Exercise 1: Mathematical Programming

May 12, 2020

Due: Juni 2, 2020, 23:59
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Exercise1-name1-name2-name3

1 Task 1

The company **LGLog** is active in forest and wood management, transporting logs from the forest to sawmills. The company operates in multiple forests and owns several sawmills. The forest can only be reached by very expensive and specialized forest transporters with high fuel consumption. Therefore, the company wants to build transshipment hubs near the harvested forest areas to move the logs to cheaper and more fuel efficient ~~trucks that will transport the logs to the sawmills~~. The company has identified several potential transshipment hubs. Your job is to decide which preselected locations should be chosen.

~~Each transshipment hub has a fixed cost for being open~~. Vehicles have travel costs depending on the amount of logs they are carrying, ~~which are arc dependent~~. ~~Each type of vehicle has a capacity on the number of logs it can carry~~. Assume that the ~~truck can handle more logs than a forest transporter~~. Additionally there is a ~~uniform handling cost per log at the hubs~~. You can assume there are enough vehicles of both types available to carry all of the demand, but ~~multiple vehicles of the same type may not travel on the same arc at the same time~~.

Assume you are aware of the ~~demand at each sawmill~~ and the ~~supply in terms of logs at each forest~~. Note that these two quantities need not be balanced. ~~LGLog is paid a fixed price per log delivered to any sawmill~~. Every hub can be reached from any forest and every sawmill can be reached from any hub with different distances in between them. It is also possible to travel directly from the forst to a sawmill. Transporting logs between hubs is prohibited. Furthermore, no logs are transported between sawmills nor between forest areas.

1.1 Model

Design a mathematical model maximizing LGLog's profit. Formally define the model and explain all of its components.

1.2 Extension

Modify for model to support the following problem extension: Due to limited storage capacity, transshipment hubs may only transship logs from a limited number of forest areas. That is, each transshipment hub i may only take logs from at most p_i forest areas.

2 Task 2

2.1 Description

The following is based on problem 12.23 from "Model Building in Mathematical Programming, Fourth Edition" by H. Paul Williams (John Wiley & Sons, 2002).

A small milk processing company is committed to collecting milk from 20 farms and taking it back to the depot for processing. The company has one tanker truck with a capacity for carrying 80 000 liters of milk. Some of the farms are small and need a collection only every other day. The other farms need a collection every day. The route of the truck starts and ends at a depot, and it is possible to travel between all nodes.

The goal is to find the optimal route for the tanker truck on each day, bearing in mind that it has to:

1. Visit all the 'every day' farms,
2. Visit some of the 'every other day' farms, and
3. Work within its capacity.

On alternate days it must again visit the 'every day' farms, but also visit the 'every other day' farms not visited on the previous day.

2.2 Model

Write a mathematical model determining two routes for the truck satisfying the constraints listed above (visit frequency of each node, truck capacity, etc.).

2.3 Extension

Assume there is a matrix of travel times between all farms and the depot and a maximum time for the route of the truck. Extend your mathematical model to support these situation. (Ignore the time it takes to load the milk into the truck at each node)

2.4 Bonus extension

Assume now that there are multiple vehicles available to serve the customers. Each vehicle has a capacity that may not be exceeded, but the travel times for the vehicles are the same. Adjust the above model to support this case.