INSTITUTO SUPERIOR DE AGRONOMIA

Test of Applied Operations Research - 31 May 2019

Number: Name:

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1. (10 val.) A forestry manager wishes to invest 12000 € in four tree plantations, A, B, C and D, so as to maximize the profit. The cost and the profit of the plantations are summarized in the table below. Each plantation must be done completely or not at all. Which combination of plantations should the manager do?

Plantation	A	B	C	D
Cost (€)	6000	5000	5000	4000
Profit (€)	8000	7000	8000	6000

a) Formulate this problem in integer linear programming.

b) Find an optimal solution of the problem.

c) Formulate constraints for the following conditions:

i) If A is planted, then B cannot be planted.

ii) B is planted if and only if D is planted.

iii) If C is planted, then D has to be planted.

iv) If A and B are both planted, then D must also be planted.

v) If A and B are both planted, then C can not be planted.

vi) If A or C are planted, then B can not be planted.

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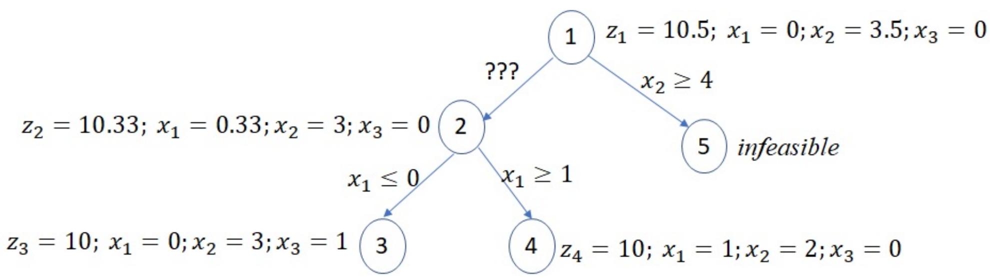
2. (6 val.) Consider the following integer linear programming problem, further denoted by (IP):

$$\max z = 4x_1 + 3x_2 + x_3$$

$$\begin{cases} 3x_1 & + & 2x_2 & + & x_3 & \leq & 7 \\ 2x_1 & + & x_2 & + & 2x_3 & \leq & 11 \\ x_1, & x_2, & x_3 & \geq 0; & x_1, & x_2, & x_3 \quad integer \end{cases}$$

The Figure below shows the branch-and-bound used for solving (IP). Information concerning the linear programming relaxation solution of each subproblem is displayed near the corresponding node, being z_i the subproblem i optimal solution value.



a) Determine a bound on the optimal value for (IP) given by the resolution of the subproblem corresponding to node 1. Is it a lower or an upper bound for (IP) optimal value?

b) Node 2 is obtained by adding which constraint(s) to (IP)?

c) Why is the subproblem corresponding to node 5 infeasible?

d) Display an optimal solution for (IP).

e) To obtain an optimal solution for(IP) can you stop the branch-and-bound at the end of node 3, without considering nodes 4 and 5? Justify your answer.

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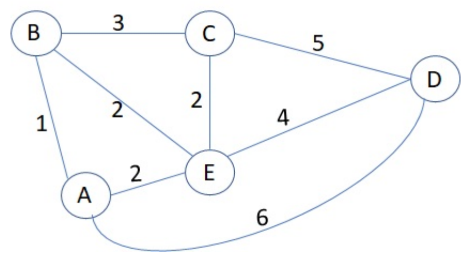
3. (4 val.) A municipal company intends to build dirt roads that allow to move between locations A, B, C, D and E. The network displayed below shows the potential roads and the distances between locations. Use a minimum spanning tree algorithm to determine the minimum distance set of dirt roads that connect all locations. Explain each step of the method you are aplying.



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