Arcade Crane

Problem author: Vitaly Aksenov

A

- You are given a permutation of the numbers 1 to $n \leq 1000$ that you need to sort.
- In a single step, you can take three consecutive numbers out of the sequence and re-insert them somewhere else.
- Output a sequence of up to 5000 steps that sorts the sequence.

Illustration of Sample Output 1.

Bisecting Bargain

Problem author: Wendy Yi, Michael Zündorf

B

- Two people want to withdraw €$n \leq 10\,000$ from a cash machine.
- Machine can dispense coins and notes of values €1, €2, €5, €10, €20, €50, €100, €200, and €500.
- Check if there exists a way of dispensing €n that cannot be split evenly into two piles of €$n/2$.
- Output the coins and notes dispensed such that they cannot be split evenly, or report that the split is always possible.

For $n = 52$, the machine could dispense a €50 note and €2 coin.

Photo by Jeroen Op de Beek

Canal Crossing

Problem author: Michael Zündorf

C

- You are given a road network (a tree) with $n \leq 10^5$ places, and a set of $m \leq 5 \cdot 10^5$ bridges connecting places from the tree.
- The roads have given lengths up to 10^6, bridges have length 0.
- Find the shortest tour that crosses all bridges, and uses each road at most once. It is guaranteed that this is possible.

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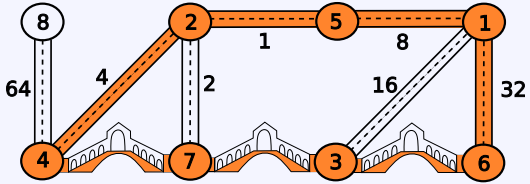


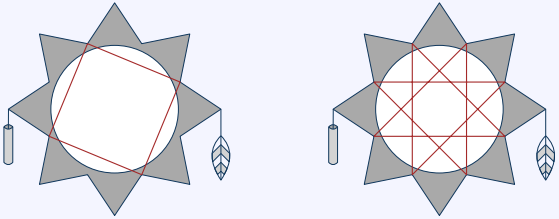
Illustration of Sample Input 1, with a shortest tour of length 45 highlighted.

Dreamcatcher

Problem author: Christopher Weyand

D

- Given a wheel with $n \leq 10^9$ evenly spaced notches.
- Wrap a string of yarn around it by starting at notch 1, and repeatedly connecting the yarn k notches ahead until you reach notch 1 again.
- What value of k maximizes the amount of used string?



A dreamcatcher with 8 notches, wrapped in a string of yarn for $k = 2$ and $k = 3$.

Erratic Lights

Problem author: Atli Fannar Franklín

E

- You have a string of $n \leq 100$ `r`ed/`g`reen/`b`lue lights.
- Every time you touch a light bulb, it randomly takes one of the three colours, each with equal probability.
- You want the lights to have *any* identical colour.
- What is the expected number of times you need to touch a light bulb to make all of them have the same colour?

Example: Given two lights `rb`, an optimal strategy is to keep touching the first light until it turns blue. This takes 3 steps on average.

Fair Share

Problem author: Yidi Zang

F

- $n \leq 10^5$ people visit a restaurant and need to pay.
- Each person has their own share b_i and an amount of cash a_i.
- One person will pay the entire bill and receive the cash from all others.
- Choose that person so they do not have to pay more than their own share b_i.
- There may be no such person.

KIT teams having a celebration dinner after NWERC.
Photo by Christopher Weyand

Group Photo

Problem author: Lucas Schwebler

G

- You are given a permutation $(a_i)_{1 \le i \le n}$ of the numbers 1 to $n \le 5 \cdot 10^5$.
- You want to turn it into a "mountain-shaped" permutation $(b_i)_{1 \le i \le n}$, meaning it is first increasing and then decreasing.
- You want to keep as many indices of the permutation the same, so maximize the number of i such that $a_i = b_i$.
- What is the smallest number of indices that need to change?

