The 2018 Ethiopian Collegiate Programming Contest

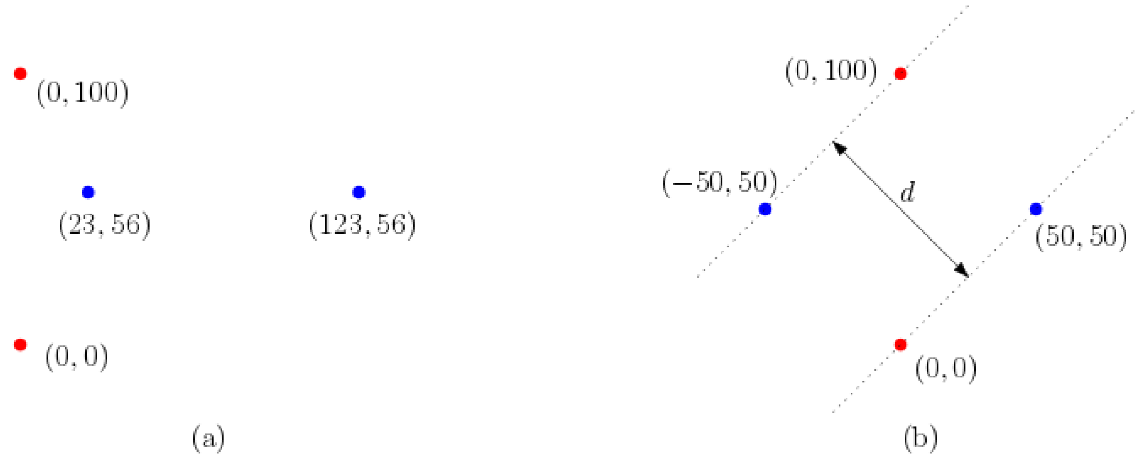
Problem D
Matching
Time Limit: 1 Second

In the geometric matching problem, two geometric objects A and B are given, and the goal is to find an optimal transformation for B such that the transformed copy of B is as close to A as possible. Usually, the distance between A and a transformed copy of B is measured by a prescribed distance function, and one wants to minimize it over all possible transformations.

Here, we consider a simple variant of the geometric matching problem. Specifically, we assume that two input objects A and B are finite sets of points in the plane and allowed transformations for B are only *translations* in the plane. A translated copy of B by a two-dimensional vector $v = (v_x, v_y)$ is defined to be

$$B + v = \{(x + v_x, y + v_y) \mid (x, y) \in B\}.$$

For any two-dimensional vector v, our *distance function* $f(v)$ measures the smallest possible perpendicular distance between two parallel lines that contain all points of A and $B + v$ in between. That is, we want to find an optimal two-dimensional vector v such that $f(v)$ is minimized.



Consider an example of $A = \{(0,0), (0,100)\}$ and $B = \{(23,56), (123,56)\}$, depicted in the above figure (a) in which the points in A are colored red while those in B are blue. Then, consider a specific vector $v = (-73, -6)$. The above figure (b) shows A and $B + v$, and two parallel lines whose perpendicular distance is d, which is exactly $d = 50\sqrt{2}$. One can verify that these two parallel lines contain all points of A and $B + v$ in between and have the smallest possible perpendicular distance. Hence, we have $f(v) = d$. Further, this is the minimum possible value of $f(v)$ over all two-dimensional vectors. Therefore, $v = (-73, -6)$ is an optimal translation vector such that $f(v)$ is minimized.

Given two sets of points in the plane, A and B, write a program that finds an optimal translation vector v for B such that $f(v)$ is minimized and outputs the value of $f(v)$.

Input

Your program is to read from standard input. The input starts with a line containing two integers, n ($1 \leq n \leq 200{,}000$) and m ($1 \leq m \leq 200{,}000$), where n is the number of points in the set A and m is the number of points in the set B. In each of the following n lines, the coordinates of each point in A are given by two integers separated by a space. Again, in each of the following m lines, the coordinates of each point in B are given by two integers separated by a space. The coordinates of all points given in the input range from -10^6 to 10^6, inclusively. Note that multiple points with the same coordinates can be given in each of A and B.

Output

Your program is to write to standard output. Print exactly one line which contains a real number z that represents the value of $f(v)$ for an optimal two-dimensional vector v such that $f(v)$ is minimized. The output z should be in the format that consists of its integer part, a decimal point, and its fractional part, and should satisfy the condition that $f(v) - 10^{-6} < z < f(v) + 10^{-6}$.

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

Sample Input 1	Output for the Sample Input 1
2 2 0 0 0 100 23 56 123 56	70.710678

Sample Input 2	Output for the Sample Input 2
7 5 0 0 99 0 47 31 36 4 10 2 71 5 45 17 98 97 89 96 101 96 132 113 122 110	31.000000