OPTIMAL JOB ASSIGNMENT FOR A HOME-HELP SERVICE

PROJECT DESCRIPTION

I am the boss of a company that schedules home-help visits for elderly patients. The staff is made up of a fixed number of support workers that have specific availability. These workers must visit a fixed number of homes, spending set amount of time at each home. Each patient has preferences about the time they want to be visited at (e.g. "between 10am and 11am) during the day. The stuff assignment must be done in such a way that the total distance travelled is minimal, while adhering as much as possible to the preferences of the patients. In addition, the job assignment should be fair, meaning that each employee must have approximately the same amount of workload. The aim of this project is to develop and implement an algorithm (or a software) to solve this real-world problem using Integer Linear Programming. This project is based on developing and implementing an optimal solution for this problem, taking in consideration as many constraints as possible.

PROJECT AIMS AND OBJECTIVES

By the end of this projects I would like to reach some goals for this project. It is essential to state that the main goal for this project is to create an algorithm that finds the optimal solution to the problem stated above. However, a nice feature that would be nice to have is an API that the company can use to access and manipulate data.

OBJECTIVES

My main goal is to have at least 2-3 constraints within the application that the patient can set. One constraint is that the patients can set at least the time they want to be visited. A second constraint that is important is the availability of the employee. The employee can set their availability by selecting times and days they are available to work. Lastly, a third constraint I would like to include is that the patient can select the person they want to visit them (if they have a preference). It would be nice to make the application as flexible as possible by adding extra constraints on the patient as well as the employee to make the application even more complex. This can include specific skills an employee has that can help a patient. Also, I would like to create a user-friendly interface for the company that will make the viewing of the assigned jobs and manipulation of data a lot easier and faster. This interface should be easy to understand and use. Finally, I would like to create a form that the patients and employees can use to fill out their preferences.

WORK PLAN

WEEK 1 -2

To begin with, I created an Excel Spreadsheet including all my milestones which can help me keep track of my project as well as ensuring progress (uploaded as a separate Excel file). Then, I need to proceed with some background research. A few things must be determined before the actual development and implementation of the application. Firstly, I need to consider the platform I am going to use to develop this project. This project involves linear programming for computational optimization. This includes looking into 'COIN-OR', 'Gurobi' or python libraries and decide which one suits the best for this kind of problem. In addition, research on similar problems must be further investigated to get ideas on how to go about this project. I will do a research on the 'Travel Salesman Problem' as well as the 'Classic Vehicle Routing Problem'. During this period, I want to generate some simple code and test how everything works before making a final decision. Next, I need to decide on the platform I would like to use to create the database I will be using for this problem. I will also need to find where to host my dummy data which may involve talking to IT staff of the University. This data can help me look into using Google Maps functionality to get the distance between 2 locations (employee's house and patient's house) so I can later find the shortest path. In addition, I would like to research different frameworks that can be used to generate a user-friendly interface for the company to control all the data. During this week, I will also set a github repository to log all my file commits which can help me back up my project.

During the second week, I will create the database with the dummy data that I will be using for the project. Also, I would like to test some algorithms to understand the platform I am using even more before starting to develop my project. At the beginning of Week 2, I will be visiting my supervisor to discuss further details about the project.

WEEK 3

During this week, I want to start with trying to come up with a general algorithm that can be used for a basic scenario within this problem. This will be done using the platform I decided on during the first 2 weeks of my research. This approach will help me understand more how the future of my software is about to go. The algorithm will mostly contain the assignment of employees to patients through the shortest distance as well as ensuring well load balance. Once this algorithm is created, then I can continue with applying more constraints in the future.

WEEK 4-8

I will spend the following 5 weeks developing a more complex algorithm, which takes into consideration the patient's and the employee's preferences. This will take the most time, as it

is the foundation of my problem. During this time, I will come up with more constraints that could be applied. This can include specified timings, employee's skills, how many visits in a day, preferences on who the patient wants to be visited by etc. Then, I will try to figure out a way to implement them in my existing algorithm.
At the beginning of week 4, I will visit my supervisor to discuss further details about the algorithm and how to make it more complex. There will be one more meeting during week 6, to show my supervisor my progress and discuss any issues I am facing.

WEEK 7-8

During these 2 weeks, I would like to generate a user-friendly API that the company can use to access data of their staff as well as their clients. This is an additional functionality to the project that can help the company further. This API should give the company the access to manipulate data. For example, the company might want to remove a certain person from their employees' list or remove a client that no longer wants to receive home-help. The company should have the opportunity to view job assignments, schedules and cancel appointments. In addition, the API should also send reminders to the employees for their jobs and to the clients for their appointments. It would be nice to have a form that the employees and patients can fill out with their preferences. Lastly, some form of confirmation of the visit could be sent out to the patient as well as a confirmation of all the job assignments to the employee.
By the end of week 8, I should have a functional project. I will visit my supervisor to get feedback on the project and minor improvements that need to be done.

WEEK 9

Finally, by week 9 I should have my main deliverables implemented the project. These deliverables include finding the shortest path, providing good load balance, employee's time preferences and patient's time preferences. I will dedicate this week to test and evaluate the final application and make any necessary changes. A series of tests need to be executed. This includes altering the preferences of employees and patients to test if the job assignment generation is completed in the expected way. Moreover, API tests need to be run, to check if the API is easy to use and if it does what it is expected. The results from the test should be gathered and evaluated, to check if the project does what it was expected. Any unusual outcomes will be reported and explained.

WEEK 9-12

Finally, I will start to generate my final report. I will be using the notes I take throughout the weeks to make my report. A section at the end of the report will be added including information about my references.
During these 3 weeks, it would be nice to meet with my supervisor to discuss my dissertation report and get feedback.

RISKS

DATABASE FAILURE

Database failure is of high risk as it depends on availability of the server, which can fail at any time. In case of failure, the application will not be able to run as intended with the original data. However, I will have a backup data on my local machine that can be used. Some functionality may be limited within the API.

PROGRAM FAILURE

Program failure may result by corruption/deletion of files. This is of low risk as the project will have a backup on github. I will also have a backup on a USB drive to eliminate the risk. However, if the program fails on all places, there will be no way of recovering the project.