

A&D Practicum Assignment 2

The problem

It is 2021 and the number of first-year students in Computer Science at Radboud University exceeds 500. In order to reduce the teaching load for the staff, the faculty board has decided that only multiple-choice exams are allowed in the Computer Science programme. The professor of the Algorithms & Data Structures course fiercely opposed this decision, since he believes it is crucial that during an exam students demonstrate their ability to design new algorithms, as well as their ability to present and analyze these algorithms at the appropriate level of abstraction. According to the professor, a multiple-choice exam for Algorithms & Data Structures is just as ridiculous as a multiple-choice exam for a course on Creative Writing. After a prolonged fight with the faculty board, the professor continues to give the course and, sulking, he even prepares multiple-choice exams. However, he rarely shows up at the department anymore and his behavior has become pretty weird.

The latest exam for Algorithms & Data Structures consisted of true-or-false questions only and was a complete disaster: the questions were so difficult that only a few students passed the course. The students would like to know what the correct answers were, but the professor did not make those available. The only feedback which he gave to students consisted of the number of correct answers in their exam. None of the students dares to ask the professor for the solutions to the exam problems. Is there another way for the students to figure out the correct answers? Based on how far some of the grades are from expected, some students suspect that the software that was used for grading is flawed. But would it be possible to prove this?

Given, for each student, the answers that he/she gave for all the questions as well as the total number of correct answers, can you figure out the correct answers for the individual questions? And if there is no solution or more than one, can you compute the total number of solutions that is consistent with the information the students have?

Instructions

You may work in groups of two. For this assignment you have to hand in two things:

- Source code. We will run the code for grading.
- A report. In the report you have to explain the algorithm and analyse it.

Source code You are allowed to submit a solution in either C, C++, Java or Python¹. Python will take significantly longer than a few seconds on the largest test cases, but the test server takes language into account. All languages have their own time limits. If you prefer another language, please contact Timo Maarse as soon as possible (no guarantees!) You are only allowed to use the Standard Library corresponding to your selected language. We will soon set up a test website on which you can upload and test your code.

Report Besides handing in code, we would like to receive a report in which you explain your algorithm and analyse its correctness and runtime complexity. The report is important and determines 40% of the final grade! We expect a clearly written high-level explanation of how your algorithm works, and a convincing analysis of correctness and asymptotic complexity.

Submission The deadline for sending in your solution is on January 8. You must submit your solutions via Brightspace. Only one team member has to submit a solution; the names and student numbers of both team members must be mentioned in the report.

Grading Grades will be determined as follows. You may earn up to 100 points for your solution:

- 20 points for the explanation of your algorithm.
- 10 points for the correctness analysis.
- 10 points for the complexity analysis.
- 50 points for the test results. We will be running several tests and you will get points for every correct answer within the time limit. (The exact time limit will be determined after the submission deadline, but it will be

¹Using the JIT-compiler pypy; the normal Python implementation is far too slow, take this into account when testing larger test cases.

in the order of 1sec.) If your code does not compile or does not read and write via `stdin` and `stdout`, you will get zero points on the test cases. So please test your code well!

- 10 points for the quality of the code.

If you have any questions, do not hesitate to contact student assistant Timo Maarse (timo.maarse@gmail.com), who is helping with the organization of the practicum, or the instructor Frits Vaandrager (F.Vaandrager@cs.ru.nl)!!!

Input

- The first line has two space-separated integers n and m ($1 \leq n \leq 12$ and $1 \leq m \leq 40$): the number of students and the number of questions in the exam, respectively.
- Then follow n lines, each with m digits, each digit either 0 or 1: the answers given by each student with 0 representing “false” and 1 representing “true”. This is followed by a space and a single integer c ($0 \leq c \leq m$): the number of correct answers for that student.

Output

- One line with m digits, each one either 0 or 1: the unique sequence of correct answers that could account for all the results. If there is not exactly one such sequence, the line should read “# solutions” instead, with the number of solutions in place of “#”.

Sample inputs and outputs

Sample 1	
Input	Output
3 5 01101 4 10100 3 00011 3	00101

Sample 2	
Input	Output
3 5 01101 0 10100 3 00011 2	0 solutions

Sample 3	
Input	Output
4 4 0000 2 1010 2 0101 2 1111 2	4 solutions