Operations Research, Spring 2020 (108-2)
Case Assignment 3

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Facing the CSR scheduling challenge and relevant data described in Case Assignment 1, Mikasa now wants to find a systematic way to solve this problem. What she wants is not just an *answer*, which is a schedule for a specific month. What she wants is a *solution*, i.e., a model or an algorithm that can produce a schedule given the rules and data for any month. As the head of the Operations Research team, we now want to apply the recently learned *Integer Programming* to construct a decision support tool.

Compared with Linear Programming, which we used in Case Assignment 2 to construct a solution, Integer Programming is much more powerful. In particular, it allows us to define a decision variable like

$$x_{ijk} = \begin{cases} 1 & \text{if CSR } i \text{ is assigned to shift } k \text{ in day } j \\ 0 & \text{otherwise} \end{cases}.$$

In other words, now we may go beyond *how many* to *who*: Instead of determining the number of CSRs to be assigned to each shift in each day, we may now determine *which* CSRs should be assigned to that shift on that day.

Though our integer program will still be an abstraction from a real-world situation (which is always true), they are much closer now. The model should be able to help us make better decisions.

In this case assignment, please refer to Case Assignment 1 regarding the decision variables, objective function, and constraints. Ignore those proxies that we used in Case Assignment 2. We will build an integer program that models everything described in Case Assignment 1 except those from Richard.[1]

Okay, let's start!

[1]You are welcome to consider how Richard's opinion may be included into your model. They may (or may not) appear in Homework 3 or the final exam.

1 Your tasks

1. (40 points) Please formulate an integer program that may find an optimal allocation of CSRs. As always, please formulate a mixed linear integer program. Except having integer variables, do not have nonlinear constraints.

   For this problem, please write down a compact mathematical formulation. Do not submit a computer program.

2. (30 points) Submit a (set of) computer program that may solve the integer program you formulated in Problem 1. You may submit an AMPL model file and an AMPL data file. Alternatively, you may submit a (set of) Python or C++ programs that invoke gurobi to solve this problem.

3. (10 points) Please summarize the optimal solution you obtain with your computer programs submitted in Problem 2. You should at least summarize the allocation of CSRs and the total lack amount returned by your computer programs. If you believe that there is other information that will be useful for executive/managers, you want provide them.

4. (20 points) This problem is designed to give you some free points. Please write down your opinions and thoughts for the three case assignments. You may say that you learned a lot, you learned nothing, you think the case assignments help you get a feeling about real-world applications of Operations Research, you think the whole approach is useless, you think it is more interesting than homework, you think it is less interesting than homework, etc. As long as you write down something, regardless of the length and content, you get 20 points.[2]

This case assignment counts for 7.5% in calculating the semester grades.

2 Submission rules

- **Teams**. Students should form teams to work on this case study. Each team should have three to five students. The team formation have been done previously. Please keep working with the team members you previously made commitment to.

[2]You may be afraid that I, the instructor, will hate you because you say the case assignments are useless. I can promise you that this will not happen, because I am extremely busy and have no time to memorize who wrote what. Nevertheless, you still have the freedom to just say "Good!" and earn twenty points.

- **Things to submit**. Please submit a set of computer programs (for Problem 2 above) and a PDF file (for the remaining problems). Include the student IDs and names of all team members in the PDF file.
- **How to submit**. Please include all the files (regardless of the number of files) you want to submit into a single ZIP file. Please submit the ZIP file to NTU COOL. Each team should make only one submission, i.e., only one student should make a submission.
- **Deadline**. The deadline of this assignment is ***1:00 AM, May 21***. Works submitted between 1:00 and 2:00 will get 10 points deducted as a penalty. Submissions later than 2:00 will not be accepted.