Desautels Faculty of Management
Master of Management in Analytics
McGill University

MGSC 695

Final project: Group # 3

Due date: Monday April 24th 2023 - 11:59 PM

Problem description: *Case study*

A popular band is planning a tour across several cities, performing at different venues in each city. The band has a single plane to complete the tour across Canada and a single pilot to carry the band, staff, and the material used to set up the concert. The band has an unique objective for this tour: to deliver a different performance at each city. This requires the plane to carry all the material and instruments for each concert. Their current band manager is responsible for defining the order of the venues given the time windows at which the staff at the venue is available to set up the concert. During their last tour across the U.S., the band had multiple timing problems. Due to manual planning, all concerts in their last tour experienced delays, resulting in additional costs to hire extra staff at each venue. The band wants to optimize their concert route for their tour across Canada to minimize complete travel time and cost while ensuring that the staff time window is respected.

The band wants to determine the most efficient route structure for their pilot to reach each venue within the staff time window while ensuring that the tour starts and ends at the band hangar. The objective is to minimize the total distance traveled by the plane while ensuring that each venue location is visited once and that the plane capacity and staff time windows are respected.

The band is asking your consulting firm to develop/create a proof of concept for an optimization software that can meet their requirements. The software will be used by the band manager to plan the tour across Canada.

Data:

The band has a range of potential venues that they need to serve in the tour. The band also knows the time window at each venue, as well as the maximum capacity of the plane and the amount of material (demand) required at each venue.

Description	Value
Min number of venues	80
Max number of venues	120
Demand per venue	1-4 Kg
Plane capacity	500 Kg

Notes:

For this problem, the following assumptions are made:

- The travel time between locations is defined by the Euclidean distance between each location.
- The distance matrix is symmetrical, meaning that the distance between location i and location j is the same as the distance between location j and location i.

Project objectives:

I, David Escobar Vargas, am your team manager. Before moving forward with the client's project, I need the following tasks to be completed by your team:

1. Define the type of problem we are working on (e.g., transportation problem, location problem, allocation problem, etc.). Is there a known problem structure in the scientific literature that fits (or relates to) the case study provided by the given company? Which one? How can you support your assumption?
2. Make a mathematical formulation to model the case study, including the decision variables, sets, and constants used to define it.
3. Provide Python code using Gurobi to solve the problem under consideration.
4. Using the data provided, define at least three scenarios (or instances) in which you can test your model using Python. Provide a small, medium, and large scenario. The size of the scenario depends on the number of customers being considered.
5. Define at least three individual Gurobi parameters (from your selection) to check how they change the optimization process of Gurobi (see the official parameter list at Gurobi page). Use only the list of parameters defined in the section 'MIP Cuts'. Additionally, run the command `model.tune()` to see if Gurobi can improve the performance of the formulation. Which parameters should we use to obtain the best performance of the proposed formulation? Why? (Recall: one can support the use of parameters based on run time or solution quality.)
6. Read the scientific paper and provide the following:
   - A summary of the paper.
   - A description of the weak and strong points of the paper.
   - Answer : Would you use this paper as the basis to address the given case study? Why?

Extra points:

- From a stochastic optimization perspective, what aspect of this case study could be the most meaningful stochastic consideration? Why? What could be the added value of considering the problem as stochastic compared to the deterministic version?

Project deliverables:

The project consists of three main deliverables:

- A single Microsoft Word or PDF document presenting the mathematical formulation, the answers to all theoretical questions, results analysis, and paper review.
- The Python code for the mathematical formulation and testing.
- The instances used to test the Python code.