MIT Programming Contest
Individual Round Problems
2004

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1 Adam's Genes

You've been hired by Gemini Labs, the world leader in human cloning, to write decision support software. At Gemini, all clones are derived from ADAM, a genetically perfect human. Something about his DNA makes him much easier to clone than normal humans. Not all the clones of Adam are the same, though, because geneticists introduce mutations, in the form of recessive genes, to learn more about genetics. For example, Bob might be a clone of Adam with a recessive gene for baldness added. Scientists would study Bob to see what subtle effects the gene may have. Clones of Bob would carry the recessive gene, as would clones of those clones, and so on. All is well as long as no clone derived from Bob is given a second recessive baldness gene. If that were to happen, a bald clone would be produced and the Cloning Board would shut Gemini down.

The software you are to write takes cloning requests from the research staff and evaluates them for consistency and safety. A collection of requests is *inconsistent* if it includes a clone that is not descended from Adam. A collection of requests is *unsafe* if it produces a clone with two identical recessive genes.

Input

Your program consumes a file of cloning requests, one per line. Here is the format of a cloning request:

```
<request>  = clone_<name>_from_<name><genelist>
<genelist> = NULL | _mutating_<gene><genes>
<genes>    = NULL | _<gene><genes>
<gene>     = 3 upper case alphabetical characters
<name>     = 1 to 10 upper case alphabetical characters
_          = one blank
```

A typical cloning request is

```
clone BOB from ADAM mutating BLD HEM
```

Note: there is always exactly one space between words; the last character on a line is immediately followed by a newline character. There can be zero to ten mutations in a request. If there are no mutations in the request, the keyword "mutating" does not appear, e.g.,

```
clone BOB from ADAM
```

The input is guaranteed to satisfy the syntactic format specifications, and it is guaranteed to contain at most one cloning request per clone, i.e., "clone BOB" will appear no more than once as the beginning of an input line. Furthermore, you are to process requests as though only those definitions which precede it are in effect. Therefore, if you have the following input segment

```
clone BOB from ADAM
clone MIKE from TIM
clone TIM from BOB
```

your output would include

```
clone MIKE from TIM has no connection to ADAM
```

because at the time MIKE was cloned, there was no connection to ADAM. If an clone is not consistent and safe, then all subsequent clones from that clone should be reported as having no connection to ADAM. For example, if you have the following input segment

```
clone BOB from ADAM mutating BLD
clone CHARLIE from BOB mutating BLD
clone DAVID from CHARLIE
```

your output would include

```
clone BOB from ADAM is consistent and safe
clone CHARLIE from BOB was at least twice mutated with BLD
clone DAVID from CHARLIE has no connection to ADAM
```

You are also guaranteed that no gene is listed twice in the same request.

Output

Your program produces a file of the processed requests, one per line, in the same order as they were consumed. The requests are modified according to the following rules.

1. If a clone is consistent and safe, the line should have the format clone JOE from ADAM is consistent and safe.

2. If a clone is inconsistent, the line should indicate this as follows clone `<name>` from `<name>` has no connection to ADAM.

3. If a clone is unsafe, the line should indicate this as follows clone `<name>` from `<name>` was at least twice mutated with `<gene>` where `<gene>` is the first gene to appear in the clone's mutation list that is a second mutation from Adam. You should print ONLY the first such doubly mutated gene.

If a particular cloning request is inconsistent, there is no need to report whether or not it is safe. Your output should contain exactly one space between words and no leading or trailing spaces.

Example

Sample Input

```
clone JOE from ADAM
clone BOB from ADAM mutating HEM
clone SAM from BOB mutating BLD
clone ED from SAM mutating BLD
clone FRANK from ED mutating HEM
clone KAIN from ABEL
clone ABEL from KAIN
```

Sample Output

```
clone JOE from ADAM is consistent and safe
clone BOB from ADAM is consistent and safe
clone SAM from BOB is consistent and safe
clone ED from SAM was at least twice mutated with BLD
clone FRANK from ED has no connection to ADAM
clone KAIN from ABEL has no connection to ADAM
clone ABEL from KAIN has no connection to ADAM
```

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2 Diverse Cows

For a very long time, Farmer John only had Holsteins (a breed of cows) on his farm. Recently, he has been reading various magazines and has become convinced that he should try to promote diversity on his farm. So he acquired k additional breeds, and numbered his $k+1$ breeds from 0 through k.

