Imagine that you are a very rich person and have recently bought one company (SpaceZ) that designs, manufactures and launches advanced rockets and spacecraft. Unfortunately, you discover that the numbers of the company are much worse than expected. However, this is just fine because you are an expert in Operations Research (OR) techniques (expertise acquired in the Master in Statistics for Data Science, UC3M).

Identify and describe an optimization problem that may contribute to improve the company management (satellite logistics, asteroid mining, hyper-jumps scheduling, alien revenue management, moon base operations, etc.,), where the decision-making process requires the formulation of a (continuous) linear optimization model with at least 100 decision variables and 20 constraints. You should not use any of the models described in class or in the slides (but a significant modification of any of them might be acceptable).

a) (*1 points*) Formulate mathematically the problem as a linear optimization model (based on the general formulation of an LP). Identify the model sets, parameters, variables, objective function and constraints.

b) (*1 points*) Implement the model in Pyomo and solve it for a set of (parameter) values, either based on real-world or randomly generated data (make sure that the values you use are coherent with the model defined in a)). In both cases, include your model and the specific data you have used.

c) (*1 point*) Compute the sensitivities associated with each constraint, and interpret the values of those you may consider more important.

d) (*2 points*) Derive the dual problem associated with a) and solve it in Pyomo. Does the Strong Duality holds?

e) (*2 points*) Modify the problem in a) to impose some logical or conditional (linear) constraints that require the use of binary or integer variables. If needed, the model can be substantially different than a). Implement and solve this new model in Pyomo and interpret the results. Include the data used for the solution of the problem.

f) (*1 point*) Write the code to define the relaxed problem corresponding to the one in d), that is, the linear optimization problem you would obtain if you do not take into account any integrality constraints on the variables. Compare the solutions for both problems and comment on them.

g) (*1 point*) For the integer problem in e), solve several instances with different sizes (different numbers of variables) using randomly generated data. Comment on the impact of the size of the problem on the time required to solve it.

h) (*1 point*) For the integer problem in e), solve several instances with the same data, using (10 to 20) different values for one of the parameters in the model (choose a parameter you think may provide insights for the interpretation of the different solution values). Collect the resulting optimal values of the objective function, print and plot them. Comment on these values.

IMPORTANT:

- Due date: **Monday, October 28, at 23:59 p.m.**
- Upload the code to Aula Global as a Jupyter notebook named as “Surname-Name-Opt.ipynb”.
- You are strongly advised to include descriptions for your formulations and comments in the same notebook, by using markdown cells.
- If this would prove too complicated, exceptionally you may present this information in a separate pdf file. In this case, name the file “Surname-Name-OPt.pdf”.
- Upload any datasets that might be required to reproduce your results (if not included with the models).