

## Editorial 2: Birthday

### 2+3=5 Points

Problem ID: birthday

Rank: 1+2

## Main Test Set

The main test set can be solved by simply calculating the answer with a loop.

### Loop, Multiply, and Add

Notice that the number of days in the  $i$ th year is  $i^2$ . We can sum up  $i^2$  from  $i = 1$  to  $i = N$  to get the number of days until the first day of the  $(N + 1)$ th year. However, the  $N$ -year-old birthday is one month before, so we subtract  $N$  out of the sum to get our final answer.

We can implement this by looping a variable  $i$  that goes from 1 to  $N$ . Each iteration, we multiply  $i$  by itself to get  $i^2$ , and add that result to another variable that holds our answer. Finally, we return the answer.

This loop runs in  $O(N)$  time.



## Bonus Test Set A

With both  $T$  and  $N$  both going up to  $10^5$ , running the  $O(N)$  algorithm from the main test set for each of the  $T$  test cases for  $O(TN)$  time per test file will take too long. We can either use a mathematical approach or a computational approach to speed things up.

### Sum of Squares Formula

One way to pass the bonus is to recognize that there's a well-known [closed-form expression for the sum of squares of the first  \$n\$  natural numbers](#). We can thus express the answer as:

$$-N + \sum_{i=1}^N i^2 = -N + \frac{N(N+1)(2N+1)}{6}$$

This calculation only uses simple arithmetic operators and requires no loops, so calculating the answer for each test case takes  $O(1)$  time. With  $T$  test cases, our runtime per test file is  $O(T)$ .

### Precomputation

Notice that during the process of running the algorithm of the main test set to find the answer for the  $N$ -year-old birthday, we actually calculate the answers for all the birthdays in between 1 and  $N$ ! After running the  $i^{\text{th}}$  iteration of the loop, the answer variable contains the answer for the  $i$ -year old birthday.

As such, we can [precompute](#) all the answers when the program begins by storing all the answers into an array. Then, for each of the test cases, we simply index into the array to get our answer.

The precomputation loops up to the maximum value of  $N$  for a runtime of  $O(N)$ . For each of the  $T$  test cases, indexing into an array takes  $O(1)$  time. Thus, the overall runtime is  $O(N + T)$ .

### Integer Overflow

Keep in mind that the largest possible answer (you can compute this using the sum of squares formula) is 333338333250000. You'll run into [integer overflow](#) if you try to use a 32-bit integer, so Java and C++ users will need to use the `long` or `long long` types instead (these are 64-bit integer types). Python does not have this problem due to having [arbitrary precision](#) integers.

# Design Notes

## Big Ben

Big Ben's character design is as old as the contest itself. However, it has been two whole years before we officially named our mascot the name he has today!

In fact, back in summer 2022, we actually surveyed in the contestants in the feedback form of [CALSUCO '22](#) asking what they think we should name the bear! We got some, uhh, *interesting* responses I suppose. Some of them were better than others, but none of them resonated with us in particular:

What should we name the CALICO bear?

12 responses

- dog
- roberto
- Bearkly The Stupendous Bear
- berry (bear-y?) idk
- Verbear
- Brian Dean
- Caliber
- Calvin
- Reeeese's
- Bearkley. ("Berkley" but its bear)
- Bobo the bear/Roco/Calco/Calo/Aligator
- Oski Jr. (jk, plz don't pick that name) ---- Actual Name Idea: Cal (short for Calvin)

We eventually settled on Big Ben after two years of back and forth and we're pretty happy with it! This problem was the official debut of his name and character in a flagship CALICO contest. Look forward to seeing more problems about Big Ben in the future!

And no, for the last time, despite some resemblances, his design is NOT a ripoff of [We Bare Bears](#).

## Big Ben's Big Birthday

As of the time of writing, the current date is 11/21/2023, the 13<sup>th</sup> birthday of Big Ben the Brown Bear! Happy Birthday Big Ben!

Fun fact: you can actually use the CALICalendar and the fact that today is Big Ben's 13<sup>th</sup> birthday to figure out when CALICO was founded!

## Problem Credits

- Idea: nacho, alfphaderp
- Problem Statement: alfphaderp, JJ, Chris, nacho
- Art: Chris
- Implementation: JJ, nacho, Nachismo
- Testing: JJ, Justin
- Editorial: rohit, alfphaderp

