Graph Optimization
Lab session 5
Facility location models part 1

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Exercise 1: base station location

In designing a wireless network, the base stations have to be located. The base stations must be chosen among a set A of possible sites. A set of test points (T) is given, which must be served by the base stations. A base station i can serve a test point j if their distance d_{ij} is below a given threshold R. A binary matrix is used to represent such feature, which has a row for each candidate base station and a column for each test point: entry (i, j) is equal to 1 if base station i can serve test point j and 0 otherwise. We have to locate base stations with the aim of minimizing their number, while guaranteeing that for each test point at least one base station which can serve it is selected.

Exercise 1: base station location

Input

- A set A of candidate sites to host base stations
- A set T of test points that base stations must serve
- Distance d_{ij} between candidate site i and test point j
- An base station can serve (*cover*) test points within a maximum distance R

Exercise 1: base station location

Problem description

- Decide in which sites the base stations are installed
- Guaranteeing that each test point is served by at least one base station, i.e. for each test point there is at least one installed base station whose distance is below R
- The objective is to minimize the number of installed base stations

To represent the distance constraint, we use a matrix $\mathbf{m}$ such that $m_{ij} = 1$ if $d_{ij} \leq R$ and $m_{ij} = 0$ if $d_{ij} > R$ (*covering matrix*)

Exercise 1: base station location

Write a .mod and a .run files to solve the base station location problem. Solve the two instances available online. Use the parameters name as defined in the file `ex5.1-parameters.mod`.

Exercise 2: terminal and edge nodes

A set of N terminal nodes must be connected to edge nodes to sent their traffic to the backbone network. Edge nodes must be installed on some points of the network. Terminal node i has an amount of traffic w_i. Each edge node can deal with a maximum amount of traffic B. We have to decide to which edge node each terminal node must be assigned, with the goal of minimizing the number of edge nodes.

Exercise 2: terminal and edge nodes

Write a .mod and a .run files to solve the edge node selection problem. Solve the five instances available online. Use the parameters name as defined in the file `ex5.2-parameters.mod`.

Exercise 3: antenna location

In a wireless network a set J of test points must be served by antennas. Each test point must be served by one antenna which must serve the whole test point demand. Antennas can be located in a set I of candidate sites. Installing antenna is expensive and the budget allows to install an antenna in $\lceil \frac{1}{5} \rceil$ of the candidate sites. For each candidate site $i \in I$ the cost of serving the demand of test point j, d_{ji} is given. We have to decide where to install the antennas and which antenna must serve each test point with the goal of minimizing the test point serving cost.

Exercise 3: antenna location

Write a .mod and a .run files to solve the antenna location problem. Solve the three instances available online. Use the parameters name as defined in the file `ex5.3-parameters.mod`.