

Data Structures and Algorithms - Assignment 1

Amsterdam University College

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1 Organization

In this assignment you are asked to write a Python program that solves a small puzzle. This assignment will count for 15% of your final grade. You will be graded based on the number of successfully passed test cases. A test case is considered successfully passed if your program gives the correct answer and it halts before the time limit. A special bonus will be awarded to the three groups that pass all of the test cases and whose average execution times are the lowest.

You are allowed to work in a group of up to two students. Of course close collaboration between different groups is *not* allowed. Groups that hand in similarly structured programs will be questioned.

The deadline for handing in your program is **Friday October 20 at 5pm**. This deadline is *hard as nails*. (You are supposed to hand in your program only once, in principle revisions of programs will not be considered.) Email your program to `petar.vukmirovic2@gmail.com`.

2 The game

Players A and B are playing with array X . However, since they are lazy, they let their friend C play all the (deterministic) moves and tell them who won at the end.

One move of the game consists of picking a smallest element of the array X , calculating value k and subtracting it from each element of X . Let the smallest element be m . Then k is calculated using the equation

$$k = \begin{cases} 2 \cdot m + 1, & \text{if } m \text{ is even} \\ 3 \cdot m + 1, & \text{if } m \text{ is odd} \end{cases}$$

After subtracting k , all elements of X that are negative are removed. This concludes one move in the game.

Player A wins the game if after a move only one element remains in the array. Player B wins if after playing a move, no elements remain in the array.

C really likes A and B, but thinks that her role in this game is boring. That's why she asks you to help her by writing a program that is going to tell who won the game.

3 Input

The input to the program contains two lines. The first consists of one number, the length of the array X , whereas the other consists of space-separated elements of X . It is guaranteed that all of the elements of X are positive numbers, less than 10^6 . X will have at most $2 \cdot 10^5$ elements.

4 Output

You need to print **one** and only one line containing **A** if player A won, or **B** if player B won.

5 Time limit

Your program will be terminated after **two seconds**. Beware that this is a very time limit and that you will have to make sure your program is efficient. Note that using a data structure like a heap could make your program much faster.

6 Test cases

Three example test cases are given to make sure you understand the problem. On the left the input to the algorithm is given, and on the right the output.

Test case 1

8 3 7 4 11 8 5 24 10	A
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Explanation In the first move number 3 is the smallest, thus k equals 10. After removing all the elements that are negative after subtracting 10, we get the array 1, 14, 0. Now 0 is the smallest element, so we subtract 1 from elements of X , and remove the negative ones again. This leaves us with the array 0, 13. Performing the same step again we end up with the array 12. Since it is a one-element array, player A wins.

Test case 2

5 21 14 7 41 33	B
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Explanation In the first move number 7 is the smallest, thus k equals 22. After removing all the elements that are negative after subtracting 10, we get the array 19, 11. After subtracting 34, no elements remain. Thus player B wins.

Test case 3

7 1 100 5 200 10 300 15	A
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Hint Be careful how you perform the operation of removing the elements. They can be in the middle of the array and it can be an arbitrary number of elements that needs to be removed.

More test cases

A full-length test case will be available on Blackboard. Note that you can test the execution times of your program using the `time` command.