Linear and Integer Optimization
Programming Exercise 1

Implement the Fourier-Motzkin elimination algorithm to decide if an LP $\max\{c^t x \mid Ax \leq b\}$ has a feasible solution. If it has a solution, print a solution vector to the standard output as a single line. If it does not have a solution, print the string "empty" followed by a certificate vector $u \geq 0$ with $u^t A = 0^t$ and $u^t b < 0$ (in one line). The program has to be implemented in C/C++ and compile with either the GNU compilers gcc/g++ or clang/clang++. The program should be run from the command line and read in a text file, whose name is given as an argument. The text file specifies the LP in the following format.

- The first line contains the number m of rows and n of columns of A.

- The second line contains n floating point numbers specifying c.

- The third line contains m floating point numbers specifying b.

- The next m lines contain the rows of A. Each line contains the n floating point numbers in the respective row.

- Entries in the same line are separated by blanks.

On the web site to the exercises you find test instances.

Example: The linear program

$$\max(-2, 0, 8) \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

$$\text{s.t.} \quad \begin{pmatrix} 3.5 & -2 & 5 \\ 0 & 1 & -4 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} \leq \begin{pmatrix} 3 \\ 0 \end{pmatrix}$$

will be encoded as follows:
```
2 3
-2.0   0.0   8.0
3.0   0.0
3.5   -2.0   5.0
0.0   1.0   -4.0
```

Of course, you can ignore the vector c for this exercise.   (20 points)

Due date: Thursday, May 2, 2019, before the lecture. Please send your solution via e-mail to you tutor.