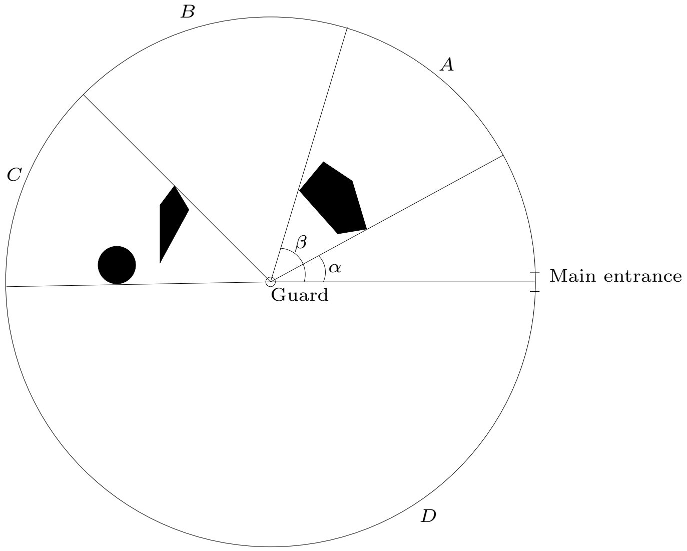
Homework Assignment #6
Due: October 22, 2015 at 4:00 p.m.

1. In Leutonia, all art galleries have perfectly circular rooms. Galleries employ night guards to make sure that none of the priceless Leutonian art hanging on the walls of the gallery is stolen. The Leutonian Night Guards' Guild insists that the guards should be provided with a swivel chair to sit on while working, and that the guard should not have to stand up from that chair to do the job. Since Leutonia is going through a period of austerity, the galleries can only afford to hire one guard per room, and they have decided to place a guard's chair in the centre of each circular room.

In each room, there are some obstacles (columns supporting the roof, large Leutonian sculptures, etc.) that prevent the night guard from seeing certain parts of the room's walls. Each obstacle can be described by two angles α and β as is shown for the pentagonal obstacle in the diagram below. The angles are measured in degrees, so $0 < \alpha < \beta < 360$.



By Leutonian custom, the main entrance to a room is always at its easternmost point. There is never an obstacle placed between the guard and the main entrance: Leutonians are notoriously superstitious and believe that would be bad for feng shui.

Suppose a gallery contains n obstacles. If you are given the α and β values for all of the obstacles, how could you efficiently compute the percentage of the walls that can be seen by the guard? (This number is needed to compute the cost of the insurance policy for the gallery, since a lower percentage makes it more likely that some of the art hanging on the walls could be stolen or damaged by scoundrels.) In the example above, only the segments labelled A and C are not visible to the guard.

(a) Give pseudocode for your algorithm. You need not prove that your algorithm is correct. However, you should state pre- and post-conditions for your algorithm and state loop invariants for any loops you use.

(b) What is the running time of your algorithm? Assume an arithmetic operation or comparison can be done in $O(1)$ time. Briefly justify your answer.

(c) Implement your algorithm in Java or C or C++ and submit the source code. Use the filename A6.java, A6.c or A6.cc (depending on which language you use). Your programme should take input from the standard input and write output to the standard output.

The input will contain data for more than one gallery room, formatted as follows. The first line will contain a single integer k, giving the number of rooms to be tested. Then, for each room there will be a line containing a single integer n, giving the number of obstacles in the room, followed by n lines, each of which contains two floating-point numbers (separated by a single space) giving the α and β values of one obstacle. You may assume that $0 \leq n \leq 1000000$. The running time of your algorithm on one input room should be under one minute.

Your output should be formatted as follows. For each room, output the percentage of the walls that the guard can see, rounded to 2 places after the decimal point.

Your solution will be marked by automatically testing it, so if you do not follow the input/output conventions precisely, it will receive 0 marks.

Before you hand in your solution, you can run the following test in the Prism lab, using the files A6.in and A6.out provided on the course website.

```
For Java:                   For C:                  For C++:
javac A6.java               gcc -o A6 A6.c          g++ -o A6 A6.cc
java A6 < A6.in > my.out    A6 < A6.in > my.out     A6 < A6.in > my.out
diff -q A6.out my.out       diff -q A6.out my.out   diff -q A6.out my.out
```

In each case, if the output of the `diff` command is that the files differ, your solution is incorrect.

Once you have a correct solution, submit it using the following command.

```
submit 3101 A6 filename
```

If you realize that you would like to change your submitted file, just submit the new version using the same command; the new version will replace the old version. (Of course, this must be done prior to the assignment deadline. If you get an error message when submitting, type `man submit` to get an explanation of the error message.