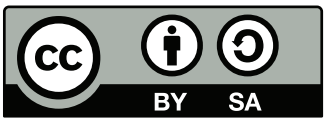
Freshmen Programming Contest

Contest Problem Set

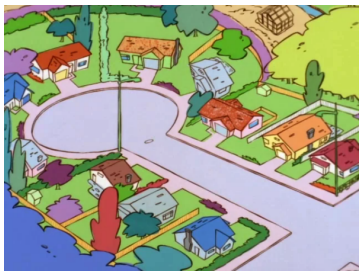
May 8, 2021

Problems



A Alleys Construction

Time limit: 1s



A neighbourhood in Andrei's city, with houses arranged in a circle.
© *Ed, Edd n Eddy*

In Andrei's city, people want to socialize as much as possible after the pandemic. The Fund for Providing the City (FPC) has announced that they want to construct alleys to create small social bubbles between households. An alley is a connection between two distinct houses. Each house must be connected with exactly one alley to another house within the same neighbourhood and the alleys may not intersect. Moreover, we know that the number of inhabitants of any neighbourhood will be even and the houses in each neighbourhood are arranged in a circle. The inhabitants want to find out, for each neighbourhood, in how many ways these alleys can be built. For example, in a neighbourhood that has six houses, there are five possible ways of constructing alleys, as shown in Figure A.1.

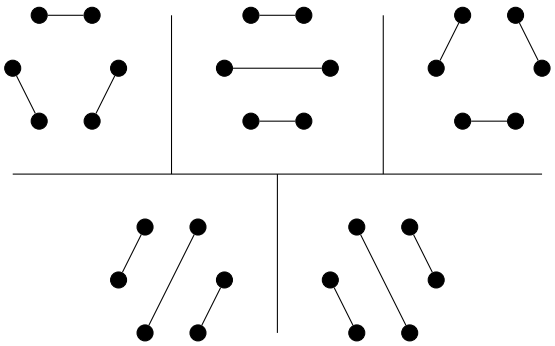


Figure A.1: For a neighbourhood of six houses, there are five possible ways of constructing alleys. Each black dot represents a house, and each line represents a possible alley.

Calculate in how many possible ways the inhabitants of Andrei's city could construct alleys in each neighbourhood. Because this number can be very high, the answer should be modulo 313109.

Input

The input consists of:

- A line with a single integer q ($1 \leq q \leq 10^4$), the number of neighbourhoods.
- q lines, each containing one even number n ($2 \leq n \leq 10^{18}$), representing the number of the houses in the neighbourhood.

Output

Output q lines, each line containing one number: the number of possible ways in which alleys can be built in each neighbourhood. This number should be modulo 313109.

Sample Input 1	**Sample Output 1**
4 6 10 122 50	5 42 256789 182049

B Bitcoin Bubble

Time limit: 2s

Cryptocurrencies

These days, all eyes and money are on crypto. The stakes are high and a team of experts, which call themselves the FPC (Fabulous People of Crypto) are on the verge of a big move. They call their move "The Bubble".

The Bubble will work as follows: one day, the FPC will release a set of classified information that will shake the market to its roots. That day, call it x, will be the epicenter of their move. To measure the impact of The Bubble, consider the longest sequence of consecutive days, starting on day a and ending on day b ($a \leq x \leq b$), for which Bitcoin's price is never lower than its price on day x. The impact is measured as the length of this sequence in days multiplied by the price of Bitcoin on day x. The starting day and the end day of The Bubble's impact should be within the boundaries of the period the FPC know the price for.

There is only one catch: despite anticipating Bitcoin's price for the foreseeable future, the FPC lack the most fabulous skill in the world: programming. Help them measure the biggest possible impact of The Bubble, given that they release the shocking information on an optimal day.

Input

The input consists of:

- A line with a single integer n ($1 \leq n \leq 5 \cdot 10^4$), the number of price anticipations for Bitcoin.
- n lines, each containing two integers p and d ($0 \leq p \leq 2 \cdot 10^9$ and $1 \leq d \leq 5 \cdot 10^4$), representing the price and the number of days the price lasts for.

