# Column generation project 2023

## Cutting stock problem

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### 1 Problem

The cutting stock problem involves finding cutting patterns of initial bars in order to meet the required number of smaller bars, as well as to have the cutting patterns as efficient as possible, i.e. using the least number of initial bars.

In this project, we have steel bars of length L=5600 mm, and we want to cut the bars so as to meet the following requirement:

Type i	1	2	3	4	5	6	7	8	9	10	11	12	13
Length $l_i$	1380	1520	1560	1710	1820	1880	1930	2000	2050	2100	2140	2150	2200
Number $b_i$	22	25	12	14	18	18	20	10	12	14	16	18	20

Furthermore, the cost of each cutting pattern  $c_p$  equals to one.

## 2 Column generation

Let P be all possible patterns,  $P' \subset P$ ,  $p \in P'$ . Let  $a_{ip} \in \mathbb{Z}_+$  be the number of pieces of length  $l_i$  in pattern p. Let  $\lambda_p$  be the number of bars cut in pattern p.

(RMP) minimize 
$$z = \sum_{p \in P'} c_p \lambda_p$$
 subject to 
$$\sum_{p \in P'} a_{ip} \lambda_p \geq b_i, i = 1, ..., n$$
 
$$\lambda_p \geq 0, p \in P'$$

Let  $\pi_i$  be the dual variables of (RMP).

(AP) maximize 
$$z = \sum_{i=1}^{n} \pi_i x_i$$
  
subject to  $\sum_{i=1}^{n} l_i x_i \leq L$   
 $x_i \geq 0$ , integer

#### 3 Solution

The optimal solution obtained from the Julia program is as follows:

- 1 unit of [ 1820 1820 1820 ]
- 1 unit of [ 1520 1930 1930 ]
- 1 unit of [ 1520 2000 2000 ]
- 7 units of [ 1380 2100 2100 ]

- 4 units of [ 1710 1710 2140 ]
- 7 units of [ 1560 1880 2150 ]
- 2 units of [ 1520 1820 2200 ]
- 1 unit of [ 1710 1930 1930 ]
- 7 units of [ 1380 2050 2150 ]
- 8 units of [ 1380 2000 2200 ]
- 12 units of [ 1520 1930 2140 ]
- 3 units of [ 1820 1880 1880 ]
- 5 units of [ 1710 1820 2050 ]
- 5 units of [ 1520 1880 2200 ]
- 4 units of [ 1520 1930 2150 ]
- 5 units of [ 1560 1820 2200 ]

The total number of bars that are cut equals 73.