
Algorithmen und Wahrscheinlichkeit

Programming Exercises

Exercise 1 – *Random Triangles*

In this exercise you are supposed to examine the random variable denoting the number of triangles in a random graph $G \sim G_{n,p}$.

For $n \in \mathbb{N}$ and $p \in [0, 1]$, we let $G_{n,p}$ denote the probability space of graphs on n vertices where each edge is present with probability p independently of other edges. Let X be the random variable denoting the number of triangles in $G \sim G_{n,p}$. Compute the expected number of triangles $\mathbb{E}[X]$ and its variance $\text{Var}[X]$.

Input The first line of the input file contains a number $t \leq 30$ of test cases. Each of the t test cases is described as follows.

- It starts with a line which consists of an integer and a real n p , separated by a space, denoting the number of vertices ($1 \leq n \leq 1000$) and the probability of an edge existing ($0 \leq p \leq 1$) of a graph $G \sim G_{n,p}$.

Output For each test case output a single line with two values $\mathbb{E}[X]$ and $\text{Var}[X]$, separated by a space. Your solution is going to be accepted if it has an absolute or relative error of at most 10^{-5} .

Points This exercise is worth 100 points.

Sample Input

```
3
6 0.5
10 1.0
10 0.3
```

Sample Output

```
2.5 5.0
120.0 0.0
3.239999 7.439039
```