FJ has a total of n cows on the farm of the various $k+1$ breeds. When it's milking time, FJ wants to line them all up. Cows are conservative creatures and aren't as excited about diversity as FJ is. A cow of one breed i will only be comfortable standing next to a cow of breed j if i and j are at most one apart. For example, a breed 5 cow and a breed 4 cow would be okay standing next to each other, but if a breed 3 cow and a breed 7 cow became neighbors, there would be udder chaos and lots of spilled milk.

FJ found it very hard to think about this constraint while trying to line up the cows. Then he thought of a new strategy: randomness! He will just randomly line up the cows and hope for the best. He is curious as to whether this strategy will work or not. He wants you to compute the probability that a random configuration will be valid, i.e., no cows would be harmed.

Input

The input consists of a sequence of lines, each line containing two integers. k and n, $0 \leq k \leq 9$, $1 \leq n \leq 100$.

Output

For each line of input, output the probability (as a percent between 0 and 100) of FJ's random strategy working. Print as many decimal places as you want as long as your answer is within 0.0001 of the correct solution.

Example

Sample Input	Sample Output
`4 1`	`100.00000`
`2 5`	`40.74074`
`3 5`	`17.38281`
`8 7`	`0.10130`

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3 Transmitters

In a wireless network with multiple transmitters sending on the same frequencies, it is often a requirement that signals don't overlap, or at least that they don't conflict. One way of accomplishing this is to restrict a transmitter's coverage area. This problem uses a shielded transmitter that only broadcasts in a semicircle.

A transmitter T is located somewhere on a 1,000 square meter grid. It broadcasts in a semicircular area of radius r. The transmitter may be rotated any amount, but not moved. Given N points anywhere on the grid, compute the maximum number of points that can be simultaneously reached by the transmitter's signal. Figure 1 shows the same data points with two different transmitter rotations.

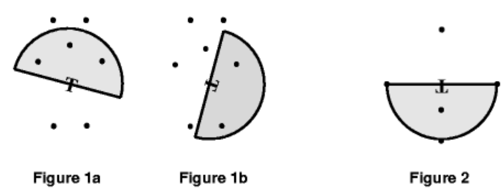


Figure 1:

All input coordinates are integers (0–1000). The radius is a positive real number greater than 0. Points on the boundary of a semicircle are considered within that semicircle. There are 1–150 unique points to examine per transmitter. No points are at the same location as the transmitter.

Input

Input consists of information for one or more independent transmitter problems. Each problem begins with one line containing the (x, y) coordinates of the transmitter followed by the broadcast radius, r. The next line contains the number of points N on the grid, followed by N sets of (x, y) coordinates, one set per line. The end of the input is signalled by a line with a negative radius; the (x, y) values will be present but indeterminate. Figures 1 and 2 represent the data in the first two example data sets below, though they are on different scales. Figures 1a and 2 show transmitter rotations that result in maximal coverage.

Output

For each transmitter, the output contains a single line with the maximum number of points that can be contained in some semicircle.

Example

Sample Input

```
25 25 3.5
7
25 28
23 27
27 27
24 23
26 23
24 29
26 29
350 200 2.0
5
350 202
350 199
350 198
348 200
352 200
995 995 10.0
4
1000 1000
999 998
990 992
1000 999
100 100 -2.5
```

Sample Output

```
3
4
4
```

4 Image Perimeters

Technicians in a pathology lab analyze digitized images of slides. Objects on a slide are selected for analysis by a mouse click on the object. The perimeter of the boundary of an object is one useful measure. Your task is to determine this perimeter for selected objects.

