SKP 2014 problem presentation; spoiler alert!

A - Administration (1/2)

Problem description

Bookkeeping problem: Read in a log file and print the costs for all users if the log is not CORRUPT. Sort the users in the output on alphabetical order (abc...z).

Solution - Variables:

- class User(String name, List books, int pay)
- TreeMap<String, User> allUsers
- Stack<String> bookpile
- boolean corrupt

A - Administration (2/2)

Solution - Processing

- borrow book: is this book available?
- return book: can this user return this book? How much does he need to pay.
- make books available: check the size of the pile
- don't forget to charge users €10.00 for every book they didn't return.

Back and Forth

Problem description

- Given a string s with length $1 \leq |s| \leq 10^6$, is this string a palindrome?

Solution

- Just loop over the string and compare the chars at the beginning with their corresponding places at the end.
- Note that you only have to check the first half of the string, if you didn't; no problem 10^6 steps is still acceptable.
- Optionally you could use a StringBuilder to reverse the string and match it against s using the matches function.

Cryptography (1/3)

Problem description

- Given a number n $1 \leq n \leq 10^{10}$, decide whether it's a prime number or not.

Things to notice

- Since n can be 10 billion you have to use longs, not integers as they can only store up to 2.1 billion.
- The problem becomes a lot more easy if you know the modulo (%) operator.

Cryptography (2/3)

Naive approach

- if $n < 2$ output BROKEN
- else if $n == 2$ output SAFE
- else loop from $i = 2$ to n and check if a number $i\%n == 0$. If true output BROKEN else output SAFE.
- This takes approximately 10^{10} steps which would result in TIME LIMIT EXCEEDED.

First optimization

- Notice that after $n/2$ no divisor can be found anymore, so loop from 2 to $n/2$. This reduces the number of steps to approximately 5 billion, which is unfortunately still too much.

Cryptography (3/3)

Correct approach

- The correct approach is to loop until the square root of n.
- You are looking for pairs of numbers a and b so that $a * b = n$ if n happens to be a composite number. You would only need the smallest of the two and this number must be smaller or equal to $\sqrt{n}$, if this would not be the case both a and b would be strictly greater than $\sqrt{n}$ contradicting the fact that $a * b = n$.
- Using this approach you end up with approximately $\sqrt{10^{10}} = 10^5 = 100.000$ which is perfectly fine.
- An optional optimization is to check if $n\%2 == 0$ and if not loop from i=3 to $\sqrt{n}$ where you skip all even numbers by incrementing i with 2 every time. This would leave you with approximately 50.000 steps.

Diagnosis

Problem description

Union of all of the sets of symptoms of selected diseases.
Print "yes" if the diseases clarify all symptoms, no otherwise.

Solution

- Set<Integer> symptoms
- loop over all sets and do 'output.add' or '.addAll'
- output contains all symptoms?

Efficient Pinning

Problem description

- Given two rectangles representing *Board* and *CPU*, count the number of possible ways *CPU* matches subrectangles of *Board*.

Solution

- Check every possible subrectangle of *Board*, with size equal to *CPU*.
- Count subrectangles that are equal.
- Print the number of matches found.
- Optimization: stop checking a subrectangle as soon as a mismatching *pin* is found.

Friends

Problem description

- Given an graph, check whether all vertices are reachable.

Solution

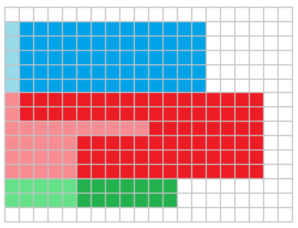
- Do a BFS, starting from node s. Keep track of the visited nodes.
- Check whether all nodes have been visited, print "yes" if so, and "no" if not.

Problem description

- Given a sequence of points defining a perimeter, find the area within this perimeter.

Smart solution

- Calculate the sum of the areas between each line segment and the y-axis.
- $|\Sigma x_i \cdot (y_i - y_{i+1})|$
- Area is positive if $y_i > y_{i+1}$ (going down) and negative if $y_i < y_{i+1}$ (going up).
- Area between tiles and y-axis is added and subtracted, leaving only the total area of tiles.



Administration
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Gardening
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Inaccurate Expectations

Gardening (2/2)

Intuitive solution

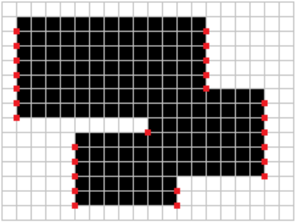
- Use a map to save a list of points for every line.
- Be careful not to count area below or above an edge.
- Going down:

$$for(j = y_i - 1 \ldots y_{i+1})$$
$$map.get(j).add(x)$$

- Going up:

$$for(j = y_i \ldots y_{i+1} - 1)$$
$$map.get(j).add(x)$$

- Finally, calculate the total area by adding $x_{i+1} - x_i$ for every even i for each row.



High Towers (1/3)

Problem description

- Count the number of upward triangles in a triangle of height n.

Recursive formula

- Recursive formula: $f(n) = f(n-1) + \text{âĂŐâĂŐ} \sum_{i=0}^{n} i\text{âĂŐ}$
- However, with $n \leq 200000$, this would result in a stack overflow.

High Towers (2/3)

Iterative formula

- $f(n) = \sum_{i=0}^{n} i + \sum_{i=0}^{n} (i-1) + \ldots + \sum_{i=0}^{n} (i-n) =$
- $\sum_{i=0}^{n} \frac{i(i+1)}{2} = \frac{1}{2} \sum_{i=0}^{n} i^2 + i = \frac{1}{2} (\sum_{i=0}^{n} i^2 + \sum_{i=0}^{n} i)$
- Should give correct answer.

Faster solution

- Direct formula is possible.

High Towers (3/3)

Things to notice

- $\sum_{i=0}^{n} i = \frac{1}{2}n(n-1)$
- $\sum_{i=0}^{n} i^2 = \frac{1}{6}n(n+1)(2n+1)$

Direct formula

- $f(n) = \frac{1}{12}n(n+1)(2n+1) + \frac{1}{4}n(n+1)$

Inaccurate Expectations (1/2)

Problem description

- For a given n, output g(n)

Solution

- "Simply" return n + n * g(n - 1), except for n = 0, which should return 0.
- Expectation:
  g(1000) = 109380...[some more digits]...20000.

Inaccurate Expectations (2/2)

Problem description

- For a given n, output g(n)

Solution

- "Simply" return n + n * g(n - 1), except for n = 0, which should return 0.
- Expectation:
  g(1000) = 109380...[2558 more digits]...20000.
- Use BigInteger