Invariants for 2-Factorizations and Cycle Systems

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ABSTRACT. We propose several invariants for cycle systems and 2-factorizations of complete graphs, and enumerate the 4- and 6-cycle systems of K_9.

1. Introduction

An *r-factorization* of the graph G is a partition of the edge-est of G into edge-disjoint regular factors of degree r; an r-factorization is *uniform* if its factors are mutually isomorphic. Any 1-factorization of a graph G is necessarily uniform; the well-known Oberwolfach problem asks whether there exists, for a given 2-regular graph Q with n vertices, a uniform 2-factorization of the complete graph K_n with n odd into 2-factors, each isomorphic to Q. In spite of a considerable effort, the Oberwolfach problem has been solved only under the additional assumption that all cycles of Q are of the same length (see, e.g., [ABS], [LR]).

An *m-cycle system* is a partition of the edge-set of G into (edge-disjoint) cycles of length m. The existence problem for m-cycle systems has been settled for the case when m is a prime power, as well as for $m \leq 50$; for more details on the existence problem for cycle systems, see [LR].

Results on isomorphism and enumeration of uniform 2-factorizations and cycle systems are less numerous. The best known algorithm for isomorphism testing of 1-factorizations, and of 2-factorizations, respectively, is

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subexponential [CC], [C2]. No polynomial time algorithm for isomorphism testing of 2-factorizations or cycle systems is known. But even when a polynomial time algorithm for isomorphism testing is known, such as in the case of Hamilton cycle decompositions [C], and even when the list of nonisomorphic designs is available (the 122 nonisomorphic Hamilton cycle decompositions of K_9 being a case in point), the problem of identifying designs on the list suggests the use of easily computable *isomorphism invariants* or simply *invariants*. An invariant on a set $\mathbf{D}$ may be viewed as a function I on $\mathbf{D}$ such that for $D_1, D_2 \in \mathbf{D}$, $I(D_1) = I(D_2)$ if D_1 and D_2 are isomorphic. When $I(D_1) = I(D_2)$ if and only if D_1 and D_2 are isomorphic, the invariant I is *complete*. The *sensitivity* of an invariant I for $\mathbf{D}$ is the ratio of the number of isomorphism classes that I distinguishes to the number of nonisomorphic elements of $\mathbf{D}$. (For more details on isomorphism testing and invariant in general, see [C2].) The purpose of this paper is twofold: inspired somewhat by recent work on invariants of 1-factorizations of complete graphs ([DW], [GR]), we first propose several invariants for 2-factorizations of complete graphs and also for cycle systems. Second, we undertake an enumeration of all nonisomorphic cycle systems of the complete graph K_9, making an essential use of the proposed invariants in the process.

2. Invariants

Let $\mathbf{F} = \{F_1, \ldots, F_n\}$ be a (uniform) 2-factorization of K_{2n+1} on the vertex-set V. Call the 2-factors of $\mathbf{F}$ *colours*. A set of invariants which proved fairly sensitive, provided the factors F_i involved do not contain too many triangles, is based on counting two-colored cycles of small length. More precisely, an i-cycle ($i \geq 3$) in K_n is said to be of *type* $[a, b]_i$ if it contains one edge of colour a and the remaining $i-1$ edges of colour b. Let $\alpha[a, b]_i$ be the number of i-cycles of type $[a, b]_i$. For $j = 0, 1, \ldots, n$, let t_{ij} be the number of ordered pairs (a, b) such that $\alpha[a, b]_i = j$, and let $T_i = (t_{ij} : j = 0, 1, \ldots, n)$. The vector T_i is the *bicolour vector* of rank i for $\mathbf{F}$.

For $a \in \{1, 2, \ldots, n\}$, let $\sum_{x \neq a} \alpha[a, x]_i = s_{a,i}$. Let S_i be the sequence of n numbers $s_{a,i}$ arranged in nondecreasing order. The sequence S_i is the *sum-bicolour* sequence of rank i for $\mathbf{F}$.

Clearly, both the bicolour vector and the sum-bicolour sequence are (easily computable) invariants for 2-factorizations of K_{2n+1}.

For example, consider a Hamilton decomposition of K_9 with the four cycles=colours being (123456789), (135247968), (148295736), (158394627)—in that order. Then we have, e.g., $\alpha[2, 1]_3 = 6$, $\alpha[3, 1]_3 = 2$, $\alpha[4, 1]_3 = 1$. Also, $\alpha[2, 3]_3 = 6$, and since no other $\alpha[a, b]$ equals 6, we get $t_{3,6} = 2$. Calculations yield in this case $T_3 = (0420402000)$, $T_4 = (0216120000)$, $T_5 = (1123320000)$, $S_3 = (4, 6, 10, 16)$, $S_4 = (7, 8, 10, 11)$, $S_5 = (4, 9, 11, 12)$.

The following observations are immediate:

$$\sum_j t_{ij} = n(n-1) \ (i \text{ fixed}) \tag{1}$$

$$\sum_{\substack{x \\ x\neq b}} \alpha[x,b]_i = 2n+1 \tag{2}$$

$$\sum_{\substack{i,j \\ i\neq j}} s_{ij} = n(2n+1) = \sum_{\substack{a,b \\ a\neq b}} \alpha[a,b] \tag{3}$$

I. For the standard Hamilton decomposition of K_{2n+1} given by $V = Z_{2n} \cup \{\infty\}$, $\mathbf{H} = (\infty\ 0\ 2n-1\ 1\ 2n-2\ 2 \ldots n+1\ n-1\ n)$ mod $2n$, the bicolour vector of rank 3 is given by

(1) if $n = 2$, $t_{3,5} = 2$, and $t_{3,j} = 0$ for all other j,

(2) if $n = 3$, $t_{3,2} = t_{3,5} = 3$, and $t_{3,j} = 0$ for all other j, and

(3) if $n \geq 4$, $t_{3,2} = n(n-3)$, $t_{3,3} = t_{3,4} = n$, and $t,j = 0$ for other j.