Price information is given in chronological order.

Output

Output a single number, the biggest impact The Bubble can have.

Sample Input 1	Sample Output 1
4 3 2 9 4 5 2 7 4	50

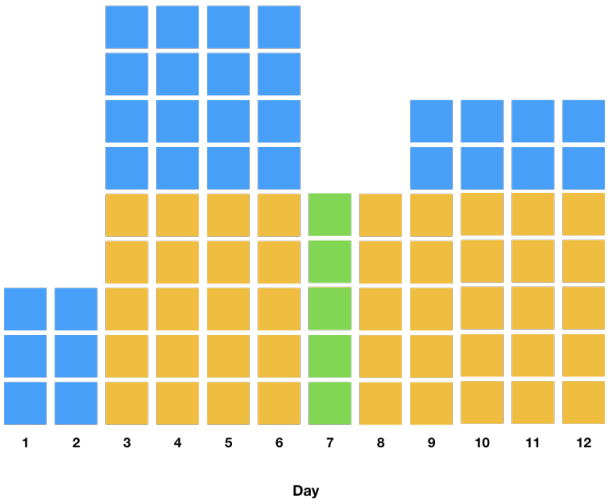


Figure B.1: A visualisation of the first sample input. The orange rectangle indicates the maximum impact of The Bubble. Day 7 (marked in green) is the epicenter of The Bubble.

Sample Input 2	**Sample Output 2**
10 5 5 8 1 8 3 9 1 0 6 1 6 1 5 6 2 6 5 9 6	78

C Coatis and Owls

Time limit: 2s

The coatis and owls have been at war for a long time already. They are preparing for battle, but given the pandemic, they also want to comply to social distancing. Therefore, they decide to do a digital battle instead, by playing the game Furious Pikemen Combat (FPC) against each other.

Two squads of pikemen in battle. (obligatory copyright notice[1])

The game features a one-dimensional battlefield. Both players control an *army*, each consisting of multiple *squads* of pikemen. The coati army is positioned on the left and the owl army is positioned on the right. During the game, the coati army walks to the right while the owl army walks to the left. When two enemy squads meet, they fight until one of the squads is completely defeated. Since all pikemen are equal in strength, the smaller squad will lose all of its pikemen. The winning squad will lose a number of pikemen depending on the size of the winning squad (w) and the size of the losing squad (l), equal to $\lceil l^2/w \rceil$ (where $\lceil x \rceil$ denotes rounding x up to the nearest integer, or ceiling). If two squads are equal in size, they will fight until both squads are annihilated.

Consider the first sample input as an example. The two squads controlled by the coatis (of 20 pikemen) walk to the right and the squad controlled by the owls (of 33 pikemen) walks to the left. When the right-most coati squad meets the owl squad, the coati squad is completely destroyed, while the owl squad loses $\lceil 20^2/33 \rceil = 13$ pikemen. In other words, the owl squad has 20 pikemen left. The single remaining squad for both players then consists of exactly 20 pikemen, so both squads will be annihilated, resulting in a stalemate.

Calculate who wins this digital battle of FPC, and how many pikemen the army of the winning player has left after the battle.

Input

The input consists of:

- A line with two integers n and m ($1 \leq n, m \leq 2 \cdot 10^5$), the number of squads controlled by the coatis and the owls, respectively.
- A line with $n+m$ integers a ($1 \leq a \leq 10^4$), where each a indicates the size of one squad of pikemen.

Output

If all pikemen from both armies are defeated, output "`stalemate`".

If one player wins the battle, output:

- A line containing either "`coatis`" if the coatis win the battle, or "`owls`" if the owls win the battle.
- A line with the number of pikemen remaining in the army of the winning player.

