Университет ИТМО

Факультет программной инженерии и компьютерной техники

Лабораторная работа №1

по «Алгоритмам и структурам данных»

Введение в алгоритмы

Выполнил:

Студент группы P3233

Нгуен Нгок Дык

Преподаватели:

Косяков М.С.

Санкт-Петербург

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Code: https://github.com/ndwannafly/ITMO_ALGO

Задача № **A. Аргоном-любитель**

My comment: Nothing special. Can be solved in O(n^2) by two for loops for O(n log n) binary search on the maximum length. But we will come up with O(n) solution.

Task reformulation:

- Find longest segment (L,R) that does not contain 3 consecutive equal elements

Constraint:

- $N \leq 200\ 000$
- $a[i] \leq 10^9$

Keyword: Two-pointers**.**

Solution:

- Remain two pointers (L, R) from the beginning.
- Expand the segment to the right while (L,R) is a good segment.
- Translate pointer L while (L, R) is not a good segment.

Note:

- Initially, L = 0, r = min(n - 1, 1), (L, R) is a good segment
- If (L, R) is a good segment then (L, R+1) is a good segment if and only if 3 last elements in it are not equal.
- If (L, R) is a good segment then (L+1, R) is a good segment if and only if 3 first elements in it are not equal

Complexity:

- Operations: O(n).
- Space: O(n)

Задача № **B. Зоопарк Глеба**

Task reformulation:

- The Latin letters (both lower case and upper case) are on the circle.
- We call two letters are «**matched**» if two of them are the same character (no case-sentitive).
- Eliminate the letter from the circle if it «**matches»** the letter nearby (to the left or to the right).
- Determine : « Is it possible to eliminate all the letter?».
- If it's possible, print **the index of letter which matches the traps** in order from **left to right** if the string.

Constraint:

- $N \leq 100000$

My comment: This task is close to «the correct open-close parenthesis problem» but instead of having '(' and ')' only, we have 26 latin character.

Keyword: Stack

Solution:

- Iterate through the string and remain a stack which restores all the unmatched letters.
- Each new character we get during iteration, check if it matches the top of the stack.
- If yes, we match them and pop the top of the stack.
- If no, push this character onto top of the stack.

Note: This statement is written not clearly. Read it carefully.

Complexity:

- Operations: O(n)
- Spaces: O(n)

Задача № **C. Конфигурационный файл**

Task reformulation:

- Write a parser which file read line by line.
- File consists of blocks which open { and close by }
- A block can contain another block inside it.
- There are two types of assignment

  + Assign «variable» = «variable» . Print out the current value.

  + Assign «varibale» = «number». No need to print
- When a block is closed, restore all variables inside it equal to their values in the outer block.

Constraint:

- Number of line ≤ 100 000

My comment: Whenever solving a parsing problem, we should always think about stack or recursion. In this case, recursion is good choice because the blocks are nested and implementation is simple.

Keyword: Parsing, recursion, map

Solution:

- Use a map to store the variable's value.
- In recursive function, use a vector to store the name of variable and its old value (in outer block).
- Read file line by line. We get these following cases:
  - The line is '{' , call recursvely the function again.
  - The line is '}', restore variables by their the old values
  - The line is an assignmenet operation:

    + if assign to a number, assign it and update the map and vector.

    + if assign to a variable, assign it, print out the new value and update the vector and map.

Complexity:

- Let **number of variables** = n;

- **Operations** : O(n * log n) because of using the map
- **Spaces** : O(n)

Задача № **D. Профессор Хаос**

Task reformulation:

- We have 5 number a, b, c, d, k.
- Initally day 0, we have a number x = a;
- Each day after, x is changed by these following rules:
  - X = x * b ;
  - X = max(0, X - c);
  - If(X > d) x = d
- Find x after k days.

Constraint:

- $1 \leq a, b \leq 1\ 000$
- $0 \leq c \leq 1000$
- $1 \leq d \leq 1000$
- $a \leq d$
- $1 \leq k \leq 10^{18}$

Keyword: Greedy

Solution:

- We can easily prove / examine that after 10^5 days the function of x is convergent.
- Result = Solve (min(10^5, k)).

Complexity:

- Operation**:** O(10^5)
- Spacing**:** O(1)