Illustration of Sample Input 1. Free Pexels License by PNW Production on Pexels

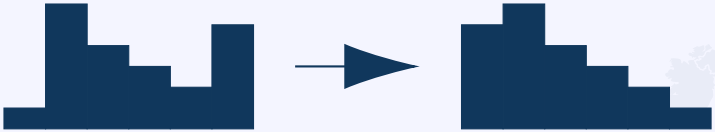


Illustration of Sample 1, where it's optimal to swap the first and last element. The answer is therefore 2.

Hasty Haul

Problem author: Michael Zündorf

H

- You need to find a strategy with no risk for moving furniture around in the registration room.
- The room has at most 64 slots to place furniture, at least one slot has furniture, at least one slot is empty.
- This strategy must be such that if it is applied twice, you return to the original state. It must also not have any state as a fixed point.
- The possible states of a room with n slots and k pieces of furniture can be represented as a bitstring of n bits and k ones.
- The strategy is thus a perfect matching on this set of states, if one exists.
- This is a multi-pass problem with up to 10 000 test cases per run.

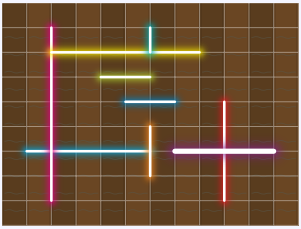
The registration area at NWERC 2024.
Photo by Maarten Sijm

Illuminated Stalls

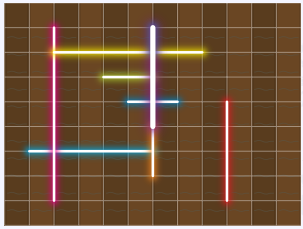
Problem author: Jeroen Op de Beek

I

- Given $n \leq 2 \cdot 10^5$ axis-aligned segments in 2D (neon light tubes).
- Horizontal lights do not touch other horizontal lights, same for vertical.
- Can you move/rotate one light to form a square?
- Up to 20 000 test cases per run, with at most $2 \cdot 10^5$ tubes in total.



Example initial light configuration.



The purple neon light was moved to make a 4×4 square.

Mulled wine stall at the Leipzig Christmas Market. CC BY-SA 4.0 by Joachim Köhler on Wikimedia Commons

Juggling Keys

Problem author: Markus Himmel

J

- There are $n \leq 10^5$ people living in an apartment, but they only have k ($\leq n$) keys to share.
- If a person comes home while someone is home, they will be let in. Otherwise, they need a key.
- Given the times when each person is out, determine when each person should take a key with them.

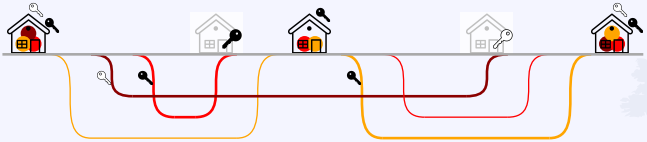


Illustration of Sample Input 1, with 3 people, 2 keys, and a total of 5 trips. Trips where the person brings a key are shown in bold. Twice, a person comes home to an empty house and has to use their key to open the door.

The DOMjudge team working in a shared flat.
Photo provided by the DOMjudge team

KIT Finding

Problem author: Paul Wild

K

- Create an $h \times w$ ($h, w \leq 100$) grid consisting of letters '`K`', '`I`' and '`T`' such that
  - each letter occurs a given number of times (k, i and t times, $k + i + t = h \cdot w$); and
  - there is exactly one occurrence of the word "`KIT`".
- Words can be read in 8 directions: horizontally, vertically, diagonally.

I	K	I	I	T
K	K	T	K	T
I	T	I	T	I
K	T	T	K	I

A possible answer for the case $h = 4, w = 5, k = 6, i = 7, t = 7$.

Last Christmas

Problem author: Jeroen Bransen

L

- Given are $n \leq 100$ top-10 lists.
- Find the artist with the highest number of appearances.
- In case of a tie, look at most 1st-place positions.
- When still a tie, look at most 2nd-place positions.
- And so on...
- If they are tied for all 10 positions, output "`tie`".

Back cover of Last Christmas, modified.
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