Coding 1

Background

If you wish to refresh your mind on basic Algorithms and Data Structures, I suggest you to look at the well-known book Introduction to Algorithms, 3rd Edition by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein.

I strongly suggest you to watch the following video lectures as soon as possible.

- Insertion Sort and Merge Sort
- Heaps and Heap Sort
- Counting Sort, Radix Sort, Lower Bounds for Sorting
- Binary Search Trees
- AVL trees
- Hashing with Chaining

How to solve a problem

- Read carefully the description of the problem.
- Make sure you understand the problem by checking the examples.
- Design a first trivial solution.
- Think about a more efficient solution. The use of some running examples usually helps a lot in finding a better solution. If your are not able to find such solution, try to find some hints by discussing with other students, by asking questions on the group, by looking at the solution in our Web page, or by searching on internet. This is perfectly fine for the first problems and for most difficult ones. In any case, make sure you really understand the solution and the properties it is exploiting! Always compare your solution with existing ones.
- Write a brief description of your solution in English. Provide an analysis of its time and space complexity.
- Implement your own solution in C++.
- Submit your implementation to the problem's site. Fix it until it passes all the tests.

Exam

The exam consists of two parts: Homeworks 50% - Written/oral test 50%.

Extra points for

- active participation to our Google group
- serious participation to online contests, e.g., CodeForces, TopCoder, Hacker Rank, Google Code Jam, ...
- successful interview with a big company

For full marks in the "Homeworks" part of the exam you must solve all the problems. I'll check your solutions by reading the code a ble to submit any solution without ar ered wrong!

Please create a git can be either private or public. I y and keep the repository updated

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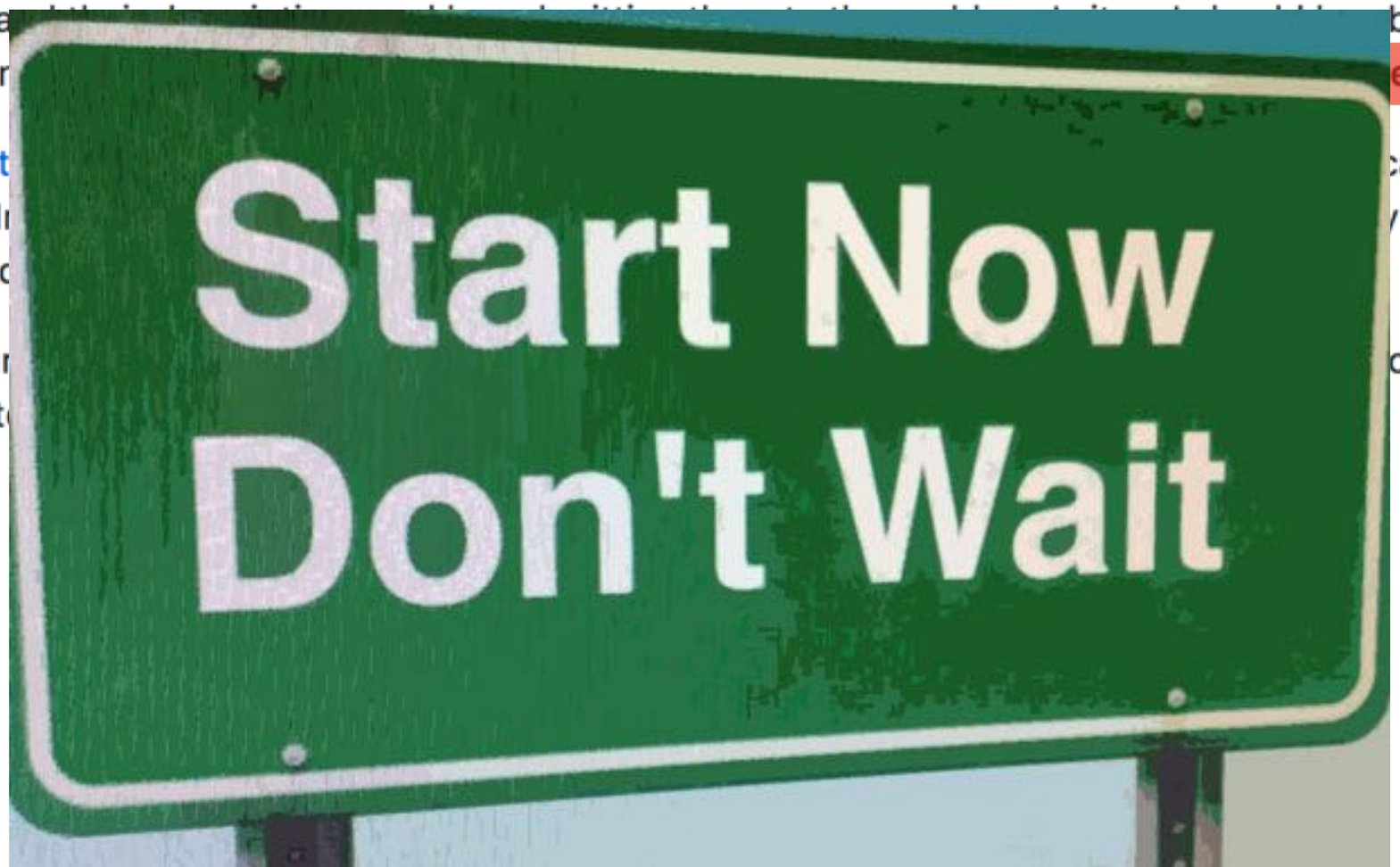

