Exercise 1: Mathematical Programming

Assigned: May 25, 2021

Due: June 15, 2021, 23:59
Upload to MyStudy in the fold **Exercise 2 submission**
Submitted in a PDF **Exercise2-name1-name2-name3**

1 Task 1

1.1 Description

The face mask problem in the first exercise is extended in the following way.

A face mask company has two factories, one at Liverpool and one at Brighton. It produces different types of masks, e.g. basic cloth face mask, surgical face mask, N95 respirator. Each factory has a monthly capacity for each type of mask in tons, which cannot be exceeded. All types of masks are produced in both factories. In addition, it has four depots with storage facilities at Newcastle, Brimingham, London and Exeter. Each depot has a maximum monthly throughput in tons, which cannot be exceeded (it is not depended on the type of masks). The company sells its product to six customers C1, C2, ..., C6. Each customer has a monthly requirement for some types of masks (in tons), which must be met. Trucks are used to transport masks and the capacity is given. You can assume that there is enough trucks to carry all the demands. The transportation costs are known (in €per ton delivered). We assume that the total supply is equal to the total demand.

1.2 Model

Design a general multi-commodity flow model to minimizing overall cost for each month. Formally define the model and explain all of its components (sets, parameters, variables and constraints).

1.3 Extension

Modify for model to support the following problem extension:

Due to short-time working in Covid-19 pandemic, the customers have tighter time windows for delivery. So the multicommodity transport problem in the description should be extented with known transport times and a time window for each customer. Explain how do you model the capacity restrictions? Note that multiple vehicles may not travel on the same arc at the same time.

2 Task 2

Please implement the **dynamic programming** approach in Python to solve a shortest path problem with time constraints on movement and parking. Please explain your dominance criteria for this problem. The problem description and an example are given in the Sancho 1992 paper. You can use the example given in the paper to test your implementation. Furthermore, you can test your program with the following situation: the feasible parking period at the source node 1 is restricted to period 0–12, instead of free parking being available. And output your solutions in Python at the end. Please document your code to make it easy to understand.

2.1 Grading

The homework will be evaluated based on the following criterion:

- Correctness and quality of the algorithm implementation, including
  - the correct implementation of dynamic programming as in slide 19
  - a meaningful dominance criteria