Indeed, while (1) and (2) are easily checked, in order to show (3), it suffices to consider the edges of any colour i, $i \in Z_n$; w.l.o.g, let $i = 0$. In the two triangles with vertices $j, j+1, 2n-1-j$ and $j+n, j+n+1, n-1-j$, respectively, the edges $\{j, 2n-1-j\}, \{j+1, 2n-1-j\}$ and $\{j+n, n-1-j\}, \{j+n+1, n-1-j\}$ all have colour 0, while the edges $\{j, j+1\}$ and $\{j+n, j+n+1\}$ have colour $j+1$. Thus these two triangles are both of type $[j,0]_3$. Further, the triangle with vertices $0, n, \infty$ is easily seen to be of type $[\lfloor n/2 \rfloor, 0]_3$, and the two triangles with vertices $\infty, j, j-1$ and $\infty, j+n, j+n-1$ are both of type $[1,0]_3$. Thus for any fixed i, a triangle of type $[i+1, i]_3$ occurs four times, of type $[i + \lfloor n/2 \rfloor, i]_3$ three times, and of type $[q, i]_3$ for all other $q = i$ twice.

II. Similarly, let $2n+1$ be prime with $n > 3$, and let $\mathbf{F}$ be the Hamilton decomposition of K_{2n+1} given by $V = Z_{2n+1}$, $H_i = (0\ i\ 2i\ 3i \ldots 2n)$ mod $2n+1$. It is easily checked that the bicolour vector T_3 for this decomposition is given by $t_{3,n} = n$, and $t_{3,j} = 0$ for all other j.

In general, however, there is a multitude of Hamilton decompositions of K_{2n+1}. We have tested the effectiveness of the above invariant on the set of 122 nonisomorphic Hamilton decompositions of K_9, as determined in [C]. The invariant T_3 alone partitions the 122 solutions into 67 classes. As soon as one adjoins to it also T_4 and T_5, the sensitivity increases considerably. The triple of invariants (T_3, T_4, T_5) fails to distinguish only two pairs of solutions ($x(8)$ and $x(10)$, and $x(71)$ and $x(107)$, respectively—see Table 1), thus its sensitivity is 0.984. Upon adjoining also S_3, the quadruple (T_3, T_4, T_5, S_3) becomes a complete invariant in this case.

The same invariants—the bicolour vector and the sum-bicolour sequence—can be also used to distinguish m-cycle systems, again provided m is not "too small". Actually, only the range of parameters and the equalities (1)–(3) above change, and have to be adjusted accordingly. However, already in the case of 6-cycle systems of order 9, the above quadruple of invariants, while still quite sensitive, is no longer a complete invariant. For details on the generation and isomorphism invariants for the 6-cycle systems of K_9, see Section 3 below.

A yet different simple invariant proved effective for distinguishing the nonisomorphic 4-cycle systems of order 9. For a 4-cycle $f = (abcd)$ and its vertex, say a, let $N(a, f)$, the neighborhood of a in f, be the path P_3 induced by the vertices b, c and d. Given a 4-cycle system $\mathbf{F} = \{F_i : i = 1, \ldots, 9\}$ of K_9, let the neighborhood graph $N(a, \mathbf{F})$ of a in $\mathbf{F}$ be the subgraph of K_9 induced by the union of the neighborhoods $N(a, F_i)$, $i = 1, \ldots, 9$. It is a simple exercise to establish that there are exactly 3 nonisomorphic graphs (see Figure 1, graphs N_1, N_2, N_3) which may occur as neighborhood graphs of a vertex in a 4-cycle system of K_9. If, for a 4-cycle system $\mathbf{F}$ of K_9, the symbol n_i, $i = 1, 2, 3$, gives the number of vertices having N_i as the neighborhood graph, then $N = (n_1, n_2, n_3)$ is clearly an invariant for 4-cycle systems of K_9. Somewhat surprisingly, this simple invariant fails to distinguish only a pair of solutions (which, however, happen to be distinguished by the automorphism group order).

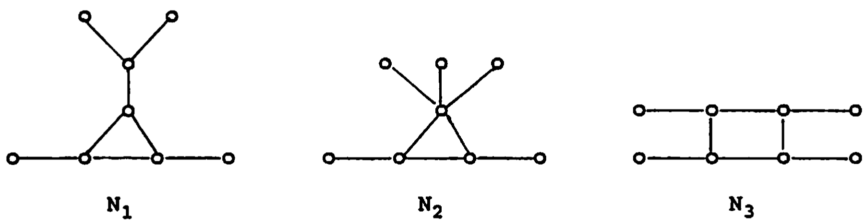

Figure 1.

3. Enumerating the cycle systems of K_9

A. The 6-cycle systems

The 640 nonisomorphic 6-cycle systems of K_9 were obtained in two ways, thus providing an independent check for correctness of the result. The first of these consisted in implementing an *orderly* generation algorithm [C], [Cal], [CRY], [R], in a manner which is a minor adaptation of the method used to generate Hamilton decompositions in [C].

