TRANSPORT SCHEDULING SYSTEM IN SUK PAHANG USING HEURISTIC METHOD

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ABSTRACT

Transport Scheduling System in SUK Pahang is a system design using Heuristic Method (HM). The system was built to enhance the schedule options by giving fair equalizer in using the resources such as drivers and transports. Personnel scheduling problems deal with the issue of assigning drivers and vehicles to shifts in a certain time period for the journey, such that several regulations are satisfied and preferences of the drivers and vehicles are taken into account, level of service is maximized [1]. The scheduling system will be based on mathematical programming for optimization. As we know, HM has been variously presented in many kinds of form such as filtering, criteria, production rules, and procedure [3]. In this scheduling system, filtering, procedures, and criteria which base on the constraints will be used using HM.

Keywords— scheduling system, heuristic, transportation, timetabling

ABSTRAK

Pengangkutan Sistem Penjadualan di SUK Pahang adalah reka bentuk sistem yang menggunakan Kaedah Heuristik (HM). Sistem ini dibina untuk meningkatkan pilihan jadual dengan memberi gol penyamaan saksama dalam menggunakan sumber-sumber seperti pemandu dan pengangkutan. Masalah kakitangan penjadualan berurusan dengan isu memberikan pemandu dan kenderaan kepada peralihan dalam tempoh masa tertentu bagi perjalanan, bahawa beberapa peraturan berpuas hati dan keutamaan pemandu dan kenderaan diambil kira, tahap perkhidmatan dimaksimumkan [1]. Sistem penjadualan akan berdasarkan pengaturcaraan matematik untuk pengoptimuman. Seperti yang kita tahu, HM telah pelbagai dipersembahkan dalam pelbagai bentuk seperti penapisan, kriteria, kaedah-kaedah pengeluaran, dan prosedur [3]. Dalam sistem penjadualan ini, penapisan, prosedur, dan kriteria yang berdasarkan kekangan akan digunakan menggunakan HM.

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HR	-	Heuristic Method
GA	-	Genetic Algorithm
PSO	-	Particle Swarm Optimization

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Transport Scheduling System in SUK Pahang using Heuristic Method is a system to ease the user management on their transportation schedule. The origin method that the user used was in a manual way whereby they record each data by themselves in a notebook. This system was proposed to enhance the managing skill of the user and to save time by using the system. Transport Scheduling System in SUK Pahang was mean for giving the best way in making schedule for the transport and personnel using heuristic method, which leads to impressive deal of managing the transportation scheduling trip.

For this thesis, we will discuss about the personnel shift scheduling with vehicle for SUK using heuristic method. Personnel scheduling problems deal with the issue of assigning employees to shifts in a certain time period for the journey such that several regulations are satisfied and preferences of the employees are taken

into account, level of service is maximized [1]. Nurse rostering using fuzzy logic which is also a similar kind of system, were also been studied for the understanding and references for the constraints. Similar to driver, a nurse should work throughout the week, and are often required to work weekends, even on official holidays. As for a business of bus operating companies, the schedule were demanded to be more logical and fair which will be based on mathematical programming for optimization [2]. The concept of a heuristic has been, and continues to be, the central in an artificial intelligence is too well known to require documentation. In an heuristic artificial intelligence solving, be it the program, rule, piece of knowledge, it gives out a practical solution whereby it can be used in problem solving, guaranteed on supplying solution, and evolutionary optimized results.

Heuristic has been variously presented in the form of proverbs, maxims, hints, suggestions, advice, principles, rules of thumb, criteria, production rules, programs, procedures, option filters and others [3]. Timetabling is a form of scheduling where the task is to assign activities to available slots in resources respecting on some defined constraints. Eventually, the activity is described by the duration, while picking available resources to do the job without breaking the hard constraints.

1.2 Problem Statement

The transportation scheduling table was usually done manually by user and data has been recorded in paper. Hence data recorded manually might sometimes lose by accident. In addition, during making a schedule for the transport, it takes some time to make a proper schedule due to afraid of time clashing. Also for task allocation for the drivers and vehicles, sometimes it is not fair to utilizing the available source.

