

# Métodos de Apoio à Decisão

## Assignment 1: *Gasoline blending*

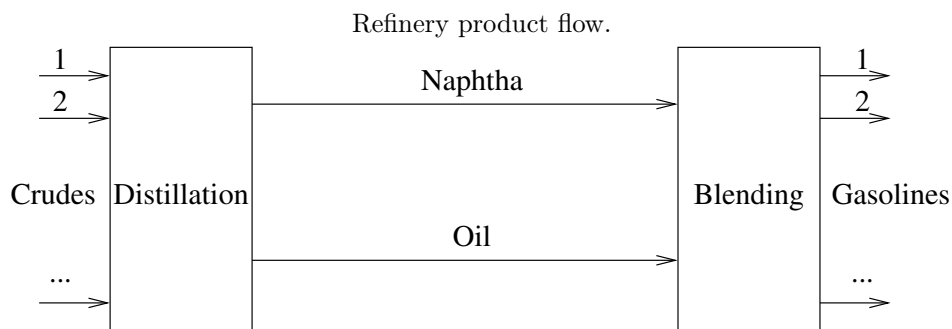
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In this assignment, you will answer some questions based on the following statement. At the time of submission, in the practical class of the week of 17-21/MAR, there will be a set of questions in the *Codex*, with the computers configured as in previous classes. The AMPL book and the slides of this course will be available for consultation.

### Exercise 1

Galco Oil manufactures various types of gasoline in a two-step process: distillation and blending, to produce gasolines and fuels that are then marketed.



Distillation separates each crude oil into intermediate products (fractions) known as *naphtha*, *oil*, and *residue*, according to their boiling points. Naphtha and oil have octane ratings of 10 and 6, respectively. The fractions into which a barrel of each type of oil is divided can be, for example, as shown in the following table:

	NAPHTHA	OIL
C1	0.50	0.42
C2	0.60	0.38
C3	0.55	0.41

Fractions of a barrel of oil.

	OCTANE RATING
NAPHTHA	10
OIL	6

The *residue* is considered a small amount of waste in distillation. It costs \$3 to distill each barrel of crude oil, and Galco's refinery can distill up to 14,000 barrels of oil per day.

The different types of gasoline sold differ in their octane rating. The blends to form each type of gasoline must have at least a certain average octane rating. It is assumed that octane ratings blend linearly by volume; the blending process has a much larger capacity than the distillery, and the blending cost is \$1 per barrel of input processed. Galco's customers require certain quantities of each gasoline, as shown in the following table.

	OCTANE RATING	DEMAND
G1	10	3000
G2	9	2000
G3	8	1000

The company considers it an obligation to fulfill these orders.

Galco also has the option to advertise to stimulate demand for its products. Each dollar spent daily on advertising a certain type of gasoline increases the daily demand for that type by 10 barrels. For example, if

Galco decides to spend \$20 daily on advertising gasoline 2, then the daily demand for gasoline 2 will increase by  $\$20(10) = 200\$$  barrels.

The selling price per barrel of gasoline and the purchase price per barrel of crude oil are given; an example follows.

Preço de venda por barril		Preço de compra por barril	
G1	70	C1	45
G2	60	C2	35
G3	50	C3	25

Galco can buy up to 5,000 barrels of each type of crude oil daily.

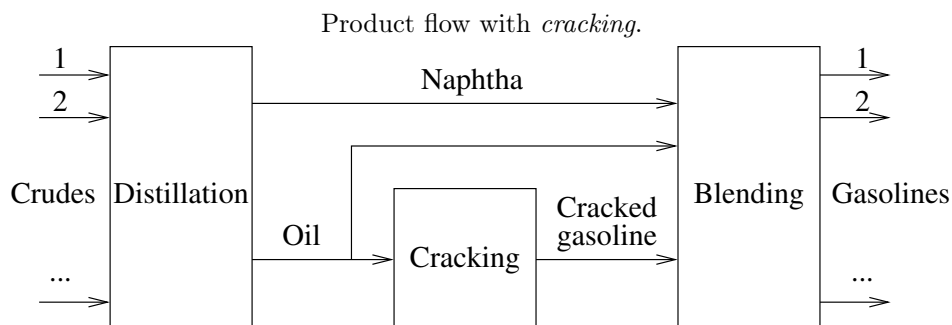
Determine the plan that will allow Galco to maximize daily profits (profits = revenue – costs).

(Hint: It may be helpful to have explicit variables for inputs (crudes), intermediates, and final products. In this case, the blending process can be modeled as in one of the exercises seen previously — analyze: *blending.mod* and *blending.dat*)

(Note: for this instance, the problem is impossible; if the octane ratings of gasolines G1, G2, and G3 were 10, 8, and 6 (respectively), the problem would have a solution, with a maximum profit of 287882.)

## Exercise 2

Refined oil can be used directly for blending or subjected to a process known as catalytic *cracking*. The catalytic “cracker” produces cracked gasoline with an octane number of 15. The cracking capacity of the refinery is limited to 3,500 barrels of oil per day, at a cost of \$4 per barrel.



Determine the plan that will allow Galco to maximize daily profits with this additional possibility of cracking.

(Hint: You can consider the inputs at the blending stage to be equal to the outputs of the distillation minus the inputs to the cracking, plus the outputs of the cracking.)

(Note: for this instance, the maximum profit is approximately 352250.9.)

**Note 1:** You can use *glpsol* and/or the commercial software *AMPL* (<https://ampl.com>); a version licensed for this course is available at <https://www.dcc.fc.up.pt/~jpp/AMPL>.

**Note 2:** Please bring scratch paper; do not use any other materials or electronic devices during class.