The digitized slides will be represented by a rectangular grid of periods, '.', indicating empty space, and the capital letter 'X', indicating part of an object. Simple examples are

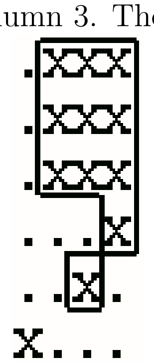
```
XX   Grid 1        .XXX   Grid 2
XX                 .XXX
                   .XXX
                   ...X
                   ..X.
                   X...
```

An X in a grid square indicates that the entire grid square, including its boundaries, lies in some object. The X in the center of the grid below is adjacent to the X in any of the 8 positions around it. The grid squares for any two adjacent X's overlap on an edge or corner, so they are connected.

```
XXX
XXX    Central X and adjacent X's
XXX
```

An object consists of the grid squares of all X's that can be linked to one another through a sequence of adjacent X's. In Grid 1, the whole grid is filled by one object. In Grid 2 there are two objects. One object contains only the lower left grid square. The remaining X's belong to the other object.

The technician will always click on an X, selecting the object containing that X. The coordinates of the click are recorded. Rows and columns are numbered starting from 1 in the upper left hand corner. The technician could select the object in Grid 1 by clicking on row 2 and column 2. The larger object in Grid 2 could be selected by clicking on row 2, column 3. The click could not be on row 4, column 3.



One useful statistic is the perimeter of the object. Assume each X corresponds to a square one unit on each side. Hence the object in Grid 1 has perimeter 8 (2 on each of four sides). The perimeter for the larger object in Grid 2 is illustrated in the figure at the left. The length is 18.

Objects will not contain any totally enclosed holes, so the leftmost grid patterns shown below could NOT appear. The variations on the right could appear:

```
Impossible   Possible

XXXX         XXXX   XXXX   XXXX
X..X         XXXX   X...   X...
XX.X         XXXX   XX.X   XX.X
XXXX         XXXX   XXXX   XX.X

.....        .....  .....  .....
..X..        ..X..  ..X..  ..X..
.X.X.        .XXX.  .X...  .....
..X..        ..X..  ..X..  ..X..
.....        .....  .....  .....
```

Input

The input will contain one or more grids. Each grid is preceded by a line containing the number of rows and columns in the grid and the row and column of the mouse click. All numbers are in the range 1-20. The rows of the grid follow, starting on the next line, consisting of '.' and 'X' characters.

The end of the input is indicated by a line containing four zeros. The numbers on any one line are separated by blanks. The grid rows contain no blanks.

Output

For each grid in the input, the output contains a single line with the perimeter of the specified object.

Example

Sample Input

```
2 2 2 2
XX
XX
6 4 2 3
.XXX
.XXX
.XXX
...X
..X.
X...
5 6 1 3
.XXXX.
X....X
..XX.X
.X...X
..XXX.
7 7 2 6
XXXXXXX
XX...XX
X..X..X
X..X...
X..X..X
X.....X
XXXXXXX
7 7 4 4
XXXXXXX
XX...XX
X..X..X
X..X...
X..X..X
X.....X
XXXXXXX
0 0 0 0
```

Sample Output

```
8
18
40
48
8
```

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5 Illumination

You are given N light sources on the plane, each of which illuminates the angle of $2\pi/N$ with the vertex in the source point (including its sides).

You must choose the direction of the illuminated angle for each of these sources, so that the whole plane is illuminated. It can be proven that this is always possible.

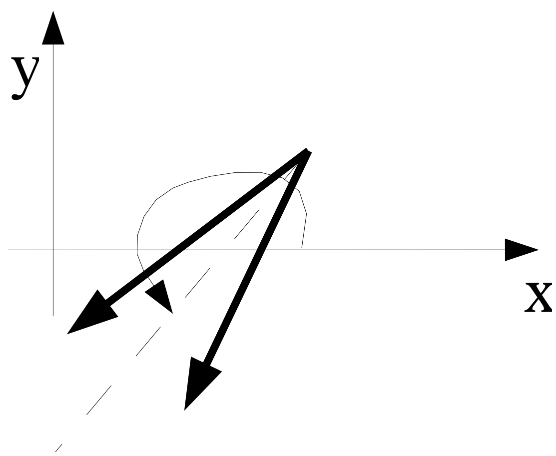
A light source itself casts on shadow and does not interfere with light beams from the other sources.