Sample Input 1	**Sample Output 1**
`2 1` `20 20 33`	`stalemate`

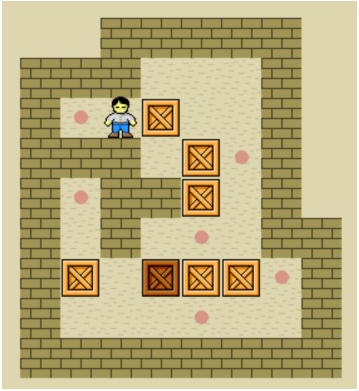
Sample Input 2	**Sample Output 2**
`3 3` `10 10 10 20 10 10`	`owls` `19`

[1]Screenshot from *Age of Empires II: Definitive Edition*. © Microsoft Corporation. This screenshot was created under Microsoft's "Game Content Usage Rules" using assets from *Age of Empires II: Definitive Edition*, and it is not endorsed by or affiliated with Microsoft.

D Distribution Center

Time limit: 4s

Sokoban is the best employee at your town's biggest distribution center. He likes his job because it is simple, albeit a bit physically intensive. Everyday he is pushing crates to some possbile destinations from where they will be loaded in trucks. Unfortunately, Sokoban's youth is behind him, so he starts to feel the effects of the physical labour. Therfore, he came up with an algorithm to help him move the crates optimally: the Fast Pushing Crates (FPC) algorithm. For the algorithm to be complete, he needs a bit of help from you.



Sokoban pushing crates in the distribution center. CC-BY 3.0 By Carloseow at English Wikipedia.

His algorithm receives as input the layout of the distribution center, as a grid, and returns the steps he needs to take to efficiently push the crates. In his algorithm, he needs to find out which squares in the grid are *dead squares*. We call a square a dead square if it is a wall or if it is impossible to push a crate from that square to any of the destinations (even if Sokoban could teleport to any location).

Given the layout of the distribution center, help Sokoban find out which squares are dead squares.

Input

The input consists of:

- A line with two integers r and c ($1 \leq r, c \leq 10^3$), the number of rows and columns of the grid.
- r lines, each containing c characters, where:
  - A '`#`' represents a wall. It is guaranteed that the grid is surrounded by walls.
  - A '`D`' represents a destination. There can be any number of them, including 0.
  - A '`.`' represents an empty square.

Output

Output r lines, each containing c characters, where the ith character of the jth line is:

- '`X`' if the square at position (i, j) is a dead square.
- '`O`' otherwise.

Sample Input 1

```
7 7
#######
#.....#
#.....#
#..D..#
#.....#
#.....#
#######
```

Sample Output 1

```
XXXXXXX
XXXXXXX
XXOOOXX
XXOOOXX
XXOOOXX
XXXXXXX
XXXXXXX
```

Sample Input 2

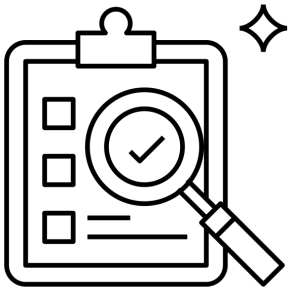
```
8 8
########
#..#D###
#..#.###
#..#.###
#..#...#
#..#.###
#D.#.###
########
```

Sample Output 2

```
XXXXXXXX
XXXXOXXX
XOXXOXXX
XOXXOXXX
XOXXOOXX
XOXXOXXX
XOXXXXXX
XXXXXXXX
```

E Efficient Grading

Time limit: 1s



CC-BY 3.0 By Becris on The Noun Project.

You are the new responsible instructor for the newest course at TU Delft: Financial Project Coordination (FPC). The course went smoothly throughout the quarter, but now you are faced with a new challenge: you have a multitude of exams to grade. You want to finish the exams as quickly as possible before your new course starts. Luckily for you, you can employ some teaching assistants (TAs) to help out. For each TA that you employ, you need to spend some time giving them a quick training, by quickly going through an example exam. As a result, a trained TA can, in turn, grade exams as well and can also train other TAs. The time you spend training is the same as the time you could spend grading.

With this in mind, you need to find out 2 things. Firstly, what is the minimum amount of time needed to grade all exams? Secondly, what is the minimum number of graders needed to achieve this time?