This is exactly what I'm expecting!

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CPC-Problems

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Collection of all the solved and implemented problems of the course Competitive Programming an

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CPC-Problems

Description

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README.md

Sliding window algorithm

Description

To find the maximum element in all the windows of size k, we use a queue in which we insert all the elements that can be useful to determine which is the maximum. So we start from an empty queue and we insert the elements of the array following this rule:

- If there are elements from the head of the queue which are no longer in the window, we remove those elements;
- If there are elements from the back of the queue which are smaller than the current element, we remove those elements. Then we insert the new element from the back of the queue.

Notice that in doing these, to determine the maximum element we just have to watch at the first element in the queue, because it is certainly in the window (otherwise it would have been removed since we start the check from the head), and it's the maximum beacuse when we insert a new element we remove all the smaller elements and we put it at the end of the queue, so the elements are sorted from the largest (the first) to the smallest (the last).

Complexity

The time complexity of the algorithm is `O(n)`. To see why, we have to notice that every element is inserted in the queue just once, so all the insertions cost `O(n)`, and every time we insert an element (after k iterations) we remove at least one, so we can't insert more elements than we remove. So the total time complexity is `O(n)`. To see the space complexity, we have to notice that during the execution of the algorithm, it can not happen that there are elements not in the window in the queue, because imagine we insert an element `x` which is not the maximum (so it

Code

```cpp
#include <iostream>
#include <vector>
#include <stack>
#include <tuple>


std::pair<std::vector<int>, int> getArrayInput(){
    int size;
    int k;
    std::cin >> size >> k;
    std::vector<int> v(size);

    for(int i=0; i<size; i++){
        std::cin >> v[i];
    }
    return std::make_pair (v, k);
}

void maxWindow(std::vector<int> v, int k){
    std::deque<std::pair<int, int>> q;

    for (int i=0; i<v.size(); i++){

        while (!q.empty() && q.front().second <= i - k)
            q.pop_front();

        while (!q.empty() && q.back().first <= v[i])
            q.pop_back();

        q.push_back(std::make_pair(v[i], i));

        if (i >= k-1) std::cout << q.front().first << ' ';

    }

    std::cout << std::endl;
}

int main() {

    int numberTest;
    std::cin >> numberTest;
    std::vector<std::vector<int>> test(numberTest);
    std::vector<int> k(numberTest);

    for (int i=0; i<numberTest; i++){
        std::tie (test[i], k[i]) = getArrayInput();
    }

    for (int i=0; i<numberTest; i++)
        maxWindow(test[i], k[i]);

    return 0;
}
```

Problems

1. Towers http://codeforces.com/problemset/problem/37/A?locale=en

Little Vasya has received a young builder's kit. The kit consists of several wooden bars, the lengths of all of them are known. The bars can be put one on the top of the other if their lengths are the same.

Vasya wants to construct the minimal number of towers from the bars. Help Vasya to use the bars in the best way possible.

Input

The first line contains an integer $N\,(1 \le N \le 1000)$ — the number of bars at Vasya's disposal. The second line contains N space-separated integers l_i — the lengths of the bars. All the lengths are natural numbers not exceeding 1000.

Output

In one line output two numbers — the height of the largest tower and their total number. Remember that Vasya should use all the bars.