A *form* of a 6-cycle system $\mathbf{F}$ of K_9 is obtained as follows. Let $V(K_9) =$

$\{1,2,\ldots,9\}$. For an ordered pair ab of vertices, we locate the unique 6-cycle F_i of $\mathbf{F}$ of the form $(abcdef)$. We then rename the it element of F_i by j. The remaining three vertices not in F_i are assigned integers $7,8,9$ in all 6 possible ways. For each of the resulting representations of $\mathbf{F}$, we shift each 6-cycle so that it commences at the smallest integer, and reverse the order of the 6-cycle if this gives a lexicographically smaller vector representing the cycle. Next, the set of vectors is sorted in lexicographically increasing order, yielding a *form*. Since there are 72 ordered pairs of vertices of K_9, we get in total $72 \times 6 = 432$ forms of $\mathbf{F}$. The lexicographically smallest among these is the *canonical form* of $\mathbf{F}$. Implementing now an exhaustive algorithm for generating forms of 6-cycle systems, we check each form for canonicity. Only canonical forms are kept; other forms are discarded since their canonical forms were encountered earlier. Altogether 640 canonical forms were obtained.

The second method was based on identifying a reasonably small subset of the set of nonisomorphic 6-cycle systems consisting of solutions that satisfy an additional condition. Subsequently, several types of transformations, which use the invariant discussed in the preceding section, are applied to this subset repeatedly. The subset of solutions in question consisted of those 6-cycle systems (call these special) which contain two 6-cycles on the same set of 6 vertices. It is easily seen that these two cycles can be taken w.l.o.g. as (123456) and (136425). There are exactly 20 nonisomorphic special 6-cycle systems of K_9, and they are listed in Table 2.

The following facts about the bicolour vector T and the sum-bicolour sequence S (cf. Section 2 above) for 6-cycle systems of K_9 are readily verified:

(i) $t_{3,4} = 2$ if $\mathbf{F}$ is a special 6-cycle system of F_9, and $t_{3,4} = 0$ otherwise; moreover, $t_{3,5} = t_{3,6}$.

(ii) $t_{4,1} = t_{4,3} = t_{4,5} = 0$.

(iii) $t_{4,2} + 2t_{4,4} = 18$, thus $t_{4,2}$ is even; moreover, $0 \le t_{4,4} \le 5$ and $8 \le t_{4,2} \le 18$.

(iv) every element of S_4 is even.

The properties (i)–(iv) above suggest using the following reduced set of invariants in this case: $T_3' = (t_{3,1}, t_{3,2}, t_{3,3})$, $T_4' = (t_{4.4})$, S_3 and S_4. This set of invariants partitions the 640 nonisomorphic 6-cycle systems of K_9 into 598 classes; thus its sensitivity is 0.934.

The transformations that were applied initially to the special 6-cycle systems, and then repeatedly to new obtained systems, were of four kinds:

1. Given a 6-cycle system **F** and two of its 6-cycles F_i and F_j, assume there exist two vertices a and b at distance 2 both in F_i and in F_j. Say, we have $F_i = (acbdef)$ and $F_j = (agbhij)$. If $F_i' = (agbdef)$, $F_j' = (acbhij)$ are also 6-cycles (this will happen precisely when g is not one of d, e, f, and c is not one of h, i, j) then the 6-cycle system $\mathbf{F}'$ obtained from **F** by replacing the 6-cycles F_i, F_j with F_i', F_j' is said to be obtained from **F** by *simple surgery of the first kind.*

2. Assume that the 6-cycles F_i and F_j of **F** contain two vertices a and b at distance 3 both in F_i and F_j, say, $F_i = (acdbef)$, $F_j = (aghbij)$. If $F_1' = (aghbef)$ and $F_2' = (acdbij)$ are also 6-cycles, then the 6-cycle system $\mathbf{F}'$ obtained from **F** by replacing F_1, F_2 with F_1', F_2' is said to be obtained from **F** by *simple surgery of the second kind.*

3. Assume that the 6-cycle F_i of **F** contains the paths ab and cde, and the 6-cycle F_j of **F** contains the paths afb and ce. If replacing in F_i ab by the path afb and the path cde by ce yields a 6-cycle F_i', and, simultaneously, replacing in F_j afb by ab and ce by cde yields a 6-cycle F_j' then the 6-cycle system $\mathbf{F}'$ obtained from **F** by replacing F_i, F_j with F_i', F_j' is said to be obtained from **F** by *double surgery.*

4. Finally, assume that **F** contains three 6-cycles F_i, F_j, F_k such that F_i contains the paths (say) ab and cde, F_j contains the paths ce and fgh, and F_k contains the paths fh and aib. If replacing the above paths in F_i with aib and ce, in F_j with cde and fh, and in F_k with fgh and ab, respectively, results in new 6-cycles F_i', F_j', F_k', then the 6-cycle system $\mathbf{F}'$ obtained from **F** by replacing F_i, F_j, F_k with F_i', F_j', F_k' is said to be obtained from **F** by *triple surgery.*

Just as for Hamilton decompositions, computing isomorphisms or automorphisms of 6-cycle systems is easy (cf. [C]). The summary of automorphism group orders for the 640 nonisomorphic 6-cycle systems of K_9 is as follows.

group order	1	2	3	4	6	36
number of systems	591	31	4	11	2	1

The 640 nonisomorphic 6-cycle systems of K_9 are listed in Table 3. The systems are listed according to the lexicographic order of the 598 distinct vectors of the reduced set of invariants as described above; this numbering is given in the last column of Table 3. The first column of Table 3 contains the number of the system in the lexicographic ordering of the canonical forms. The next five columns contain the last five cycles of the canonical form of the given system (whose first cycle is always 123456); the next column contains the order of its automorphism group. The next four columns list the reduced set of invariants T_3', S_3, T_4', S_4 (with commas and parentheses omitted; here $10 = a$, $11 = b$, $12 = c$ etc.)