Input

The first line contains N – the number of light sources ($3 \leq N \leq 30$). Next N lines contain two integer numbers each – the coordinates of the light sources. All coordinates do not exceed 100 by their absolute values. No two sources coincide.

Output

Print N real numbers – for each light sources specify an angle that the bisector of the illuminated angle makes with Ox axis, counterclockwise. Print at least six digits after the decimal point. No angle must exceed 100π by its absolute value.



Example

Sample Input	Sample Output
3 0 0 2 0 1 1	0.52359877559829887 2.61799387799149437 4.71238898038468986

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6 Arctic Network

The Department of National Defence (DND) wishes to connect several northern outposts by a wireless network. Two different communication technologies are to be used in establishing the network: every outpost will have a radio transceiver and some outposts will in addition have a satellite channel.

Any two outposts with a satellite channel can communicate via the satellite, regardless of their location. Otherwise, two outposts can communicate by radio only if the distance between them does not exceed D, which depends of the power of the transceivers. Higher power yields higher D but costs more. Due to purchasing and maintenance considerations, the transceivers at the outposts must be identical; that is, the value of D is the same for every pair of outposts.

Your job is to determine the minimum D required for the transceivers. There must be at least one communication path (direct or indirect) between every pair of outposts. You can determine which of the transceivers are to be installed with a satellite channel.

Input

The first line of input contains N, the number of test cases. The first line of each test case contains $1 \leq S \leq 100$, the number of satellite channels, and $S < P \leq 500$, the number of outposts. P lines follow, giving the (x, y) coordinates of each outpost in kilometers (coordinates are integers between 0 and 10,000).

Output

For each case, output should consist of a single line giving the minimum D required to connect the network. Output should be specified to 2 decimal points.

Example

Sample Input

```
1
2 4
0 100
0 300
0 600
150 750
```

Sample Output

```
212.13
```

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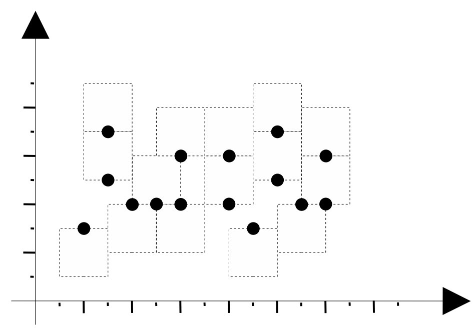
7 Map Labeling

Map generation is a difficult task in cartography. A vital part of such a task is automatic labeling of the cities in a map. For each city there is a text label to be attached to its location. The labels must be placed so that no two labels overlap. In this problem, we are concerned with a simple case of automatic map labeling.

Assume that each city is a point on the plane, and its label is a text bounded in a square with edges parallel to x and y axes. The label of each city should be located such that the city point appears exactly in the middle of the top or bottom edges of the label. In a good labeling, the square labels are all of the same size, and no two labels overlap, although they may share one edge. Figure 1 depicts an example of a good labeling (the texts of the labels are not shown.)

Given the coordinates of all city points on the map as integer values, find the maximum label size (an integer value) such that a good labeling exists for the map.



Input

The first line contains a single integer t ($1 \leq t \leq 10$), the number of test cases. Each test case starts with a line containing an integer m ($3 \leq m \leq 500$), the number of cities followed by m lines of data each containing a pair of integers; the first integer (X) is the x and the second one (Y) is the y coordinates of one city on the map ($-10000 \leq X, Y \leq 10000$). Note that no two cities have the same (x, y) coordinates.

Output

The output will be one line per each test case containing the maximum possible label size (an integer value) for a good labeling.

Example

Sample Input	Sample Output

```
1
6
1 1
2 3
3 2
4 4
10 4
2 5
```

```
2
```