

# Network Design [Network Optimization Module]

Exam 18/7/2017

Surname \_\_\_\_\_  
Name \_\_\_\_\_

## Exercise #1

The graph **graph18072017.gml** in the attached file contains a set of potential customers that a telecom company can connect with a network rooted in node 1. Each location (node)  $u$  has associated a profit [**profit** attribute in the graph] and each edge  $uv$  has a connection cost [**cost** attribute in the graph].

## Questions

1. Find the set of links that connects **all** nodes at minimum cost.
2. Find the set of links that connects all nodes at minimum cost with the constraint that each node with index  $> 15$  in the network can accept up to 2 connections.
3. Suppose that you can install in node 21 a hub with the following features:
  - A. If the hub is installed, the cost of a link cost from node 21 to any other node decreases by a factor of 10;
  - B. The hub accepts a maximum of 6 connections;
  - C. Hub installation costs 150 Euro.Is it convenient to install the device in node 21?

## Exercise #2

The graph **atsp18072017.gml** represents a logistic distribution network. Each arc has a cost [**dist** attribute in the graph].

## Questions

1. Find the shortest Hamiltonian cycle starting from (ending to) node 1 with the lifted MTZ formulation plus the size 2 subtour inequalities. Report the value of the linear relaxation and the number of enumerated nodes.
2. Evaluate the linear relaxation and strengthen the formulation by violated DFJ subtour elimination constraints.
3. Suppose that each node represents a customer that demands exactly one unit of a good and that the company owns a vehicle with capacity  $C=10$ . Compare the following distribution strategies:
  - A. Goods are stored in nodes 1, 10 and 20 at a cost of 120.
  - B. Goods are stored only in node 1 and delivers are split in three different tours.