B. The 4-cycle systems

There are only 8 nonisomorphic 4-cycle systems of K_9. The small number of solutions (both, expected and actual) makes it unnecessary to use orderly generation algorithm. The latter was nevertheless used as an independent check to a conventional generation method; a post-hoc observation suggests that this was a case where hand calculations alone would have succeeded. The vector $N = (n_1, n_2, n_3)$ described in Section 2 above together with the automorphism group order provide a complete invariant. Table 4 lists the 8 nonisomorphic 4-cycle systems of K_9 in lexicographic order of their canonical form, together with the automorphism group order, and the invariant N.

4. Conclusion

Table A below summarizes the information on the number of nonisomorphic m-cycle systems of K_n for $n \leq 9$.

It is hoped that the invariants described in Section 2, and their natural extensions, will prove useful in enumerating and distinguishing cycle systems and uniform 2-factorizations of K_n for $n > 9$, as well as cycle systems of other graphs, such as, for instance, of $K_n - F$, the cocktail-party graph on an even number of vertices.

n	m	number of nonisomorphic systems	reference
3	3	1	trivial
5	5	1	trivial
7	3	1	PG(2,2)
	7	2	[C]
9	3	1	AG(2,3)
	4	8	this paper
	6	640	this paper
	9	122	[C]

Table A.

References

[ABS] B. Alspach, J.C. Bermond, D. Sotteau, Decomposition into cycles I: Hamilton decompositions, in: Cycles and Rays, NATO ASI Ser., Kluwer, 1990, pp. 9–18.

[C] C.J. Colbourn, Hamiltonian decompositions of complete graphs, *Ars Combinatoria* **14** (1982), 261–269.

[CC] C.J. Colbourn, M.J. Colbourn, Combinatorial isomorphism problems involving 1-factorizations, *Ars Combinatoria* **9** (1980), 191–200.

[CR1] C.J. Colbourn, R.C.Read, Orderly algorithms for graph generation, *Int. J. Computer Math.* **A7** (1979), 167–172.

[CR2] C.J. Colbourn, R.C.Read, Orderly algorithms for generating restricted classes of graphs, *J. Graph Theory* **3** (1979), 187–195.

[C2] M.J. Colbourn, Algorithmic aspects of combinatorial designs, *Ann. Discrete Math.* **26** (1985), 67–136.

[DW] J.H. Dinitz, W.D. Wallis, Trains: An invariant for one-factorizations, *Ars Combinatoria* **32** (1991), 161–180.

[GR] T.S.Griggs, A.Rosa, An invariant for one-factorizations of the complete graph, *Ars Combinatoria* (to appear).

[LR] C.C. Lindner, C.A. Rodger, Decompositions into cycles II: Cycle Systems, in: Contemporary Design Theory: A Collection of Surveys (Ed. J.H. Dinitz, D.R. Stinson), J.Wiley & Sons, 1992, pp. 325–369.

[R] R.C. Read, Every one a winner, *Ann. Discrete Math.* **2** (1978), 107–120.

TABLE 1

x(2)		x(42)		x(87)	
4111211--	135247968	1113111--	135274968	22231-1--	135284796
12332----	146285937	132311---	148592637	1234-1---	146295738
3123-11--	157294836	-5221-1--	157938246	23411-1--	158639427
x(3)		x(45)		x(90)	
1223-11--	135247968	233211---	135279468	23122-1--	135286497
213311---	146293857	12621----	142857396	13431----	142736958
1324--1--	159482736	15132----	159263847	21242----	157483926
x(6)		x(46)		x(93)	
-12211--1	135247968	3311-12--	135279468	23232----	135286497
-22122---	146392857	151-22---	142859637	241311---	147583926
1123-1--1	159483726	-6112-1--	157483926	133121---	159637248
x(7)		x(47)		x(97)	
411411---	135247968	213311---	135279468	-43-1-2--	135286947
-343-1---	146395827	214121---	142963857	-6-14----	146297385
13321-1--	157384926	222221---	159374826	14131-1--	163957248
x(11)		x(49)		x(100)	
13-231---	135247968	2223-2---	135279468	24-42----	135286974
-23311---	148592637	2145-----	147382695	-42-22---	157293648
1312111--	157283946	15213----	163924857	2-24-2---	162495837
x(12)		x(60)		x(101)	
112411---	135247968	31141-1--	135279648	22-222---	135286974
323121---	148593627	22214----	142936857	22-222---	158493627
141221---	157382946	12141-1--	159473826	22-222---	164295738
x(14)		x(63)		x(102)	
-242-2---	135247968	-4521----	135279648	14131-1--	135297468
152211---	149583627	1335-----	147392685	231212---	142758396
12251----	157392846	1335-----	163824957	-23311---	159482637
x(16)		x(67)		x(103)	
412221---	135248697	2321111--	135279648	13321-1--	135297468
2145-----	146275938	233211---	149268375	242121---	148593627
31251----	158294736	-6-14----	163958247	-6-14----	157382496
x(17)		x(69)		x(104)	
-4-24----	135248697	22422----	135279648	-4122-1--	135297468
-35111---	146293758	-52121---	149573826	-7113----	149582637
242121---	159472836	2324-1---	158639247	-1143----	157248396
x(19)		x(75)		x(105)	
133121---	135248697	-3422----	135284697	3224--1--	135297468
234-21---	146372958	12332----	142957368	233211---	149628375
233211---	157493826	233211---	158394726	13223----	163958427
x(20)		x(78)		x(106)	
3-233----	135248697	21242----	135284697	113221---	135297486
11522----	146375928	-262-1---	147385926	13431----	149583627
322311---	158394726	225111---	157249368	-5412----	157396428
x(21)		x(80)		x(108)	
12222-1--	135248697	11233----	135284697	-4221-1--	135729468
116111---	146392758	132311---	147583926	-513-1---	142583597
33212-1--	159473826	233211---	159427368	23221-1--	159374826
x(41)		x(83)		x(109)	
-4232----	135274968	-3312-1--	135284697	132311---	135729648
-43211---	146392857	-2531----	149583726	12332----	147938526
-433--1--	159738426	2252--1--	157429368	23411-1--	159428637

