

Problem set # 2

Numerical Methods for Data Science 2021/22

UC3M — *Master on Statistics for Data Science*

Due date: Friday October 29 (through Aula Global).

Note: This is an individual assignment. Evidence of plagiarism will be penalized. Deliver the assignment as a pdf file, with Gurobi–Python code printouts where required.

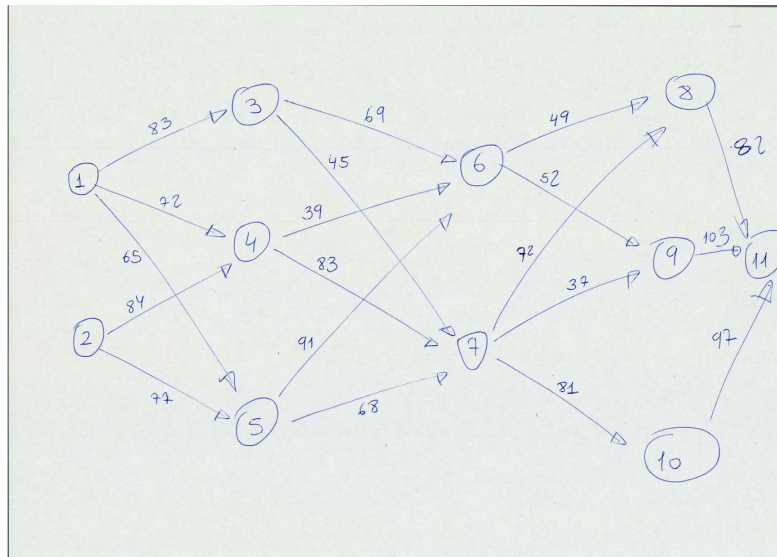


Figure 1: Network for Problem 1.

Problem 1 (50 points). Consider the network in Figure 1. Node 11 represents a city in a state of emergency, which urgently needs humanitarian supplies. Nodes 1 and 2 are origins of the required supplies. The numbers shown on arcs are their daily transportation capacities, e.g., at most 83 units of supplies can be sent in a day from node 1 to node 3. Consider the problem of sending as many humanitarian supplies as possible in a day from nodes 1 and 2 to node 11.

- (a, 12 points) Formulate the problem as an integer optimization model and formulate its linear relaxation.
- (b, 14 points) Implement in Gurobi–Python the model and solve the linear relaxation. Do you obtain an integer solution. Why?
- (c, 12 points) Generate through Gurobi–Python sensitivity information and interpret it.
- (d, 12 points) If you had a limited budget to increase the capacity of some arcs, which ones would you prioritize? Why?

Problem 2 (50 points). A person wants to visit by car the following Spanish cities, starting and ending in Madrid: Alicante, Barcelona, Córdoba, La Coruña, Valencia and Granada. The table in Figure 2 shows the road distance between each pair of such cities:

	Madrid	Barcelona	Valencia	Alicante	Granada	Córdoba	La Coruña
Madrid	0	624	357	421	420	394	597
Barcelona	624	0	351	538	888	862	1088
Valencia	357	351	0	165	546	521	950
Alicante	421	538	165	0	351	552	1017
Granada	420	888	546	351	0	208	1009
Córdoba	394	862	524	552	208	0	986
La Coruña	597	1088	950	1017	1009	986	0

Figure 2: Road distances between some Spanish cities.

- (a, 15 points) Formulate the problem of finding the shortest tour. How many constraints has in this case the integer optimization formulation seen in class?
- (b, 35 points) Apply the iterative procedure seen in class to try to find an optimal tour, carrying out at most three iterations using Gurobi-Python. Discuss the results.