ACM-ICPC Live Archive

6505 Metal

We found rare and valuable metals under the ground. The metals are widely scattered underground, so we need a careful plan to dig them. For this, we are going to build a number of horizontal tunnels connected by vertical elevators, as in Figure 1. Every vertical elevator connects the right end of a tunnel to the left end of another tunnel. Furthermore, the connected chain of tunnels and elevators should be monotone to the ground, i.e., when one traverses the chain from the leftmost end of the tunnels to the rightmost end of the tunnels, one passes through all the tunnels without going back to the left.

Due to the limit of the budget, we can construct at most k horizontal tunnels for some positive integer k. Thus at most $k-1$ vertical elevators connecting them are used. We now construct an additional vertical tunnel connecting each metal to the horizontal tunnels. The digging cost of a metal is defined as its vertical distance from the horizontal tunnel. The digging cost for metals is defined as the maximum digging cost of the metals.

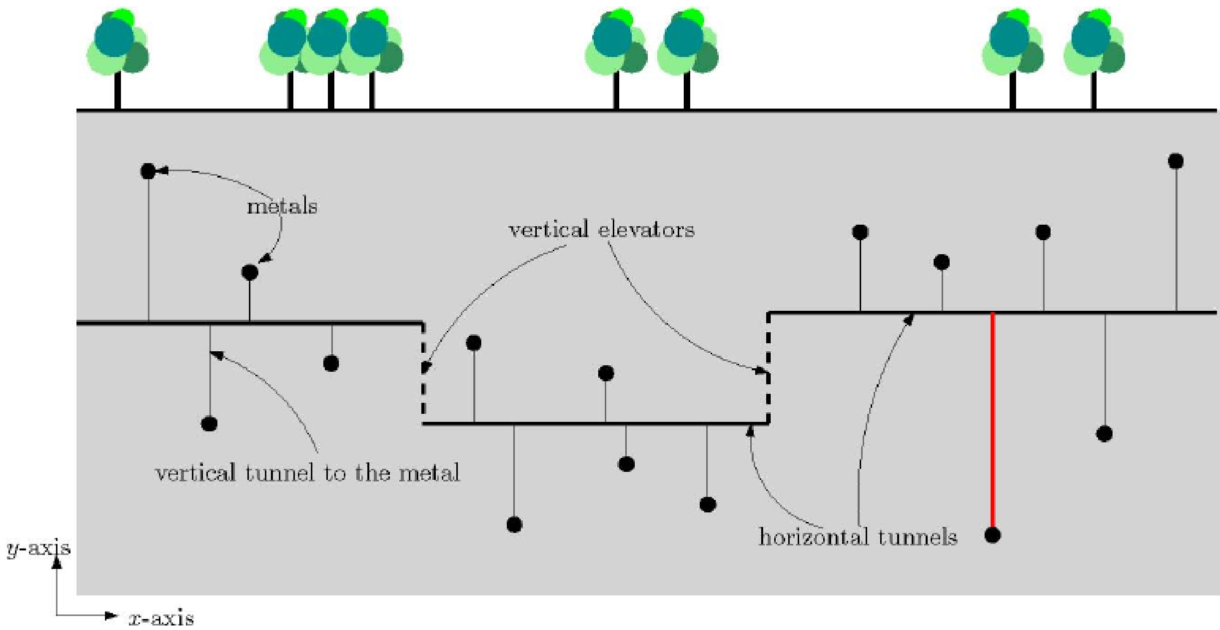

Figure 1. A digging plan for 15 metals for $k = 3$. The vertical distance from the rightmost horizontal tunnel to the lowest metal is the maximum distance in this plan, which determines the digging cost for the metals.

More formally, as in Figure 1, each metal is represented as a point in the two dimensional plane, a horizontal tunnel as a horizontal line segment, a vertical tunnel as a vertical line segment, and an elevator as a vertical line segment. You are given a set of n points, $P = \{p_1, p_2, \ldots, p_n\}$, where p_i has x-coordinate x_i and y-coordinate y_i, and the positive integer k, the maximum number of horizontal tunnels. The digging cost of a metal p_i, $cost(p_i)$, is the vertical distance to the horizontal tunnels. The digging cost of $P = \{p_1, p_2, \ldots, p_n\}$, $cost(P)$, is defined as the maximum cost of $cost(p_i)$ over all i, i.e., $cost(P) = \max_{1 \le i \le n} cost(p_i)$. The goal is to determine the position of (at most) k horizontal tunnels such that $cost(P)$ is minimized.

Given a set P of n points and a positive integer k, you write a program to compute the minimum value of $cost(P)$.

Input

Your program is to read from standard input. The input consists of T test cases. The number of test cases T is given in the first line of the input. Each test case starts with a line containing two positive integers, n ($2 \leq n \leq 10,000$) and k, where n is the number of points (metals) and k is the maximum number of horizontal tunnels to be used. The next line contains $2n$ integers, $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$, which respectively represent the coordinates of the points $p_1, p_2, \ldots, p_n$, and $-100,000,000 \leq x_i, y_i \leq 100,000,000$ for each i. Two neighboring coordinates are separated by a single space. Note that no two points have the same x-coordinates.

Output

Your program is to write to standard output. Print exactly one line for each test case. The line should contain the minimum value of $cost(P)$. Your output must contain the first digit after the decimal point, rounded off from the second digit.

The following shows sample input and output for two test cases.

Sample Input

```
2
3 1
-1 0 0 0 1 0
5 2
2 5 9 2 6 3 -2 2 7 0
```

Sample Output

```
0.0
1.5
```