Examples

input
3 1 2 3
output
1 3

input
4 6 5 6 7
output
2 3

```cpp
#include <iostream>
#include <vector>
#include <algorithm>

using namespace std;

template<typename T>
vector<T> get_input_sequence(size_t n) {
    vector<T> sequence(n);

    for(size_t i = 0; i < n; ++i)
        cin >> sequence[i];
    return sequence;
}

int main() {
  std::ios_base::sync_with_stdio(false);

  size_t n;
  cin >> n;
  auto length = get_input_sequence<int>(n);
  sort(length.begin(), length.end());

  size_t numTowers = 0, currentLength = 0, currentHeight = 0, maxHeight = 1;
  for(size_t k = 0; k < n; k++) {
    if(length[k] == currentLength) {
      currentHeight += 1;
      if(currentHeight > maxHeight)
        maxHeight = currentHeight;
      } else {
        currentLength = length[k];
        currentHeight = 1;
        numTowers++;
      }
  }
  cout << maxHeight << " " << numTowers << endl;
  return 0;
}
```

2. Finding Team Member

http://codeforces.com/problemset/problem/579/B?locale=en

There is a programing contest named SnakeUp, $2n$ people want to compete for it. In order to attend this contest, people need to form teams of exactly two people. You are given the strength of each possible combination of two people. All the values of the strengths are **distinct.**

Every contestant hopes that he can find a teammate so that their team's strength is as high as possible. That is, a contestant will form a team with highest strength possible by choosing a teammate from ones who are willing to be a teammate with him/her. More formally, two people A and B may form a team if each of them is the best possible teammate (among the contestants that remain unpaired) for the other one.

Can you determine who will be each person's teammate?

Input

There are $2n$ lines in the input.

The first line contains an integer n ($1 \le n \le 400$) — the number of teams to be formed.

The i-th line ($i > 1$) contains $i - 1$ numbers $a_{i1}, a_{i2}, \ldots, a_{i(i-1)}$. Here a_{ij} ($1 \le a_{ij} \le 10^6$, all a_{ij} are distinct consisting of person i and person j (people are numbered starting from 1.)

Output

Output a line containing $2n$ numbers. The i-th number should represent the number of teammate of i-th

Examples

input
2 6 1 2 3 4 5
output
2 1 4 3

input
3 487060 3831 161856 845957 794650 976977 83847 50566 691206 498447 698377 156232 59015 382455 626960
output
6 5 4 3 2 1

```cpp
struct team {
  size_t m1;
  size_t m2;
  int32_t strength;

  team(size_t a, size_t b, int64_t s)
    : m1(a)
    , m2(b)
    , strength(s) {}
};

int main() {
  std::ios_base::sync_with_stdio(false);

  size_t n;
  cin >> n;

  vector<team> teams;
  teams.reserve(n*(n-1)/2);

  for(size_t i = 1; i < 2*n; ++i) {
    for(size_t j = 0; j < i; ++j) {
      int32_t strength;
      cin >> strength;
      teams.emplace_back(i, j, strength);
    }
  }

  sort(teams.begin(),
       teams.end(),
       [](const team &a, const team &b) {
         return a.strength > b.strength;
       }
       );

  vector<size_t> assign(2*n);
  for(auto &team: teams) {
    if(assign[team.m1] == 0 and assign[team.m2] == 0) {
      assign[team.m1] = team.m2 + 1; // +1, 0 is reserved to "no assigment yet"
      assign[team.m2] = team.m1 + 1;
    }
  }

  for(auto assigment: assign)
    cout << assigment << " ";
  cout << endl;

  return 0;
}
```

3. Megacity

http://codeforces.com/problemset/problem/424/B?locale=en

The administration of the Tomsk Region firmly believes that it's time to become a megacity (that is, get population of one m
of improving the demographic situation, they decided to achieve its goal by expanding the boundaries of the city.

The city of Tomsk can be represented as point on the plane with coordinates $(0; 0)$. The city is surrounded with n other loca
one has coordinates (x_i, y_i) with the population of k_i people. You can widen the city boundaries to a circle of radius r. In su
locations inside the circle and on its border are included into the city.

Your goal is to write a program that will determine the minimum radius r, to which is necessary to expand the boundaries o
that it becomes a megacity.

Input

The first line of the input contains two integers n and s ($1 \le n \le 10^3$; $1 \le s < 10^6$) — the number of locatons around Tomsk
population of the city. Then n lines follow. The i-th line contains three integers — the x_i and y_i coordinate values of the i-th
the number k_i of people in it ($1 \le k_i < 10^6$). Each coordinate is an integer and doesn't exceed 10^4 in its absolute value.

It is guaranteed that no two locations are at the same point and no location is at point $(0; 0)$.

Output

In the output, print "-1" (without the quotes), if Tomsk won't be able to become a megacity. Otherwise, in the first line print
number — the minimum radius of the circle that the city needs to expand to in order to become a megacity.