x(110)

13-121--1	135729648
13-231---	149738625
-4-13---1	163958247

x(111)

-543-----	135824796
2235-----	149258375
5-421----	172593648

x(118)

3-36-----	135842796
22422----	146375928
22422----	152683947

x(119)

-363-----	135842796
-63-3----	147593628
-363-----	152946837

x(121)

2226-----	135842796
13512----	149528637
1254-----	157462938

x(1)

23-321---	135247968
-23311---	146283957
1332-2---	158492736

x(25)

23-321---	135248697
21612----	149275836
22341----	159374628

x(15)

-5123----	135248697
217-11---	146273958
2226-----	157492836

x(26)

-5123----	135268497
-5331----	142759638
-363-----	158293746

x(22)

32223----	135248697
2226-----	146395728
311321---	158374926

x(24)

32223----	135248697
133121---	147582936
3224--1--	159462738

x(18)

32113-1--	135248697
13431----	146295738
3-152----	158274936

x(23)

32113-1--	135248697
15213----	147395826
213311---	157294638

x(28)

3215-1---	135268497
2324-1---	142963758
13431----	159382746

x(51)

3215-1---	135279468
234-21---	148573926
14322----	159638247

x(43)

332112---	135279468
21531----	142693857
14322----	159284736

x(44)

332112---	135279468
31332----	142695837
15132----	157482936

x(59),

31251----	135279648
323-4----	142863957
121321---	158374926

x(113)

31251----	135827946
151-22---	148396257
1341-11--	159247368

x(61)

15213----	135279648
-282-----	147368295
13431----	162493857

x(91)

15213----	135286497
12332----	142758396
213311---	159263748

x(65)

14322----	135279648
1433-1---	147583926
13431----	159428637

x(85)

14322----	135284796
12332----	142957368
24221-1--	158394627

x(73)

12621----	135279684
-6222----	158293746
1335-----	175942638

x(82)

12621----	135284697
1335-----	149386275
124211---	163742958

x(71)(compare x(107))

-444-----	135279684
2422-2---	157493628
2226-----	164295837

x(107)(compare x(71))

-444-----	135726948
2422-2---	142597386
2226-----	158293647

x(5)	
322311---	135247968
2226-----	146385927
213311---	157394826
x(9)	
322311---	135247968
23232----	148395726
124211---	158294637
x(13)	
322311---	135247968
21242----	149285736
124211---	159384627

x(4)	
42-4-2---	135247968
1254-----	146295837
12332----	157284936
x(8)(compare x(10))	
42-4-2---	135247968
21612----	148295736
12332----	158394627
x(10)(compare x(8))	
42-4-2---	135247968
21612----	148573926
12332----	159463827

x(32)	
2324-1---	135269748
21612----	142863957
152211---	158372946
x(48)	
2324-1---	135279468
1352-1---	147369285
13512----	162483957
x(50)	
2324-1---	135279468
324-12---	147582936
25-221---	159624837

x(35)	
14241----	135269748
1173-----	149273685
15331----	164283957
x(53)	
14241----	135279486
1332-2---	142695738
3215-1---	158293647
x(64)	
14241----	135279648
2341-2---	147582936
2324-1---	159426837

x(52)	
-6222----	135279486
1335-----	142693758
1335-----	159283647
x(62)	
-6222----	135279648
15213----	147386295
13-231---	163942857
x(95)	
-6222----	135286497
-5331----	148572936
13431----	159624738

x(54)	
1254-----	135279486
31251----	142963758
23151----	159382647
x(56)	
1254-----	135279486
22422----	146293758
14322----	159638247
x(79)	
1254-----	135284697
13431----	147386295
116111---	163942758
x(98)	
1254-----	135286947
31332----	146372958
22422----	157938426

x(68)	
13431----	135279648
241311---	149362857
241311---	159247386
x(89)	
13431----	135284796
2226-----	149362758
2226-----	159246837
x(94)	
13431----	135286497
2145-----	148396275
323121---	163742958
x(99)	
13431----	135286947
231131---	146392758
25112-1--	159738426

x(76)	
-282-----	135284697
-3133----	147293685
3313-2---	162495738
x(86)	
-282-----	135284796
3117-----	142958637
242121---	157264938
x(96)	
-282-----	135286947
161121---	146275938
12251----	158429736
x(120)	
-282-----	135842796
1352-1---	149268375
13431----	174639528