The timeslot will be in a week of seven days. All days will be filled with drivers and their transports, with each driver have their own constraint and will satisfy them. Soft constraints such as each driver must not work too long and working hours on previous and the day after will be considered, while depending on the time they travel. The hard constraints will be the schedule must not clash by the same driver and the same vehicle.

As a result, the problem statement should be question on:

- How to decide the soft constraints and hard constraints.
- How to make fair timetable in selection of resource.

1.3 Objectives

I. To study the way of scheduling a timetable for the travelling of SUK Pahang by using heuristic method.
II. To design a simple and usable system.
III. Develop a prototype to schedule the solution for a given case study.

1.4 Project Scope

The project scope is for SUK staff to manage their transportation more effectively by enable user to make schedule more systematic. User will be able to identify the transportation status and schedule time for the entire week. The new schedule will be added once there is travelling request and it will auto-generate and available vehicle with driver based on the highest fitness.

The algorithm use for the artificial intelligence is heuristic method. Constraints will be determined by drivers, location, and vehicles. Constraints will have a given penalty points where the lesser the penalty, the higher the fitness level of the scheduling result. The scope will limit to the area of Peninsular Malaysia's main city. The pattern will only focus on single destination and a one day trip without staying. The scheduling system also limit SUK Pahang's department into 3 categories, which are "Bahagian Khidmat Pengurusan", "Bahagian Teknologi Maklumat", and "Majlis Sukan Pahang".

1.5 Thesis Organization

This thesis consists of five chapters, and each chapter has its own specific content. Chapter one includes the starting point of the thesis, which is introduction, problem statement, objectives, and project scope of the project.

Chapter two evaluates the research for the project. The literature review will be proceeding with research of the techniques that will be used in the development and studies about the scheduling of the current system.

Chapter three will discuss about the methodology of the working progress. It sums up the work load for the entire project and elaborates the framework of the project.

Chapter four is the implementation of the project where layouts will be reviewed. Chapter five, the last chapter discuss about the discussion and conclusion of the system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews about the knowledge and understanding of the project background. Different literature with different techniques will be reviewed, as they all have one objective which is optimization on scheduling timetable. Of course, the main technique will be more focus on details which is the heuristic method.

2.2 Background

Scheduling for personnel is one issue that had been a problem statement for all company who needed staff scheduling. In a transportation scheduling, drivers and vehicles were to include as the main domain factors as to make an optimum timetable. Scheduling has become an issue because of the constraint for drivers despite to satisfy their working hours and other constraints while getting a suitable time belt. Both constraints of the drivers and vehicles should be considered wisely to develop a more optimum schedule.

Driver's constraint will be included as the working hours, where the working hours should not over work. As for the vehicles, the consideration on how many passengers will be included to the travel to get the suitable vehicle and also the working hours. As mentioned that the project was basically set on some of the area of Peninsular Malaysia. As a result, the two factors which affect the constraints and rule will be:

- Driver
- Vehicle

Finally, in order to satisfy both the workers and the vehicle while giving a more perfect timetable, there were several techniques being studied which are the heuristic method, genetic algorithm, and particle swarm optimization. All these techniques were introduced and recommended in implementing into this system, but the final decision was using heuristic method as the technique to be used, just to prove that heuristic method can schedule timetable.

2.3 Artificial Intelligence Techniques

Artificial intelligence is the intelligence where the computer generates the knowledge and gives out an output of results which is logical. For this scheduling system, there will be three types of artificial intelligence techniques to be reviewed which are heuristic method, genetic algorithm, and particle swarm optimization.

2.3.1 Heuristic Method

A finite constraint satisfaction problem consists of a set of variable associated with finite domains and a set of constraints restricting the values that the variables can simultaneously take [4]. The heuristic method (HM) tends to solve solutions to a constraints satisfaction problem as an assignment of a value from its domain to every variable, in such way that every constraint should be satisfied.

