2019 Practical Exam - Q1a

The management of BigCorp want to know where to locate their factories in a new market, so as to serve 20 big customers. They have 10 possible factory locations. For each possible location, they know the cost of building a factory there, given by the vector `Build` in the code stub. For each customer/location pair, they know the cost of assigning the customer to a factory at the location, given by the matrix `Assign` in the code stub. Each customer must be assigned to a built factory and each factory can serve at most 6 customers.

a) Formulate an integer programming problem to choose the factories to build and the customer/factory assignments to make so as to minimise the total cost of building factories and assigning customers to factories. Write the formulation in the space below. Implement your formulation in Python. Your code should use Gurobi to calculate the solution and then print out the optimal objective value, the factories to build, and a list of customers for each factory to be built. *[8 marks]*

Sets F factory locations

C customer locations

Data b_f cost to build at $f \in F$

a_{cf} cost of assigning $c \in C$ to $f \in F$

m max customers at each factory.

Variables y_f 1 if we build factory $f \in F$

x_{cf} 1 if we assign $c \in C$ to $f \in F$

z_f 1 if $f \in F$ is a big factory.

Objective $\min \sum_{f \in F} b_f y_f + \sum_{c \in C} \sum_{f \in F} a_{cf} x_{cf} + \sum_{f \in F} 0.5 b_f z_f$

Constraints

$$\sum_{f \in F} x_{cf} = 1 \quad \forall c \in C$$

$$\sum_{c \in C} x_{cf} \leq m y_f + 2 z_f \quad \forall f \in F$$

$$x_{cf}, y_f \in \{0, 1\}$$

$$\rightarrow \quad z_f \leq y_f \quad \forall f \in F$$