Input

The input consists of a single line containing two integers:

- n ($1 \leq n \leq 10^6$), the number of exams to grade.
- t ($1 \leq t \leq 10^9$), the amount of time needed to grade an exam or train a TA.

Output

Output a single line, with 2 space-separated numbers:

- The minimum amount of time needed to grade all exams.
- The minimum number of graders (yourself plus the number of trained TAs) needed to finish grading within the minimum amount of time.

Sample Input 1	Sample Output 1
4 2	6 2

Sample Input 2	Sample Output 2
100 100	800 36

This page socially distances the two surrouding problems.

F Fraud Checking

Time limit: 1s

The exam of the First Programming Course (FPC) was a success: all students have passed, with excellent grades! In fact, they have done so well, that it is somewhat suspicious. It is time to do a fraud check, but nobody has time to sift through the hundreds of code submissions manually. Therefore, you have been tasked with finding code submissions that are similar in structure: you should make a fraud report if the only difference between two pieces of code is the renaming of some variables.

Image by Maarten Sijm. Magnifying glass from Wikimedia Commons.

More precisely, one piece of code is *similar* to another when it is possible to make the two pieces of code identical to each other by processing a sequence of word replacements. When, after processing all word replacements, the first piece of code is identical to the second piece of code, and this also applies vice versa, then the two pieces of code are similar.

Each word replacement should replace *all* occurrences of a word. A word replacement can only replace a *complete* word. Spaces between words or at the start/end of a line should be ignored, but newlines cannot be ignored: for two pieces of code to be similar, each line of the first piece should have the same number of words as the same line in the second piece.

Given two pieces of code, check whether they *similar*. If they are similar, print a fraud report that gives the sorted list of word replacements.

Input

The input consists of:

- A line with one integer n ($1 \leq n \leq 1000$), the number of lines of each code submission.
- n lines of code for the first submission.
- n lines of code for the second submission.

The lines of code consist of only spaces (‘ ’), letters from the English alphabet (‘`A-Z`’ and ‘`a-z`’), numbers (‘`0-9`’), and underscores (‘_’). The lines of code are at least 1 and at most 120 characters long, excluding the newline character.

Output

If the two pieces of code are not similar, output “`-1`”.

If the two pieces of code are similar, output:

- A line containing a non-negative number r, indicating the number of word replacements.
- r lines, each containing a word replacement. A word replacement consists of two words, separated by a space. The list should be lexicographically ordered by ASCII values.

Sample Input 1

```
4
i is 42
while i
    subtract i
print i
j is 1337
while j
    add j
print j
```

Sample Output 1

```
3
42 1337
i j
subtract add
```

Sample Input 2

```
3
ans is 42
if ans is 42
    print ans
ans is 42
if ans is not 42
    print ans
```

Sample Output 2

```
-1
```

Sample Input 3

```
2
ans is 42
print items
ans is 42
print ans
```

Sample Output 3

```
-1
```

G Gardening

Time limit: 1s

In preparation for the Fashionable Park Competition (FPC), you have set out to prune all the trees of your town's park into fashionable shapes. With so much work to do, you decide that you might as well make a fun game out of it. You take a tree that looks particularly odd, label all the branches, and start chopping off branches according to the following rules:

- Only a leaf can be chopped off the tree.
- When choosing between multiple leaves to chop, start with the leftmost one.

Your town's fashionable park, after pruning the trees. CC0 on Wikimedia Commons.

The tree can be codified as a string. Each node has a non-unique label on it (a lowercase letter) and a list of children. The children of the node are given as a list of labels between '`(`' and '`)`' and separated by '`,`'. Note that a leaf (a node with no children) is not followed by a list of labels.

The tree in Figure G.1 shows a visualisation of the codified tree of the first sample input. For this tree, the leaf with label '`b`' should be chopped first, followed by '`d`', '`e`', and '`f`'. Node '`c`' is now a leaf, so it should be chopped next. Finally, '`a`' can be chopped as well.