The answer is considered correct if the absolute or relative error don't exceed 10^{-6}.

Examples

input

```
4 999998
1 1 1
2 2 1
3 3 1
2 -2 1
```

output

```
2.8284271
```

input

```
4 999998
1 1 2
2 2 1
3 3 1
2 -2 1
```

output

```
1.4142136
```

input

```
2 1
1 1 999997
2 2 1
```

output

```
-1
```

```cpp
int main(){
  std::ios_base::sync_with_stdio(false);

  size_t n;
  cin >> n;
  int pop;
  cin >> pop;

  vector<pair<double, uint64_t>> cities;
  cities.reserve(n);

  for(size_t i = 0; i < n; i++) {
    int x, y, population;
    cin >> x  >> y >> population;
    double distance = sqrt(x*x + y*y);
    cities.emplace_back(distance, population);
  }

  sort(cities.begin(),
       cities.end(),
       [](const pair<double, uint64_t> & a, const pair<double, uint64_t> & b) {
            return a.first<b.first;
          }
  );

  for(auto &a : cities) {
    pop += a.second;
    if(pop >= 1000000) {
      cout.precision(8);
      cout << a.first << endl;
      return 0;
    }
  }

  cout << -1 << endl;
  return 0;
}
```

4. Two Heaps

http://codeforces.com/problemset/problem/353/B?locale=en

Valera has $2 \cdot n$ cubes, each cube contains an integer from 10 to 99. He arbitrarily chooses n cubes and puts them in the first heap. The remaining cubes form the second heap.

Valera decided to play with cubes. During the game he takes a cube from the first heap and writes down the number it has. Then he takes a cube from the second heap and write out its two digits near two digits he had written (to the right of them). In the end he obtained a single fourdigit integer — the first it is written on the cube from the first heap, and the second two digits of it is written on the secc from the second heap.

Valera knows arithmetic very well. So, he can easily count the number of distinct fourdigit numb get in the game. The other question is: how to split cubes into two heaps so that this number (th of distinct fourdigit integers Valera can get) will be as large as possible?

Input

The first line contains integer n $(1 \le n \le 100)$. The second line contains $2 \cdot n$ space-separated in $(10 \le a_i \le 99)$, denoting the numbers on the cubes.

Output

In the first line print a single number — the maximum possible number of distinct four-digit num can obtain. In the second line print $2 \cdot n$ numbers b_i $(1 \le b_i \le 2)$. The numbers mean: the i-th cu to the b_i-th heap in your division.

Examples

input
1 10 99
output
1 2 1

input
2 13 24 13 45
output
4 1 2 2 1

5. Find Pair

http://codeforces.com/problemset/problem/160/C?locale=en

You've got another problem dealing with arrays. Let's consider an arbitrary sequence containing n (not necessarily different) integers $a_1, a_2, \ldots, a_n$. We are interested in all possible pairs of numbers (a_i, a_j), $(1 \le i, j \le n)$. In other words, let's consider all n^2 pairs of numbers, picked from the given array.

For example, in sequence $a = \{3, 1, 5\}$ are 9 pairs of numbers:
$(3, 3), (3, 1), (3, 5), (1, 3), (1, 1), (1, 5), (5, 3), (5, 1), (5, 5)$.

Let's sort all resulting pairs lexicographically by non-decreasing. Let us remind you that pair (p_1, q_1) is *lexicographically less* than pair (p_2, q_2) only if either $p_1 < p_2$, or $p_1 = p_2$ and $q_1 < q_2$.

Then the sequence, mentioned above, will be sorted like that:
$(1, 1), (1, 3), (1, 5), (3, 1), (3, 3), (3, 5), (5, 1), (5, 3), (5, 5)$

Let's number all the pair in the sorted list from 1 to n^2. Your task is formulated like this: you should find the k-th pair in the ordered list of all possible pairs of the array you've been given.

Input

The first line contains two integers n and k ($1 \le n \le 10^5$, $1 \le k \le n^2$). The second line contains the array containing n integers $a_1, a_2, \ldots, a_n$ ($-10^9 \le a_i \le 10^9$). The numbers in the array can coincide. All numbers are separated with spaces.

Please do not use the `%lld` specificator to read or write 64-bit integers in C++. It is preferred to use `cin`, `cout`, streams or the `%I64d` specificator instead.

Output

In the single line print two numbers — the sought k-th pair.

Examples

input
2 4 2 1

output
2 2

input
3 2 3 1 5

output
1 3