

## PopSwap (popswap)

For a given integer  $N$ ,  $S_N$  is the set of all permutations of  $(0, \dots, N - 1)$ .

Furthermore,  $E_N$  is the set of all ordered pairs  $(p, q)$  where:

- $p$  and  $q$  are elements of  $S_N$ ;
- $p$  and  $q$  can be obtained from each other by swapping two adjacent elements.

Note that, if  $(p, q) \in E_N$ , then  $(q, p) \in E_N$ .

Your goal is to label each element of  $S_N$  with an unique natural number in  $[0, 2^{60})$ , i.e. to produce an injective function<sup>1</sup>  $\mathcal{L}$  (called a *labeling*) from  $S_N$  to the set of natural numbers less than  $2^{60}$ .

The quality of a labeling is measured by two parameters which should minimized:

- the *magnitude*  $M(\mathcal{L})$ , defined to be the smallest natural  $k$  number such that  $2^k > \mathcal{L}(p)$  for all elements  $p$  of  $S_N$ .
- the *closeness*, defined to be:

$$C(\mathcal{L}) = \sum_{(u,v) \in E_N} \text{popcount}(\mathcal{L}(u) \oplus \mathcal{L}(v)).$$

where  $\oplus$  is the bitwise exclusive or and  $\text{popcount}(x)$  is the number of set bits in the binary representation of  $x$ .

Your task is to find a labeling  $\mathcal{L}$  that achieves low values for both  $M(\mathcal{L})$  and  $C(\mathcal{L})$ . Note that an optimal solution is not required.

## Implementation

This is an output-only task. You should submit a separate output file for each input file. Input and output files should follow the following format.

### Input format

The input files consist of a single line containing an integer  $N$  and the index  $G$  of the input.

### Output format

The output files should consist of  $N!$  lines, the  $i$ -th of which contains the label of the  $i$ -th permutation in lexicographical order.<sup>2</sup>

## Scoring

This task has exactly 2 test cases: `input000.txt` and `input001.txt`, in both of which  $N = 10$ .

The score for your solution on each test case is determined as  $S_M(\mathcal{L}) \times S_C(\mathcal{L})$ , where  $S_C(\mathcal{L})$  and  $S_M(\mathcal{L})$  are functions of your output labeling  $\mathcal{L}$ .

- $S_C(\mathcal{L}) = (\min(1, 36 \cdot 10^6 / C(\mathcal{L})))^2$  for every input.
- $S_M(\mathcal{L})$  is different for every input, according to the following tables. Between the values specified in the tables,  $S_M$  varies linearly.

A malformed output always scores zero points.

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<sup>1</sup>A function is said to be injective if it maps distinct elements to distinct elements

<sup>2</sup>Formally, given two permutations  $p \neq q$ , we say that  $p$  is lexicographically smaller than  $q$  if and only if  $p_k < q_k$  where  $k$  is the smallest index such that  $p_k \neq q_k$ .

input000.txt		input001.txt	
$M(\mathcal{L})$	$S_M(\mathcal{L})$	$M(\mathcal{L})$	$S_M(\mathcal{L})$
> 60	0	> 25	0
60	6	25	0
$\leq 25$	60	$\leq 22$	40

The score for the task is the sum of the score on each test case.

## Examples

input	output
3 -1	32 16 8 4 2 1

## Explanation

Note that the **first sample case** is not an official test case, since  $N \neq 10$  and  $G \notin \{0, 1\}$ .

The sample output represents the following labeling:

$$\mathcal{L}(p) = \begin{cases} 32 & \text{if } p = (0, 1, 2) \\ 16 & \text{if } p = (0, 2, 1) \\ 8 & \text{if } p = (1, 0, 2) \\ 4 & \text{if } p = (1, 2, 0) \\ 2 & \text{if } p = (2, 0, 1) \\ 1 & \text{if } p = (2, 1, 0) \end{cases}$$

Since  $2^5 \not> 32$  but  $2^6 > 32$ , the magnitude of the labeling is  $M(\mathcal{L}) = 6$ .

Since there are  $3! \cdot (3 - 1) = 12$  elements in  $E_3$  and since  $\text{popcount}(\mathcal{L}(p), \mathcal{L}(q)) = 2$  for all  $p, q \in S_N$ , the closeness of the labeling is  $C(\mathcal{L}) = 12 \cdot 2 = 24$ .