

# Two and a half years

Cryptoverse CTF 2023

## 1 Description



Mr Cai has been a trainee for two and a half years. He loves singing, dancing, rapping and playing basketball. After  $n$  days the Bilibili lawsuit outcome will be announced, therefore his mood is changing everyday. A single mood is defined by a function  $y : [0, n] \rightarrow [0, h]$  which for each x-coordinate in the range  $[0, n]$  (day number) gives the mood value (between 0 and  $h$ ) on that day.

For some reason, his mood follows a randomised algorithm described below:

**Step 1** Set  $y(0) = a$ .

**Step 2** For each  $i = 1, 2, \dots, n$ , let

$$y(i) = \text{fix}(y(i-1) + r(i)), \quad (1)$$

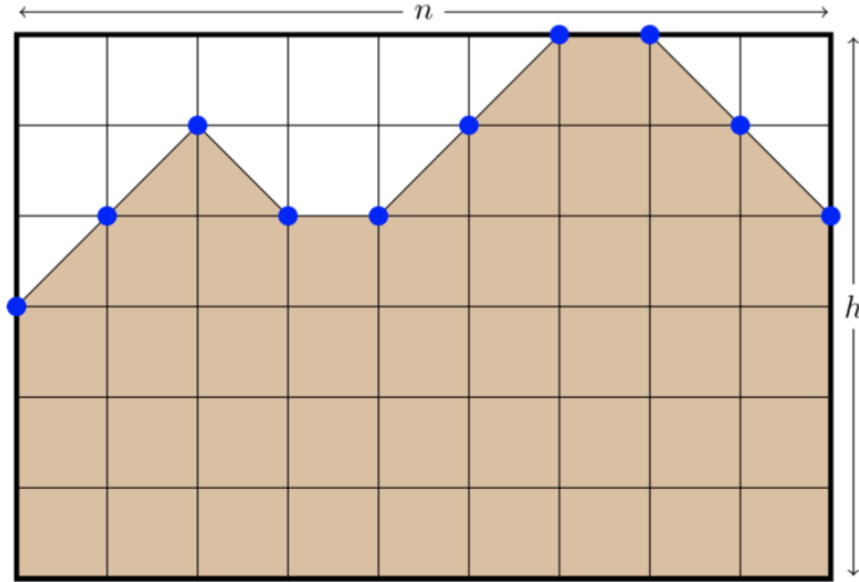
where  $r(i)$  is a random integer chosen from the set  $\{-1, 0, 1\}$  with probabilities  $P_{-1}, P_0$  and  $P_1$  percent respectively ( $P_{-1} + P_0 + P_1 = 100$ ).  $fix$  is a function defined by

$$fix(y) = \begin{cases} 0, & \text{if } y < 0 \\ y, & \text{if } 0 \leq y \leq h \\ h, & \text{if } h < y \end{cases}$$

which restricts its output to the range  $[0, h]$ .

**Step 3** Once we have  $y(i)$  for each  $i = 0, 1, \dots, n$  we draw straight lines connecting the points  $(i, y(i))$  and  $(i + 1, y(i + 1))$ .

**Step 4** All of the area under  $y$  is shaded.



An example with  $n = 9$ ,  $h = 6$ ,  $a = 3$ . The area of moods is 42.5. One possible function  $r$ :  $r(1) = 1, r(2) = 1, r(3) = -1, r(4) = 0, r(5) = 1, r(6) = 1, r(7) = 1, r(8) = -1, r(9) = -1$ .

Since you want to know the total mood area (so-called 心理阴影面积 in Chinese) of Mr Cai, **write a program to determine the expected area under the mood curves across all days.**

## 2 Input

The input consists of a single line containing six integers:  $n$  ( $1 \leq n \leq 100,000$ ), which is the total number of days,  $h$  ( $0 \leq h \leq 100$ ), which is the maximum value of the mood,  $a$  ( $0 \leq a \leq h$ ), which is the mood value at  $x = 0$ ,  $P_{-1}$  ( $0 \leq P_{-1} \leq 100$ ),  $P_0$  ( $0 \leq P_0 \leq 100$ ),  $P_1$  ( $0 \leq P_1 \leq 100$ ), which are the probability of  $r$  being  $-1$ ,  $0$  and  $1$ . It is guaranteed that  $P_{-1} + P_0 + P_1 = 100$ .

## 3 Output

Output the expected area under the mood curve. Your answer should have an absolute error of less than  $10^{-6}$ .

### Sample Input 1

4 10 3 100 0 0

### Sample Output 1

4.5

### Sample Input 2

2 10 5 50 0 50

### Sample Output 2

10.0