# Probabilistic Algorithms
# Homework 3

## P1. (100 points)

Implement in MATLAB the algorithm SIMPLEX for the linear programming problem

$$\min L(\mathbf{d}) = \mathbf{c}^T\mathbf{d} + \vartheta = \sum_{i=1}^{n} c_i d_i + \vartheta, \text{ under the constraints}$$

$$\begin{cases} \mathbf{Ad} & \leq & \mathbf{b} \\ d_i & \geq & 0, i = 1..n \end{cases}$$

where $\mathbf{A} = \begin{pmatrix} a_{11} & \dots & a_{1n} \\ \vdots & \vdots & \vdots \\ a_{m1} & \dots & a_{mn} \end{pmatrix} \in R^{m\times n}, \mathbf{d} = \begin{pmatrix} d_1 \\ \vdots \\ d_n \end{pmatrix} \in R^n, \mathbf{c} = \begin{pmatrix} c_1 \\ \vdots \\ c_n \end{pmatrix} \in R^n, \mathbf{b} = \begin{pmatrix} b_1 \\ \vdots \\ b_m \end{pmatrix} \in R^m, b_i > 0, i = 1..m.$

The MATLAB function

```
function x = simplex(c, A, b)
```

will receive as input parameters the vector $\mathbf{c}$, the array $\mathbf{A}$ and the vector $\mathbf{b}$, and will return the optimal solution $\mathbf{d}^*$ in the vector $\mathbf{x}$.

*Remark: you may test your implemented function using the numerical example for the LP problem detailed in the course support.*

## P2 (50 points bonus)

Implement a MATLAB function

```
function [n, c] = parse(s)
```

which receives as input a string `s` corresponding to a linear constraint and returns two outputs, the number of decision variables (`n`) and the vector of corresponding coefficients (`c`). Examples:

1. for the input '4X1 - 5X2 + X3 < 12', the function returns $n = 3$ and $c = [4, -5, 1, 12]$;
2. for the input 'X1 - 7X3 + 2X5 > 3', the function returns $n = 5$ and $c = [1, 0, -7, 0, 2, 3]$;

You may consider any useful hypothesis about the format of the string `s` (e.g., all variables are expressed as a space character, followed by an integer number (including 1), followed by capital letter 'X', followed by the index of the variable (integer number), followed by a space character;).