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  1254-----|142683957
  1335-----|158294736
x(74)
  22341----|135284697
  1335-----|142759368
  222221---|158374926
x(81)
  22341----|135284697
  2145-----|149362758
  322311---|159247386
x(88)
  22341----|135284796
  3-36-----|146385927
  31332----|157394268
x(92)
  22341----|135286497
  22422----|147263958
  323121---|157384296
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x(29)
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  -363-----|146372958
  1173-----|157428396
x(31)
  -5331----|135269748
  1335-----|142759386
  132311---|158294637
x(33)
  -5331----|135269748
  -343-1---|146385927
  -352--1--|157394286
x(57)
  -5331----|135279486
  22341----|146293857
  213311---|159637428
x(66)
  -5331----|135279648
  -4521----|147592836
  1335-----|158624937
x(84)
  -5331----|135284796
  12332----|142936857
  1223-11--|159462738
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x(34)
  1335-----|135269748
  3-522----|146829375
  24123----|163859427
x(39)
  1335-----|135274968
  1254-----|146283795
  15213----|163924857
x(70)
  1335-----|135279684
  21612----|157382946
  241311---|174263958
x(77)
  1335-----|135284697
  2226-----|147362958
  323121---|157249386
x(112)
  1335-----|135824796
  22341----|149526837
  22214----|157293648
x(115)
  1335-----|135842697
  2341-2---|146375928
  22422----|152749386
x(122)
  1335-----|135847926
  3411-3---|146938257
  312212---|159427368
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  152211---|142857396
  22341----|159274638
x(30)
  -444-----|135268497
  1335-----|146395728
  12621----|158374296
x(36)
  -444-----|135269748
  -444-----|149285736
  1335-----|159386427
x(37)
  -444-----|135274968
  -444-----|142638597
  -444-----|157392846
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x(38)
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  22422----|142857936
  2243-1---|159264837
x(40)
  -444-----|135274968
  -3133----|146283957
  -13212---|158429736
x(55)
  -444-----|135279486
  323121---|142963857
  13142----|159374628
x(72)
  -444-----|135279684
  --4--4---|158293647
  44---4---|162495738
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x(114)
  -444-----|135829647
  -8--4----|142597386
  ---44----|157263948
x(116)
  -444-----|135842697
  1433-1---|149375286
  13431----|159274638
x(117)
  -444-----|135842796
  -363-----|146283957
  -282-----|152947368
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TABLE 3

639	136278	146895	175839	249735	284769	6	10	66666	0	006aa	1
640	136278	146975	173859	248935	286749	36	10	66666	0	66666	2
638	136278	146895	174829	249735	385769	2	4g0	55666	2	006aa	3
636	136278	142579	159837	284769	358649	1	6f0	45667	3	44668	4
249	135247	148695	185739	264978	276389	1	8b2	45577	2	44488	5
101	135247	146895	182739	263879	485769	1	6c2	44559	4	66666	6
106	135247	146895	183729	263978	485769	1	6c2	44559	4	66666	
113	135247	146895	185739	263879	276948	2	6c2	45566	2	66666	7
143	135247	148279	159468	267839	369857	1	7a3	55666	2	024aa	8
142	135247	148279	159468	263789	385769	1	7a3	55667	2	44668	9
109	135247	146895	185729	263978	376948	1	8b2	44567	2	66666	10
103	135247	146895	182769	263879	375849	1	8b2	44568	2	66666	11
12	135247	146289	159278	369758	376849	1	8b2	44677	2	0446a	12
115	135247	146895	185739	267948	278369	1	8b2	45567	2	44488	13
33	135247	146389	159378	269758	276849	1	8b2	45667	3	04688	14
170	135247	148369	157398	267958	278649	1	8b2	46667	3	44668	15
191	135247	148395	185769	264978	273689	1	8b2	55667	2	46666	16
576	135278	147389	159467	248639	269758	1	8e0	44567	0	04688	17
579	135278	148297	157469	249836	376859	1	8e0	45667	3	44668	18
565	135278	146975	176829	248936	374958	4	8e0	55558	4	66666	19
637	136278	142579	159837	286749	358469	4	8e0	55558	4	66666	
549	135278	146895	174829	249736	385769	1	8e0	56666	2	0466a	20
534	135278	146795	173869	248936	285749	4	8e0	66666	0	66666	21
141	135247	148279	159268	369857	387649	1	993	44668	3	0248a	22
286	135247	148795	185769	264938	273689	1	993	45667	3	44668	23
185	135247	148379	159468	269857	287639	1	993	55567	3	04688	24
140	135247	148279	159268	364987	385769	1	993	55577	3	24668	25
184	135247	148379	159468	263987	285769	1	993	55577	3	46666	26
243	135247	148695	183679	264987	285739	1	9c1	35578	1	44668	27
268	135247	148739	159628	276389	468579	1	9c1	35677	2	2246a	28
245	135247	148695	183729	264978	367589	1	9c1	36677	1	26666	29
265	135247	148739	157968	264958	276389	1	9c1	44578	2	0446a	30
3	135247	146289	157948	273869	367859	1	aa2	44677	2	24668	31
110	135247	146895	185729	267938	369487	2	aa2	45566	2	44668	32
114	135247	146895	185739	267849	279638	1	aa2	45567	2	44668	33
146	135247	148295	183679	264987	375869	1	aa2	45567	2	44668	
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244	135247	148695	183729	263978	467589	1	aa2	45568	4	44488	
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357	135267	142895	185739	274869	364978	2	884	46666	0	2266a	36
397	135267	147839	157948	246859	273698	1	8b2	45666	3	04888	37
350	135267	142895	183729	364879	475869	1	a74	44567	0	24668	38
362	135267	142895	187469	273849	368579	1	aa2	25578	3	22488	39
398	135267	147839	157948	246958	273689	1	aa2	35667	4	04688	40
317	135267	142789	159738	284639	475869	1	aa2	44668	2	2444a	41
382	135267	146895	182739	248579	369478	1	aa2	44677	0	24668	42
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171	135247	148369	157398	268597	287649	1	aa2	45577	3	44668	44
316	135267	142789	159648	286379	385749	1	aa2	45667	2	24688	45
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126	135247	148269	157298	367958	378649	1	aa2	45677	2	24668	47
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104	135247	146895	183679	269378	275849	1	aa2	55567	2	44666	49
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320	135267	142839	157298	369487	468597	1	aa2	55567	3	2266a	51
77	135247	146859	157298	267938	369487	2	aa2	55666	2	2266a	52
76	135247	146859	157298	263978	376948	1	aa2	55666	2	46666	53
78	135247	146859	157398	263879	276948	2	aa2	55666	2	66666	54
32	135247	146389	159378	268579	276948	1	aa2	55666	4	04688	55
23	135247	146389	157948	267859	273968	1	aa2	55667	3	44668	56
469	135278	142697	157689	283649	374859	1	ad0	25678	3	24668	57
480	135278	142839	159647	267589	368497	1	ad0	35578	2	2248a	58
444	135274	157839	176498	248596	286379	1	ad0	35578	3	2246a	59
445	135274	157839	176928	249586	364897	1	ad0	35677	2	24468	60
547	135278	146895	173849	247639	269758	1	ad0	35677	2	44668	61
564	135278	146975	176289	248639	374958	1	ad0	35677	3	46666	62

