



Final Project

Use Julia Jump to implement a simple column generation program to solve the cutting stock problem of class 2. Your grade will be given by:

- (5 pts) a written report containing :
 - explanations of the subject;
 - numerical results of both exercises (primal and dual solutions of the Gilmore Gomory model);
 - all RMPs and APs printed.
- (5 pts) the file .jl with the implementation that generated the informations contained in the written report .

This project is to be done in groups of at most 3 persons.

The due date to this project is march 25th and it has to be sent by e-mail to af.macambira@gmail.com and to alain.faye@ensiie.fr

We know that the optimal solution to RMP is not integer, but you don't have to run a B&B at the optimal solution.

Below I put the first iteration just to remember you.

Exercise 1:

A company produces steel bars with $L = 10$ m and cuts the bars for the costumers according to their necessities. Now, the company has to satisfy the following demand:

Type de demande i	1	2	3
Longueur d'une bande l_i	2	3	4
Nombre de bandes n_i	6	4	2

Exercise 2:

A company produces steel bars with $L = 100$ m and cuts the bars for the costumers according to their necessities. Now, the company has to satisfy the following demand:

l_i	number of pieces needed
22	45
42	38
52	25
53	11
78	12

The costs c_p are all equal to one.

We want to minimize the number of steel bars we need to cut in order to satisfy the demand.

In order to find an initial solution, we compute how many pieces of each length fits in one bar.

$$\left\lfloor \frac{L}{l_i} \right\rfloor$$

So, for exercise 2, we have:

$$\left\lfloor \frac{100}{22} \right\rfloor = 4, \left\lfloor \frac{100}{42} \right\rfloor = 2, \left\lfloor \frac{100}{52} \right\rfloor = 1, \left\lfloor \frac{100}{53} \right\rfloor = 1, \left\lfloor \frac{100}{78} \right\rfloor = 1.$$

so our matrix A at the first iteration is:

$$\begin{pmatrix} 4 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

Our first *RMP* is:

$$\begin{aligned} (RMP1) \text{ minimize } & z = \lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 \\ \text{subject to: } & 4\lambda_1 \geq 45 \\ & 2\lambda_2 \geq 38 \\ & \lambda_3 \geq 25 \\ & \lambda_4 \geq 11 \\ & \lambda_5 \geq 12 \\ & \lambda_1, \dots, \lambda_5 \geq 0. \end{aligned}$$

The solution is: $\lambda_1 = 11.25$, $\lambda_2 = 19$, $\lambda_3 = 25$, $\lambda_4 = 11$, $\lambda_5 = 12$.

The value of the dual variables are: $\pi_1 = 0.25$, $\pi_2 = 0.5$, $\pi_3 = \pi_4 = \pi_5 = 1$.

In our auxiliary problem we want to check if there exists a new column with negative reduced cost.

$$\begin{aligned} (AP1) \text{ maximize } & z = 0.25x_1 + 0.5x_2 + 1x_3 + 1x_4 + 1x_5 \\ \text{subject to: } & 22x_1 + 42x_2 + 52x_3 + 53x_4 + 78x_5 \leq 100 \\ & x_1, \dots, x_5 \geq 0 \text{ and integer.} \end{aligned}$$

The solution of *(AP1)* is $x_1 = x_3 = x_5 = 0$, $x_2 = x_4 = 1$. Hence, the reduced cost is $1 - 1.5 = -0.5$ and we have a new column a_6 ,

$$a_6 = \begin{pmatrix} a_{16} \\ a_{26} \\ a_{36} \\ a_{46} \\ a_{56} \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \\ 0 \\ 1 \\ 0 \end{pmatrix}$$