Assignment 1: Introduction to OPL

Objectives:
- Basic concepts of Mathematical Programming
- Modeling; main data structures

Background:
- Lab sessions L.1 and L.2
- Examples and OPL project developed during lab session 2.OPLBasics

The OPL Modeling Language: Mixed Integer Linear Programming (MILP)

OPL can also solve models that include both integer and real variables, generally known as mixed integer-linear programs (MILP). OPL approaches them in essentially the same way as integer programs. A branch-and-bound algorithm can exploit the linear relaxation except, of course, that branching takes place only on integer variables.

<u>Case Study</u>: A blending problem. Follow the three steps developing method:

- Problem description and modeling.
- Codification of the optimization model
- Solving the optimization problem

Consider the following application involving mixing some metals into an alloy. The metal may come from several sources:

- in pure form
- from raw materials (mixture containing varying amounts of metals)
- scraps from previous mixes,
- ingots (mixture containing varying amounts of metals).

The alloy must contain a certain amount of the various metals, as expressed by a production constraint specifying lower and upper bounds for the quantity of each metal in the alloy. Each source also has a cost and the problem consists of blending the sources into the alloy while minimizing the cost and satisfying the production constraints. Similar problems arise in other domains, e.g., the oil, paint, and the food processing industries.

The aim is to develop an optimization model to determine the quantities of metal from the various sources that must be blended in the preparation of the alloy. The model should be as generic as possible. Nevertheless, the data for a specific instance is given:

- The alloy is made from 3 metals.
- There are two types of raw material, with the following proportions of each of the metals:

$$\begin{pmatrix} 20\% & 1\% \\ 5\% & 0\% \\ 5\% & 30\% \end{pmatrix}$$

with a cost per kilo of 6 € and 5 € respectively.

- There are two types of scraps, with the following proportions of each of the metals:

$$\begin{pmatrix} 0\% & 1\% \\ 60\% & 0\% \\ 40\% & 70\% \end{pmatrix}$$

  with a cost per kilo of 7 € and 8 € respectively.
- There is one type of ingot (1 kilo each ingot) with the following proportions of each of the metals:

$$\begin{pmatrix} 10\% \\ 45\% \\ 45\% \end{pmatrix}$$

  with a cost per ingot of 9 €. The ingots have to be used as entire units.
- The cost of each of the pure metals is 22€, 10€ and 13€ per kilo.
- The proportions of each metal in the alloy are defined as:

$$Low = \begin{pmatrix} 5\% & 30\% & 60\% \end{pmatrix}$$
$$Up = \begin{pmatrix} 10\% & 40\% & 80\% \end{pmatrix}$$

- They have to produce 7100 kilos of alloy.

<u>Exercise assignment</u>

From the information provided, develop a mathematical programming model that:

- Optimizes costs
- Ensures that the metal proportions in alloy are met.
- Can be reused in solving similar problems where only vary the number of metals involved in the alloy, the proportions or the number of metals from each of the sources described in the case.

Do follow the steps shown in the previous exercises, by answering the following questions:

1. Problem Description
2. Modeling
3. Coding the model
4. Solving

You have to submit by the due date (see Virtual Campus):

- A word or pdf file containing your answers to 1 and 2
- A valid OPL project with your solution to 3 and 4

These documents have to be uploaded to the virtual campus as a compressed file (zip or rar) named A.1.Student_surname