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567	135278	146985	174829	249736	386759	1	ad0	46667	3	04688	66
548	135278	146895	174829	249376	369758	1	ad0	55567	1	24688	67
535	135278	146795	174289	263849	375869	1	ad0	55666	2	44668	68
540	135278	146829	159847	249736	385769	1	ad0	55667	0	24668	69
536	135278	146795	174829	249836	375869	1	ad0	55667	3	46666	70
209	135247	148579	159468	269837	287639	1	b43	44578	3	24668	71
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90	135247	146859	157948	269837	287639	1	b43	45567	3	24688	73
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14	135247	146289	159378	276849	369758	1	b55	34678	1	22688	75
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203	135247	148579	159368	269837	287649	1	b83	35677	2	26666	79
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261	135247	148729	159768	264938	369857	1	b83	55666	3	22688	89
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60	135247	146829	159378	263897	485769	1	bb1	45667	1	44668	96
236	135247	148679	159278	264938	369857	1	bb1	45667	2	2246a	97
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63	135247	146829	159738	263987	485769	1	bb1	45667	3	44468	100
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310	135267	142789	157968	283749	364859	1	c64	34677	3	24668	113
315	135267	142789	159648	283749	368579	1	c64	34678	3	24688	114
395	135267	147589	159368	246978	273849	4	c64	44777	0	4444a	115
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366	135267	146389	159478	248579	273968	2	c64	45568	2	22288	117
329	135267	142859	157398	274869	364978	2	c64	45577	0	44668	118
358	135267	142895	185739	278649	369748	1	c64	45677	0	24688	119
330	135267	142859	157398	278649	369748	1	c64	55666	1	44666	120
410	135267	148295	187469	249837	368579	1	c92	16677	3	04666	121
311	135267	142789	157968	284639	374958	1	c92	25677	4	44466	122
309	135267	142789	157968	283649	374859	1	c92	34677	3	44666	123
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404	135267	147869	157928	249837	364859	1	c92	34678	4	44666	125
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408	135267	147895	186429	273948	369758	1	c92	35677	1	24468	131
149	135247	148295	183769	264987	368579	1	c92	35677	2	24468	132
371	135267	146829	157398	248597	369478	1	c92	36667	1	24468	133
415	135267	148695	183729	249758	364789	1	c92	36667	1	44468	134
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10	135247	146289	159278	368497	385769	1	c92	44668	2	24488	137
157	135247	148295	186739	264987	369758	1	c92	44677	2	44468	138
385	135267	147289	157938	246859	369487	1	c92	45567	0	24668	139
168	135247	148369	157398	264978	276859	1	c92	45577	3	46666	140
118	135247	146895	187369	267938	275849	1	c92	45667	2	46666	141
122	135247	146895	187639	269738	275849	1	c92	45667	2	46666	
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79	135247	146859	157698	263879	273948	1	c92	45667	4	44488	143
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248	135247	148695	185739	263897	287649	1	c92	45677	2	44668	145
31	135247	146389	159378	268497	285769	1	c92	45677	3	44668	146
147	135247	148295	183679	269857	378649	1	c92	46666	2	44666	147
111	135247	146895	185729	269378	367948	1	c92	55566	2	44668	148
411	135267	148369	159278	247398	468579	1	c92	55567	1	26668	149
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153	135247	148295	185769	268937	364978	1	c92	55567	2	44668	151
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399	135267	147839	159248	273698	468579	1	c92	55667	1	24668	155
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25	135247	146389	157948	269587	286739	1	c92	56666	3	26668	158
599	135278	148639	159647	249758	267389	1	cc0	25578	3	04666	159
573	135278	147369	158497	246839	267598	1	cc0	34668	2	2444a	160
470	135278	142697	157689	283749	364859	1	cc0	34678	2	04688	161
442	135274	157829	176498	248396	368597	1	cc0	34678	3	2246a	162
471	135278	142697	157689	284639	374958	1	cc0	34678	3	24666	163
556	135278	146937	158249	268479	367598	1	cc0	34777	3	06668	164
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437	135274	157689	173948	246978	263859	1	cc0	35578	2	44488	
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625	135728	146795	173689	248396	258749	6	cc0	44488	0	222aa	170
577	135278	147689	159637	248579	264938	1	cc0	44577	3	06666	171
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443	135274	157829	179368	248596	376498	1	cc0	44668	5	0068a	
