

**Computational methods in  
operations research**  
21 February, 2019

**Exercise 1.** Install and run the program GUSEK. Open the Examples/diet.mod file and try to understand the model.

**Exercise 2.** A farmer would like to improve the forage for his racing horses by adding oatmeal and vitamin concentrate to the commercially available feed. During the racing season, it is particularly important that horses consume a given quantity of nutrients labeled with A, B and C without gaining weight. The table below shows the amount of each nutrient contained in 1 kg of the ingredients in the mixture:

	Normal forage	Oatmeal	Concentrate
Nutrient A	0.08	0.02	0.0
Nutrient B	0.1	0.15	0.3
Nutrient C	0.01	0.06	0.2

The horses need 3, 6 and 4kg from nutrients A, B and C, respectively, per week. However, to prevent them from gaining weight, they can eat at most 60kg of food per week. The farmer's goal is to minimize the costs subject to the above constraints. The costs of the ingredients: normal forage 25 Ft/kg, oatmeal 50Ft/kg, vitamin concentrate 300Ft/kg.

**Exercise 3.** Assume that we want to find a feasible rook-placement in the matrix below with maximum total weight (that is, we have to find four entries in the matrix such that any two of them are in different rows/columns). Reformulate the problem as the problem of finding a maximum weight matching in a bipartite graph. Write up an IP model and solve it using GUSEK.

$$\begin{vmatrix} 8 & 7 & 9 & 9 \\ 5 & 2 & 7 & 8 \\ 5 & 1 & 4 & 8 \\ 2 & 2 & 2 & 6 \end{vmatrix}$$

**Exercise 4.** There are  $n$  workers in a factory and there are  $n$  jobs. Every job has to be done and each worker has to get exactly one job. There are no restrictions on the worker-job pairs. However, the cost of giving a job  $j$  to a worker  $i$  has cost  $c_{ij}$ . Write up an LP model for the problem (the aim is to minimize the cost). Compare your model with the GUSEK Examples/assign.mod file.