Deterministic Operations Research II

Group Project Assignment: Nurse Scheduling Problem

Introduction:

The Nurse Scheduling Problem is a complex optimization problem that deals with the allocation of a limited number of nurses with different skillsets to various tasks, keeping in mind the needs of patients, nurse availability, task duration, and location constraints. This assignment aims to model this problem effectively and solve it using optimization techniques.

Project Description:

Datasets: You will work with three datasets. Each dataset contains:

- A list of nurses, each with specific skillsets.
- A list of patients with distinct needs.
- Simulated data estimating the likelihood that a patient will adhere to their medication or physical therapy regimen on specific days of the week (M, T, W, Th, F, S, Su).
- A list of locations where patients reside.

Constraints:

- Each nurse may visit only one location per day.
- Each nurse will work four days a week.
- A nurse may visit up to two different locations during their working days, but they must spend consecutive days at each location. (i.e., no alternating between locations on different days).
- Every task type (e.g., medication, drawing blood, physical therapy) has an associated duration in minutes or hours.
- Nurses can work for a maximum of 10 hours per day.

Objective:

- Ensure all mandatory tasks are covered by the available nurses.
- Maximize the expected success rate for patients taking their medications and completing physical therapy.

Optimization & Reporting:

- Construct an optimization model that best describes the given problem.
- Solve each dataset using Gurobi with a runtime limit set to one hour.
- Report on the solutions, detailing the decisions made and the outcomes achieved.
- Analyze each solution using a combination of graphs, plots, tables, and discussion.

- In the event that the mandatory tasks cannot be covered by the available nurses, find the minimum number of nurses needed to do so and repeat the optimization problem given those nurses.

Team Composition and Guidelines:

- Groups should be composed of 3-4 students.
- Every member is expected to actively participate in all stages of the project.
- In case of any team member not participating actively:
  - The group is encouraged to approach Robert to address the issue.
  - The member may face potential consequences, including the requirement to complete the project individually.

Data: Three excel workbooks are provided on Canvas in the Files/Projects/Project1 folder. There is a small and a large dataset based in Virginia, and there is a very large dataset based in California.

Submission Requirements:

Problem Description: Clearly describe the problem in words such that someone not taking this class can understand.

Optimization Model: Clearly describe the mathematical model, including decision variables, constraints, and the objective function.

Gurobi Solutions: Provide solutions obtained from Gurobi for each dataset, including any assumptions made and any challenges faced during the optimization process.

Analysis: This section should contain:

- Graphs, plots, or tables showcasing your results.
- Discussion and insights drawn from the outcomes.
- Recommendations or suggestions for potential improvements or alternative strategies.

Contribution Statement: A brief description of each team member's contributions to the project.

Evaluation Criteria:

- **Clarity and Structure:** Clear presentation of the optimization model, solutions, and analyses.
- **Completeness:** All requirements of the project are addressed.
- **Quality of Analysis:** Depth and thoroughness of the analysis, insights, and discussions.
- **Teamwork:** Effective collaboration and balanced contributions from all team members.

Deadline: September 22, 2023

Here is an example of data on the patients in each city. (Note: these numbers are not the same as those used in any of the datasets).

Virginia and Its Major Cities with Patient Needs

Richmond (100)
Norfolk (85)
Virginia Beach (95)
Chesapeake (80)
Arlington (70)
Alexandria (65)
Roanoke (75)
Fredericksburg (55)
Williamsburg (60)
Lynchburg (50)