FPC 2015 problem presentation; spoiler alert!

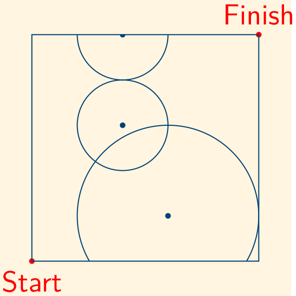
A - Alcatraz

Problem description

Find out if a path from $(0,0)$ to (w,h) is possible.

Solution

- Breadth First Search (BFS) over guards within each other's range.
- BFS over points not possible, because space is continuous.
- Guards overlap if: $(x_1^2 - x_2^2) + (y_1^2 - y_2^2) <= (r_1 + r_2)^2$.



B - Bad English (1/2)

Problem description

Given a string which represents (a part of) the recording, was it literally translated from Dutch to English?

Solution - variables

- String r – A representation of the recording.
- String t – The Dutch equivalent of r.
- String d – The Dutch words used in t (no repetition, sanitized and sorted alphabetically).
- String e – The English translation of the words in d.

B - Bad English (2/2)

Solution - processing

First check if r and t contain the same amount of words. If not, return “VALID”. Else, perform the following steps:

1. Sanitize both r and t: make them lowercase and remove punctuation.
2. For each dutch word, retrieve the English counterpart and compare with the word in r.
3. If all words correspond, output “STONECOAL” else “VALID”.

Key data structure: Map. Simply use the words in d as keys and the corresponding translation in e as value. I.e. looping over arrays for each word in t is too slow since you have up to 10^4 words.

C - Composius' Wrath

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Road selection:

This can be solved by constructing a Minimum Spanning Tree (MST) of the graph and count the number of prime roads and non-prime roads.

D - Deal or No Deal

Problem description

How much did the contestant won and how much could he have won by declining all bank offers?

Solution

- The amount of money the contestant wins by declining all bank offers, is the amount of money in his chosen box
- Simulate the game, keep track of opened boxes and calculate the bank offers.

E - Excellent Grades (1/2)

Problem description

Output the grade required for achieving a *cum laude* degree.

Solution:

- Calculate total required points $8 \sum w_i$.
- Subtract all exam grades multiplied by their weight.
- Divide by the weight of the final exam's grade.

E - Excellent Grades (2/2)

Problems

- Print 1 decimal.
- Print 5.8 if required ≤ 5.8.
- Ceil the required grade.

F - Floor Tiling (1/5)

Problem description

In how many ways can a $3 \times 2n$ floor be tiled with domino tiles?

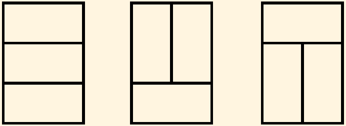
Solution

- Special case of the domino tiling problem (with an unbounded width/height of the floor).
- If the floor always has width 2, the number of tiling of a $2 \times 2n$ floor is described by the Fibonacci sequence.

F - Floor Tiling (2/5)

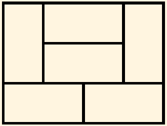
Solution - 3×2 case

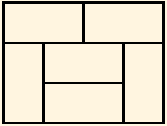
- Trivial, we have three possibilities here:



Solution - 3×4 case

- For the 3×4 case, we can make combinations of 3×2 patterns.
- However, we have two extra possibilities:

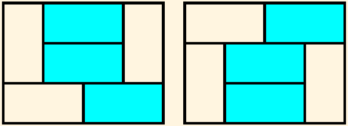




F - Floor Tiling (4/5)

Solution - $3 \times 2n$

- let a_n the number of tilings of a $3 \times 2n$ rectangle, we get a_{n+1} by adding a 3×2 block which gives $3a_n$.
- we also get a_n by considering cases where this block is added to previous blocks without any 3×2 block.
- we can construct $3 \times n$ blocks without any 3×2 blocks by duplicating the "internal" tiles of the 3×4 cases.



F - Floor Tiling (5/5)

Solution - $3 \times 2n$

$$a_{n+1} = 3a_n + 2\sum_{i}^{n} a_i$$

By subtracting a_n from both sides and some rewriting, we get:

$$a_{n+1} = 4a_n - a_{n-1}$$

- The numbers can become big, use the Java built-in `Math.BigInteger`.

G - Grand opening (1/2)

Problem description

Given a key and one or more locks, in how many locks does the key fit.

Solution - Notes

Since the key is given last, you will need to store information about the locks. One way is to store each lock in a 2D String[][] array (where line 6 of lock 2 is array[1][5]).

G - Grand opening (2/2)

Solution - Processing

Start by checking every line. For every lock L, check if the key K fits:

1. find the first # in every line in L
2. find the last # in every line in K
3. per line: if the position of the last # in K is lower then the corresponding position of the first # in L, the line will fit
4. if every line fits, the key fits.

Now all there is left to do is print the number of keys that fit.

H - Hypotenuse (1/2)

Problem description

Calculate the unknown in $a^2 + b^2 = c^2$.

Solve the unknown:

Three possibilities:

- a unknown: $a = \sqrt{c^2 - b^2}$
- b unknown: $b = \sqrt{c^2 - a^2}$
- c unknown: $c = \sqrt{a^2 + b^2}$

Simplify a square root:

- $\sqrt{72} = \sqrt{4}\sqrt{18} = 2\sqrt{18}$
- $2\sqrt{18} = 2\sqrt{9}\sqrt{2} = 6\sqrt{2}$