UNIVERSITÀ DI PISA

Logistics

Project Report

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Introduction & Problem Description

A developer of video game software has seven proposals for new games. Unfortunately, the company cannot develop all the proposals because its budget for new projects is limited to $950,000 and it has only 20 programmers to assign to new projects. The financial requirements, returns, and the number of programmers required by each project are summarized below.
Projects 2 and 6 require specialized programming knowledge that only one of the programmers has. Both of these projects cannot be selected because the programmer with the necessary skills can be assigned to only one of the projects. (Note: All dollar amounts represent thousands.)

Project	**Capital Required**	**Programmers required**	**Estimated Return**
1	250$	7	650$
2	175$	6	550$
3	300$	9	600$
4	150$	5	450$
5	145$	6	375$
6	160$	4	525$
7	325$	8	750$

1. Formulate an ILP model to decide what projects to develop in order to maximize the return, subject to the constraint on the number of available programmers, the constraint on the specialized programming knowledge for projects 2 and 6, and the budget constraint.

2. Implement the proposed model by means of the modeling language AMPL, and solve it using the optimization solver CPLEX.

2
Solution

2.1. Question one

The goal is to select the project such that the estimated return is maximized.

Define variables
The decision variables must be non-negative integers:

$$x_j = \begin{cases} 1 & \text{if project } j \text{ is selected} \\ 0 & \text{otherwise} \end{cases}, j = 1,2,3,4,5,6,7.$$

Objective function
The function to be maximized is the sum of the estimated return of each project:

$$\max \quad 650x_1 + 550x_2 + 600x_3 + 450x_4 + 375x_5 + 525x_6 + 750x_7$$

Constraints
The objective function is subject to the following constraints:

- the number of programmers available:

$$7x_1 + 6x_2 + 9x_3 + 5x_4 + 6x_5 + 4x_6 + 8x_7 \leq 20$$

- budget available ($950,000):

$$250x_1 + 175x_2 + 300x_3 + 150x_4 + 145x_5 + 160x_6 + 325x_7 \leq 950,000$$

- specialized programming knowledge of project 2 and 6 (cannot be selected at the same time):

$$x_2 + x_6 \leq 1$$

The ILP model is:

$$\begin{aligned} \max \quad 650x_1 + 550x_2 + 600x_3 + 450x_4 + 375x_5 + 525x_6 + 750x_7 & \\ 7x_1 + 6x_2 + 9x_3 + 5x_4 + 6x_5 + 4x_6 + 8x_7 &\leq 20 \\ 250x_1 + 175x_2 + 300x_3 + 150x_4 + 145x_5 + 160x_6 + 325x_7 &\leq 950,000 \\ x_2 + x_6 &\leq 1 \end{aligned}$$

2.2. Question two

The optimal solution obtained from the implementation of the model in AMPL, using the solver CPLEX is defined by the selection of the projects number **1, 6** and **7**, therefore all the constraints were respected. In this way, the estimated return is **1,925,000$**.
In order to get this result, I created three files in AMPL:

- `Project_logistics.mod` in which the parameters, variables, objective function and constraints were declared.
- `Project_logistics.dat` in which the values of the parameters were defined.
- `Project_logistics.run` which simply puts together the two files mentioned before, to solve the problem.

The output of the project selection is:

$$x_1 = 1, \quad x_2 = 0, \quad x_3 = 0, \quad x_4 = 0, \quad x_5 = 0, \quad x_6 = 1, \quad x_7 = 1$$

And the result of the objective function is:

$$1,925,000\$$$