The interactive behaviour of the algorithm requested to solve the result should be clear. While building the solution shall be step by step and that can present a result at any time. A frequent requirement is to have a sound solution or sub-solution even during the search. In such a solution some variables can still be unattached, but all constraints over attached variables have to be satisfied. It means that there is no violated constraint during the search.

2.3.1.1 Basic Concept

The algorithm should provide some fractional solution at each step. This fractional solution should be good enough in respect to satisfaction of soft constraints and it must be sound (all required constraints are satisfied). The activity of the algorithm is which means two kind: the difference between the solutions provided by the algorithm in two consecutive steps should be minimal, and the solution process can be interfering by user. The algorithm must be able to start from modifying solution, make it sound and continue in extending the partial solution to a complete solution.

There are two basic approaches how to solve problems defined by means of constraints: backtracking based search that extends a partial sound solution to a complete solution, and local search that decreases the number of violations in a complete solution [5]. Idea of local search is provided at each step, the difference of the solution is in accordance with the requirements of us that there is a solution of some relatively small successive steps. However, the provided solutions are not sound. On the other side, it is not easy to add interactive behaviour into backtracking based search but it can provide a partial sound solution at each step. In particular, it does not support external changes of the partial solution and the difference between two consecutive solutions can be large after a long backtrack.

2.3.1.2 Algorithm

There are two kinds of structure which are: a set of variables that are not attached, and a partial sound solution. Each iteration for the algorithm tries to evolve the partial solution into complete one. The algorithm starts with an empty partial/fractional solution, and then it goes repeatedly from one partial sound solution to the other sound variable. This ends until the maximum number of iterations is reached or the variables are assigned.

```
procedure solve(unassigned, solution, max_iter)
  // unassigned is a list of un-assigned variables
  // solution is a partial solution (empty at the beginning)
  //     e.g. a list (variable, assigned value)
      iterations=0;
      while unassigned non empty & iterations<max_iter
            & non user interruption do
              iterations ++;
              variable = selectVariable(unassigned, solution);
              unassigned -= variable;
              value = selectValue(variable, solution);
              unassigned += assign(solution, variable, value)
                 // assign the variable and return violated variables
      end while;
      return solution;
end solve
```

Figure 2.1: Interactive algorithm of the heuristic method

At first, the algorithm passes through an un-assigned variable and chooses its value. The selection of the value can be made by evaluation from each domain via heuristic function operating over the current fractional solution. Finally, when the best fitness is selected the loops will then end.

2.3.1.3 Variable Selection Criterion

As mentioned from the algorithm phase, the current algorithm requires a function that selects an unassigned variable to be assigned in the current iteration step. The problem is same to what is a variable selection criterion in constraint programming. There are several guidelines how to select a variable. In local search based the variable participating in the largest number of violations is usually selected first. While the first-fail principle is often used in backtracking based algorithms.

Due to complexity of computing the heuristic value it could be rather expensive in some cases although it is possible to select the worst variable among all unassigned variables. Therefore selection of a subset from unassigned variables randomly and then chooses the worst variable from this subset would be the best

decision. The results will not be much worse and we can select the variable much faster.

2.3.1.4 Value Selection Criterion

After selecting the variable finding a value to be assigned should be the next step. Value selection in a constraint programming is to select the best-fitness value So, we are looking for a value, which is most preferred for the variable and also which causes the least trouble. It means that we need to find a value with minimum potential conflictions with other variables.

To stop cycling, randomise the value selection procedure will be used to get the final result. For an example, the selection for the final stage has five best values for the variable; the final result will be chosen one of them randomly. Or, it is possible to select a set of values as the heuristic evaluation for the worst value is maximally twice as large as the heuristic evaluation of the best value (lower value means better value). Again, the value is selected randomly from this group. This second rule inhibits randomness if there is a single very good value.

2.3.1.5 Decision Guider

To prove the decision guider is the primary function of heuristics, the first thing is the element of choice is always present when the heuristics are discussed. Besides that, the heuristics as a group should not consistently influence any other elements of constraints problem solver. The use of heuristic always counts on the existence of a decision mechanism and the effect is to lead this mechanism to one path as opposed to others. In short, heuristic method decides on where to go to search for a better result.