IOI '19 P4 - Broken Line

Time limit: 30.0s **Memory limit:** 1G

Azerbaijan is famous for its carpets. As a master carpet designer you want to make a new design by drawing a **broken line**. A broken line is a sequence of t line segments in a two-dimensional plane, which is defined by a sequence of $t+1$ points $p_0, \ldots, p_t$ as follows. For each $0 \leq j \leq t-1$ there is a segment connecting points p_j and p_{j+1}.

In order to make the new design, you have already marked n **dots** in a two-dimensional plane. The coordinates of dot i $(1 \leq i \leq n)$ are $(x[i], y[i])$. **No two dots have the same x or the same y coordinate**.

You now want to find a sequence of points $(sx[0], sy[0]), (sx[1], sy[1]), \ldots, (sx[k], sy[k])$, which defines a broken line that

- starts at $(0, 0)$ (that is, $sx[0] = 0$ and $sy[0] = 0$),
- contains all of the dots (not necessarily as the endpoints of the segments), and
- consists solely of horizontal or vertical segments (two consecutive points defining the broken line have an equal x or y coordinate).

The broken line is allowed to intersect or overlap itself in any way. Formally, each point of the plane may belong to any number of segments of the broken line. Your score will depend on the number of segments in the broken line (see Scoring below).

At IOI, this was an output-only task. You were given the 10 input files and had to submit a zip file containing your solutions to the test cases. Unfortunately, a similar output-only format is not currently possible on DMOJ since any files you submit can be at most $65\,536$ characters long. Instead, you will submit a program that will be run on the test cases like for a normal problem. This means it will read the input file from standard input and write the solution to standard output. We will still provide you with the input files, and the time limit for the problem will be very high. You can use the value of n and the first point to determine which case your program is being run on if you want to write a solution with significantly different behaviour on the different test cases.

Input Specification

Each input file is in the following format:

- line 1: n
- line $1+i$ (for $1 \leq i \leq n$): $x[i]$ $y[i]$

Output Specification

Your solution must output the broken line in the following format:

- line 1: k
- line $1+j$ (for $1 \leq j \leq k$): $sx[j]$ $sy[j]$

Note that the second line should contain $sx[1]$ and $sy[1]$ (i.e., the output **should not** contain $sx[0]$ and $sy[0]$). Each $sx[j]$ and $sy[j]$ should be an integer.

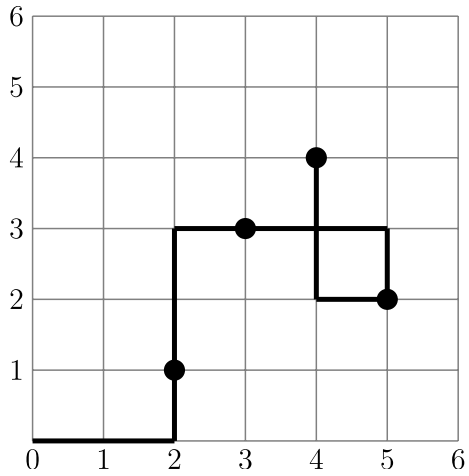
Example

For the sample input:

```
4
2 1
3 3
4 4
5 2
```

a possible valid output is

```
6
2 0
2 3
5 3
5 2
4 2
4 4
```



Please note this example is not among the actual inputs of this task.

Constraints

- $1 \leq n \leq 100\,000$
- $1 \leq x[i], y[i] \leq 10^9$
- All values of $x[i]$ and $y[i]$ are integers.
- No two dots have the same x or the same y coordinates, i.e. $x[i_1] \neq x[i_2]$ **and** $y[i_1] \neq y[i_2]$ for $i_1 \neq i_2$.
- $-2 \cdot 10^9 \leq sx[j], sy[j] \leq 2 \cdot 10^9$

Scoring

For each test case, you can get up to 10 points. Your output for a test case will get 0 points if it does not specify a broken line with the required properties. Otherwise, the score will be determined using a decreasing sequence $c_1, \ldots, c_{10}$, which varies by test case.

Assume that your solution is a valid broken line consisting of segments. Then, you will get

- i points, if $k = c_i$ (for $1 \leq i \leq 10$),
- $i + \frac{c_i - k}{c_i - c_{i+1}}$ points, if $c_{i+1} < k < c_i$ (for $1 \leq i \leq 9$),
- 0 points, if $k > c_1$,
- 10 points, if $k < c_{10}$.

The sequence $c_1, \ldots, c_{10}$ for each test case is given below.

Test cases	01	02	03	04	05	06	07-10
n	20	600	5 000	50 000	72 018	91 891	100 000
c_1	50	1 200	10 000	100 000	144 036	183 782	200 000
c_2	45	937	7 607	75 336	108 430	138 292	150 475
c_3	40	674	5 213	50 671	72 824	92 801	100 949
c_4	37	651	5 125	50 359	72 446	92 371	100 500
c_5	35	640	5 081	50 203	72 257	92 156	100 275
c_6	33	628	5 037	50 047	72 067	91 941	100 050
c_7	28	616	5 020	50 025	72 044	91 918	100 027
c_8	26	610	5 012	50 014	72 033	91 906	100 015
c_9	25	607	5 008	50 009	72 027	91 900	100 009
c_{10}	23	603	5 003	50 003	72 021	91 894	100 003

Visualizer

In the attachments of this task, there is a script that allows you to visualize input and output files.

To visualize an input file, use the following command:

```
python vis.py [input file]
```

You can also visualize your solution for some input, using the following command. Due to technical limitations, the provided visualizer shows only **the first** 1000 **segments** of the output file.

```
python vis.py [input file] --solution [output file]
```

Example:

```
python vis.py examples/00.in --solution examples/00.out
```

Note that the visualizer depends on the matplotlib package which you will have to install yourself.

Attachment Package

The test cases and the visualizer are available here.