

Introduction to ZIMPL and SCIP

Capacitated Facility Location In *facility location* problems one considers potential locations for new plants (or facilities) and existing stores (or customers) that have to be assigned to the plants. One needs to decide which potential plants are actually built. The goal is to minimize total cost consisting of costs for building new plants and transportation costs between plants and stores. Therefore, an expensive plant can compensate for this disadvantage by cheaper transportation costs. Furthermore, let the capacity of each plant be limited to a certain amount.

Using the notation

P	set of potential plants
S	set of stores to supply
c_p	building cost for plant p
c_{ps}	transportation cost between plant p and store s
δ_s	demand of store s
κ_p	production capacity of plant p
$z_p \in \{0, 1\}$	decision variable: Will plant p be built?
$x_{ps} \in \{0, 1\}$	decision variable: Does plant p supply store s ?

this problem can readily be put as an IP:

$$\begin{aligned} \min \quad & \sum_{p \in P} c_p z_p + \sum_{p \in P, s \in S} c_{ps} x_{ps} \\ \text{s. t.} \quad & \sum_{p \in P} x_{ps} = 1 \quad \forall s \in S && \text{(assignment)} \\ & x_{ps} \leq z_p \quad \forall p \in P, s \in S && \text{(building)} \\ & \sum_{s \in S} \delta_s x_{ps} \leq \kappa_p \quad \forall p \in P && \text{(capacity)} \\ & z_p, x_{ps} \in \{0, 1\} \quad \forall p \in P, s \in S. \end{aligned}$$

Constraint (assignment) ensures that each store is served by exactly one plant. Due to constraints (building) each plant supplying a store has to be built. Finally, (capacity) guarantees that no plant produces beyond capacity.

This IP model is the basis of this exercise with ZIMPL and SCIP.

Exercises

1. Deactivate the capacity constraints in the ZIMPL program and check how the solution found by SCIP changes!
2. Add another store to the problem. The new store shall have demand 15 and transportation cost 20, 30, 52, 42 for plants A, B, C, and D, respectively. How does the solution change?
3. Use ZIMPL's `do print`-mechanism (see page 15 in the ZIMPL manual) to determine the capacity used of each of the plants built according to the solution of the last exercise.

4. Adjust the ZIMPL program such that it reads the build cost, plant capacities and store demands from a file. This is described on page 12ff in the ZIMPL manual.