(0,1,3,6,10,15,21,28,2), (0,9,19,30,8,21,2,18,1)
35	(0,1,3,6,10,15,21,28,20), (0,9,19,30,7,20,1,16,33)
38	(0,1,3,6,10,15,21,28,36), (0,9,19,30,4,17,31,8,24), (0,18,35,16,17,20,24,29,6)
39	(0,1,3,6,10,15,21,28,36), (0,9,19,30,3,16,31,6,22), (0,18,37,38,1,5,10,16,23)
40	(0,1,3,6,10,15,21,28,36), (0,9,19,30,2,15,29,4,20), (0,18,35,14,15,17,20,25,31)
41	(0,1,3,6,10,15,21,28,36), (0,9,19,30,2,14,28,3,18), (0,17,36,15,16,18,21,25,31)
42	(0,1,3,6,10,15,21,28,36), (0,9,19,30,2,14,27,1,16), (0,18,35,13,32,11,12,14,17)
43	(0,1,3,6,10,15,21,28,36), (0,9,19,30,42,12,26,41,14), (0,17,35,11,31,9,10,12,15)
44	(0,1,3,6,10,15,21,28,36), (0,9,19,30,42,11,25,40,12), (0,17,35,10,30,7,29,32,33)
47	(0,1,3,6,10,15,21,28,36), (0,9,19,31,44,11,26,42,12), (0,18,37,10,31,6,29,30,32)
48	(0,1,3,6,10,15,21,28,36), (0,11,20,30,43,10,24,40,9), (0,18,37,9,30,5,27,3,4)
49	(0,1,3,6,10,15,21,28,36), (0,9,19,30,42,7,22,38,6), (0,18,37,8,29,2,28,3,4)
50	(0,1,3,6,10,15,21,28,36), (0,9,19,30,42,5,20,36,3), (0,18,37,7,28,1,23,47,22)
2.8.	GN ₂ -designs for k = 10
v	Initial Blocks
12	(0,2,5,6,10,3,9,4,8,11)
13	(0,1,3,7,12,2,6,11,4,10)
19	(0,1,3,6,10,15,2,9,17,7)
22	(0,2,3,7,10,15,21,6,14,1), (0,10,21,1,5,8,13,19,4,12)
23	(0,1,3,6,10,15,21,5,13,22), (0,11,21,1,3,7,12,18,2,10)
24	(0,1,3,6,10,15,22,4,12,21), (0,10,21,9,7,11,16,22,5,13)
25	(0,1,4,6,10,15,21,3,11,20), (0,11,21,8,10,14,17,23,5,13)
26	(0,1,3,6,11,15,21,2,10,19), (0,10,22,7,20,21,23,1,4,9)
27	(0,2,3,6,10,15,21,1,9,18), (0,10,21,6,19,20,22,25,2,7)
28	(0,1,3,6,10,15,21,2,9,17), (0,11,21,6,18,4,5,7,10,15)
29	(0,1,3,6,10,15,21,28,7,16), (0,10,21,4,17,2,3,5,8,12)
32	(0,1,3,6,10,15,21,28,4,13), (0,10,21,1,14,28,11,27,5,6)
33	(0,1,4,6,10,15,21,28,3,12), (0,10,21,1,13,27,9,25,26,28)
34	(0,1,3,6,10,15,21,28,2,11), (0,10,21,33,12,26,8,23,6,7)
35	(0,2,5,6,11,15,21,28,1,10), (0,10,22,33,11,25,5,21,3,4)
36	(0,2,3,6,10,15,21,28,1,9), (0,11,21,33,10,24,3,19,1,18)
37	(0,1,3,6,10,15,21,28,36,8), (0,10,21,33,9,23,1,17,34,15)
38	(0,1,3,6,10,15,21,28,36,27), (0,10,22,35,11,26,4,21,1,20)
39	(0,1,3,6,10,15,21,28,36,27), (0,12,22,35,10,25,2,19,37,17)
42	(0,1,4,6,10,15,21,28,36,3), (0,10,21,34,4,18,33,7,24,1), (0,18,38,17,19,23,28,34,41,10)
43	(0,1,3,6,10,15,21,28,36,2), (0,10,21,33,3,17,32,5,22,40), (0,19,39,17,18,22,27,33,40,10)
44	(0,2,3,6,10,15,21,28,36,1), (0,10,21,33,2,16,31,3,20,38), (0,19,39,16,38,40,43,3,8,15)
45	(0,2,3,6,10,15,21,28,36,), (0,9,20,32,2,15,29,1,17,35), (0,19,40,15,37,39,42,1,6,12)
46	(0,1,3,6,10,15,21,28,36,45), (0,10,21,33,1,14,29,45,16,34), (0,19,39,14,36,13,15,18,22,27)
47	(0,1,3,6,10,15,21,28,36,45), (0,10,21,33,46,13,28,44,14,32), (0,20,39,13,35,11,12,15,19,24)
48	(0,1,3,6,10,15,21,28,36,45), (0,10,21,33,46,12,27,43,13,30), (0,19,39,12,34,9,33,35,36,40)
49	(0,1,3,6,10,15,21,28,36,45), (0,12,22,33,46,11,26,42,10,28), (0,19,39,11,33,7,31,32,34,37)

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