Technische Universität Chemnitz
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Optimization for Non-Mathematicians

Sheet 10

Exercise 22: Setup of `Graphviz`

The package `Graphviz` with the MATLABinterface `graphViz4Matlab` is very useful to draw graphs. You can find a supplement sheet for `Graphviz` on our homepage. Follow the steps described there and test the functionality for the example of the supplement.

Exercise 23: Generation of the incidence matrix

Let the n edges of a graph be given as a matrix $E \in \mathbb{R}^{n \times 2}$, where each row contains the start and the end node of one particular edge. For instance, the edge set

$$\big\{(1,4),(1,5),(2,4),\dots\big\}.$$

can be expressed by the matrix

$$E = \begin{pmatrix} 1 & 4 \\ 1 & 5 \\ 2 & 4 \\ \vdots & \vdots \end{pmatrix}.$$

Write a function `edge2inc` in MATLAB, which generates the corresponding incidence matrix A^{in} for a given edge matrix E. Test your function using the example of the supplement for `Graphviz` (Example 14.1 from the lecture).

Exercise 24: Transportation problem, minimum-cost flow

Against the shortage of drinking water in a country, several villages in a certain region shall be supplied with fresh water in the future. To this end, two water treatment plants are avaible in this region, from which water transports are sent to four collection points. The aim is to find a transportation plan with minimal costs for the water supply on a given road network, which is modeled by a graph (Figure 1). Due to unpaved roads and the fact that too many heavy load transports might damage the roads too badly, it was agreed that only a certain number of transports per month are allowed.

(a) Model the problem as a mathematical optimization problem.

(b) Solve the problem in MATLAB using `linprog`. Details about the road network can be found in the file `Daten_Wassertransport.m` on the homepage. Plot the solution using `Graphviz`.

(c) Assume that one of the roads becomes too damaged, such that the maximal number of transports on this road has to be decreased. How does the solution change if the transportation limit of edge $(13, 5)$ is decreased to 100? What would happen, if this road breaks down completely?

(d) Why does the optimization problem become unsolvable if water treatment plant 1 increases its production by 100? How can we change the optimization problem to make it solvable again?

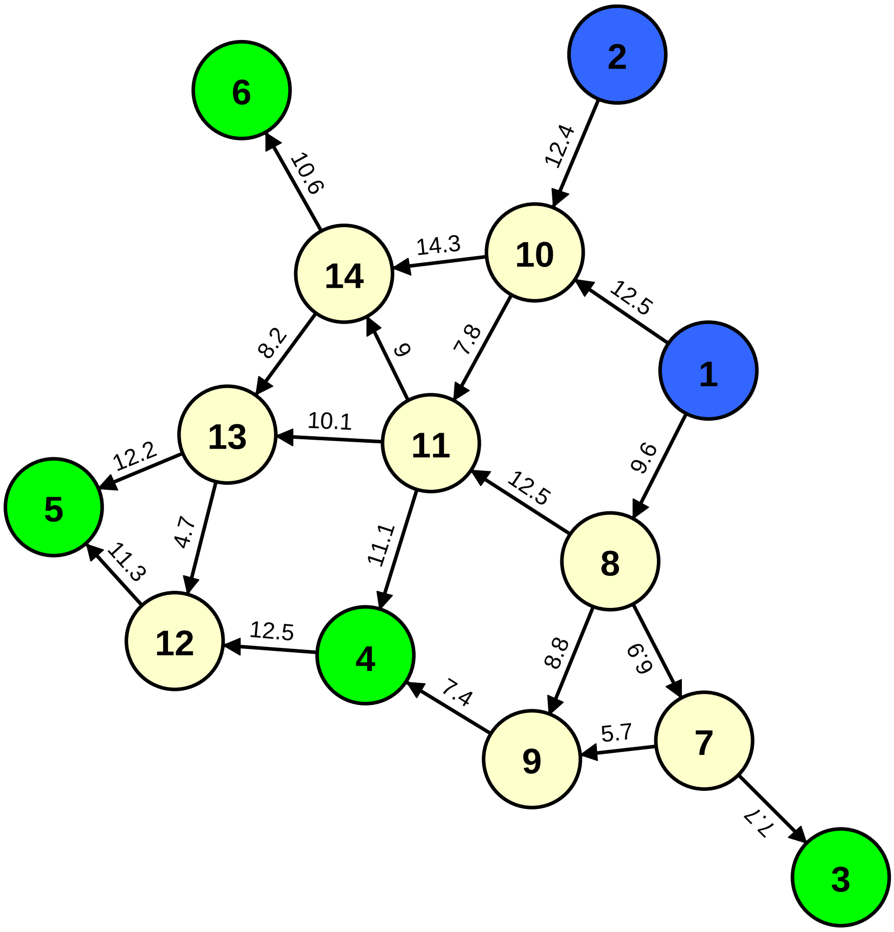

Figure 1: Graph of the road network with costs of the individual roads. The transports should go from the water treatment plants 1 and 2 to the collection points 3, 4, 5 and 6.