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446	135274	157869	179248	263958	376498	1	cc0	45567	3	22668	175
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568	135278	146985	174839	249576	286379	1	cc0	45677	1	26668	180
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546	135278	146839	159847	249736	285769	1	cc0	46667	0	24668	182
476	135278	142839	158967	264759	368497	1	cc0	55567	0	2446a	183
635	135789	146738	159627	249368	258479	3	cc0	55577	3	66666	184
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571	135278	146985	176829	249736	384759	2	cc0	55666	2	22688	186
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65	135247	146829	159738	269857	367849	1	da1	55666	3	26668	249
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61	135247	146829	159378	269857	367948	1	da1	55667	3	46666	251
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360	135267	142895	186479	278369	375849	1	e82	35677	1	44468	267
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605	135278	148937	157649	247968	263859	1	eb0	35677	1	44666	318
578	135278	148295	174689	249376	369758	1	eb0	36667	0	24488	319
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629	135728	147369	158497	246839	259876	1	eb0	45667	4	24668	339
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67	135247	146839	157298	267958	369487	1	f35	35578	1	24468	368
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177	135247	148369	159728	267589	378649	1	f35	35677	3	24468	370
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428	135274	157389	179268	246958	367849	1	i90	55667	3	44668	559
622	135728	146379	159867	248396	258749	1	i90	56666	1	26668	560
484	135278	142895	174639	268379	485769	1	i90	56666	1	46666	561
427	135274	157389	176948	246859	263978	1	i90	56666	2	46666	562
558	135278	146937	158679	247598	263849	1	i90	56666	4	46666	563
8	135247	146289	157968	273859	367849	1	j71	36667	1	22888	564
296	135247	148975	183769	263958	278649	1	j71	45568	1	44668	565
91	135247	146879	157298	263948	376958	1	j71	45667	1	44668	566
93	135247	146879	157398	263849	276958	1	j71	45667	1	44668	
290	135247	148975	182639	278649	376958	1	j71	45667	1	44668	
294	135247	148975	183629	276958	378649	1	j71	45667	1	44668	
298	135247	148975	186739	269587	283649	1	j71	45667	1	44668	
300	135247	148975	187369	264938	276859	1	j71	45677	1	24668	567
48	135247	146789	159368	269738	275849	1	j71	46667	1	46666	568
256	135247	148729	159368	269738	467589	1	j71	46667	2	24688	569
16	135247	146289	159678	275839	368497	1	j71	55567	2	24668	570
128	135247	148269	157398	276859	364978	1	j71	55567	2	44668	571
34	135247	146389	159678	268497	285739	1	j71	55667	3	44668	572
21	135247	146389	157928	269487	376859	1	j71	56666	3	24688	573
347	135267	142879	159368	275849	374698	2	k24	46667	0	44666	574
348	135267	142879	159638	275849	374689	2	k24	46667	0	44666	
313	135267	142789	159368	285749	379648	1	k24	55667	0	44668	575
416	135267	148729	159368	249758	374698	4	k24	66666	0	66666	576
417	135267	148729	159638	249758	374689	4	k24	66666	0	66666	
521	135278	146389	158697	249576	284739	1	k80	36667	1	44666	577
542	135278	146839	158497	247698	263759	1	k80	45577	0	24668	578
612	135278	149385	174869	246759	263798	1	k80	46667	0	44468	579
509	135278	142985	174639	269738	486759	1	k80	46667	0	44668	580
498	135278	142897	158649	263759	384769	1	k80	55577	3	24688	581
488	135278	142897	157369	264859	386749	1	k80	55666	2	44668	582
452	135274	158269	176498	248379	368759	1	k80	55666	3	04668	583
507	135278	142985	173649	269748	386759	1	k80	55667	0	24668	584
499	135278	142937	157689	264958	369748	1	k80	55667	0	44668	585
512	135278	146289	158497	247369	386759	1	k80	55667	1	24668	586
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592	135278	148397	158649	247369	267598	1	k80	55667	3	24668	589
496	135278	142897	158469	263759	386749	1	k80	55667	3	46666	590
299	135247	148975	187269	283649	376859	1	161	45677	1	44666	591
541	135278	146839	158497	247369	267598	1	m70	45568	1	24668	592
555	135278	146937	157489	249768	263859	1	m70	45667	0	44666	593
456	135274	158369	179268	249378	467598	1	m70	46666	3	04488	594
506	135278	142985	173649	267938	475968	1	m70	55667	0	44468	595
621	135728	146379	159867	247839	258496	1	m70	55667	2	46666	596
626	135728	146839	158497	247369	259876	3	o60	55577	3	66666	597
631	135728	147985	173649	248695	267839	4	o60	66666	0	4444a	598