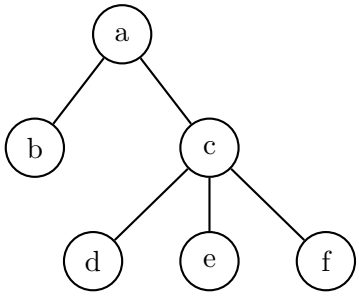


Figure G.1: A visualisation of the first sample input.

Given the codification of a tree, parse it and compute the order in which the nodes should be chopped off the tree, if you would chop them off all the way to the root.

Input

The input consists of:

- A line with a single string s ($1 \leq |s| \leq 10^5$), the tree codification.

The string s contains no spaces, and you can assume that it is a correct codification for some tree.

Output

A string consisting of the nodes' labels, printed in the order in which they should be chopped.

Sample Input 1	**Sample Output 1**
`a(b,c(d,e,f))`	`bdefca`

Sample Input 2	**Sample Output 2**
`t(z(t(z,t(c,c))),y)`	`zccttzyt`

H Heraldic Prediction

Time limit: 0.5s

After beating your friend Reyn in various games such as Chess, Backgammon, Checkers, and Battleships, you have almost managed to convince him that you possess the Monado – a magic sword that lets you see the future. In an act of desparation, he offers you one last challenge. He will tell you a number n between 1 and 10^{16} and then secretly pick a prime number p of any size. It will then be your job to tell him an even number m, where $n < m < n + 50$, and $p^2 + m$ is a composite number (a composite number is a positive integer, which can be formed by multiplying two smaller positive integers). If both of those conditions are fulfilled, it will be clear that the future truly is yours to decide. Luckily, you suspect that Reyn might not have thought this game through very well, and that it is probably possible to determine an m, which adds up to a composite number with any possible value of p.

With this knowledge in mind, make a program that can beat Reyn, no matter what numbers he picks.

The Monado – a magical sword that lets its wielder glimpse the future.

Input

The input consists of:

- A line with a single integer n ($1 \leq n \leq 10^{16}$), the number chosen by Reyn.

Output

Output a single even number m, where $n < m < n + 50$ and $p^2 + m$ is composite for any prime p.

If there are multiple valid solutions, you may output any one of them.

Sample Input 1	Sample Output 1
5	26

Sample Input 2	Sample Output 2
4242	4256

This page socially distances the two surrouding problems.

I Icarus' Rebirth

Time limit: 1s

Jacob Peter Gowy's
The Flight of Icarus (1635–1637)

In an attempt to escape from Crete's highest tower, where they were imprisoned, Icarus and his father Daedalus made two pairs of wings, with which they could fly away to Athens. During their flight, all was well until Icarus' hubris led him to fly too close to the sun, causing his wings to melt and him to drown in the Mediterranean Sea. Mourning the loss of his child, Daedalus now undertakes a perilous journey through the underworld to find Hades – the god of the dead. He meets Hades and begs him to give back his son.

"Your request shall be granted, craftsman, but only if you prove yourself worthy by solving this task," says Hades. "I shall give you a word in the language of the gods. You see, the way we gods measure a word's length is different from the method you humans use. We measure the length of a word by calculating the minimum number of steps that need to be taken from the first character, to reach the last one. In a step, starting from the character with value x at position i, you may either go to a character with position $i-1$ or $i+1$, or you can go to the closest character with value x to the left or to the right." Daedalus is a smart man, and knowing he can not solve this problem for enormous words, he asks you to write a computer program that calculates the length of any word on your magical stone tablet.

Given some word in the language of the gods, calculate its length according to the gods' way of measuring, so Daedalus can take back his beloved son Icarus.

Input

The input consists of:

- A line with a single word w ($1 \leq |w| \leq 10^5$). The word contains only lowercase letters from the English alphabet ('`a-z`').

Output

Output a single number, the length of the word w, according to the gods' way of measuring.

Sample Input 1	Sample Output 1
`word`	`3`

Sample Input 2	Sample Output 2
`adiacrac`	`3`