Goal Programming Model for Tutor Scheduling

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**Abstract.** This article presents goal programming model for tutor scheduling. Goal programming is the development of linear programming which has multiple objectives. Goal programming minimizes the deviation among the the desired level of goals and the actual achievement, which is achieved by changing inequality into equality by including positive and negative deviation variables accomplished by converting inequalities into equalities by including positive and negative deviation variables that allow the achievement below or above each goal. The results obtained from this model provide the optimal solutions where all objectives are achieved. This model also aims to achieve harmony and fairness between tutors and institutional management.

Keyword: Goal Programming, Linear Programming, Tutor Scheduling

Abstrak. Artikel ini menyajikan model goal programming untuk penjadwalan tutor. Goal programming adalah bentuk pengembangan dari linear programming yang mana mempunyai multi tujuan. Goal programming berfungsi meminimumkan penyimpangan (deviasi) antara level tujuan (target) yang diinginkan dan pencapaian sebenarnya, yang mana diperoleh dengan mengubah ketidaksetaraan menjadi persamaan yang memungkinkan pencapaian di bawah atau di atas setiap sasaran dengan memasukkan variabel deviasi positif dan negatif yang memungkinan pencapaian di bawah atau di atas setiap sasaran. Hasil yang dipeoleh dari pemodelan ini adalah sousi yang optimal dimana semua fungsi tujuan tercapai. Pemodelan ini juga bertujuan meningkatkan keharmonisan dan kesesuaian antara tutor maupun manajemen institusi.

Kata Kunci: Goal Programming, Linear Programming, Penjadwalan Tutor

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1. Introduction

Scheduling is the process of organizing, controlling and optimizing. Pinedo [1] explains the notion of scheduling as a decision-making process that is used regularly in the industrial and service sectors. The problem of scheduling is how to schedule several components consisting of employees, shifts, the number of employess and assignment days with due regard to certain restrictions and conditions. However if an institution has many location or rooms, scheduling will involve one more component, namely the work location or workspace. The problem of scheduling work is a matter of assigning a number of jobs to a limited number of workers at different specified times, so that the performance of the workers, the total number of workers, and the total costs incurred reach optimal.

The problem of scheduling pays attention into two things namely regarding the resources that will do the operation and the start - end time of a job. Therefore scheduling will always be related to the allocation of existing resoursces at a certain time period. It is a decision process whose purpose is for optimality.

In the optimization process, modeling is needed which generally consist of objective functions and constraint functions. There are many goals in tutor scheduling. Among these goals is how to allocate tutors to work on certain sessions and days that are sustainable and accordance with the policies of institution and school.

The problem is influenced by several factors such as : suitability of tutor time with school time policy is not same, the required of specification tutor does not meet, varying amounts of classrooms, school personal policies (such as minimum number of meetings and learning days), and unpredictable absenteeism. In addition some of these considerations can be contradictory with other cases, such as the numbers of tutors available versus the tutors needed to balance the workload.

In the scheduling process, goal programming is usually used Charnes dan Cooper [2] began to popularize the goal programming method which is able to solve linear programming cases that have more than one goal to be achieved.

Goal programming is a variation or development of a linear programming whose main difference lies in the formulation of objective functions and deviation variables in the goal constraint equation. The goal programming method is a dual purpose linear programming model, so that all assumptions, notations, mathematical model formulations, model formulation procedures and solution are not much different. The difference only in the presence of a pair of variables called deviational variables. Deviational variables function to accommodate deviations or deviations that will occur in the value of the left segment of an equation againts the value of the right segment. Goal Programming model and scheduling have been discussed in [1], [3]–[7].

1. Goal Programming Formulation

First step : Set the target priority level for each goal

Second step : Determine the weight of each goal

If a priority level has more than 1 goal for each goal a weighting are placed on the deviation or on the goal.

Third step : Establish the linear program form

Min

Fourth step : Complete the current linear program

If there is a lowest priority level to step 5, if not the final solution has been reached

Step 5 : Create a new linear program form. Consider the next lowest level of goal priority and formulate an objective function based on that goal. Add the barries needed to reach the next highest priority level. A new linear program form is

Min

(Repeat steps 4 and 5 until all priority levels has been examined).

1. Numerical Examples

This scheduling of tutor is assumed at an institution that cooperates with a secondary school, where the school chooses the UN preparatory learning package. There are 4 classrooms to be given, there are : 6B, 6C, 6D, and 6E. And there 6 tutors are available to each for this learning package. And to achieve the completeness and fairness of each tutor requires 12 meetings for every tutor in a week. The school proposes that there are only 3 sessions each day. So that the active learning day is 6 days in a week (Monday-Saturday). The notations are stated as follows :

: index for session,

: index for classrooms,

: index for days,

: index for tutors available,

: tutor teaches of day ,

: tutor doesn’t teach of day ,

1. Decision Variables
2. Formulating and Model Constraints
   1. Hard constraints

Satisfy daily tutor requirements

Ensure no tutor enters in two or more classrooms at the same time.

for all:

Ensure no tutor enters two consecutive sessions at the same class.

for all:

Ensure each tutor teaches m session minimum and maximum in every cathegory of learning package.

* 1. Soft constraints

Ensure classroom must consist of session maximum with the model:

for all:

1. Formulating Goals

In order to simplify and resolve the abstacles that exist in the achievement of objectives, the following goals are formulated. Achievement goals are simplified into four problems as follows:

Goal 1 : It minimizes the deviations between the sum of actual days and the minimum days needed. This goal confirms that each tutor teaches no more than 12 sessions in 6 days.

for all:

Goal 2 : it avoids assigning tutors to teach two classroom or more at the same time.

for all:

Goal 3 : it strives to have in the schedule, every classroom is taught by 1 tutor for each session every day.

for all:

Goal 4 : it avoids assigning tutor to teach I session and II session of the following class.

for all:

1. Established Important Weights

Important weights are determined for each goal based on relative important of those goals. The level of punishment for violating relevant goals expreeses these important weights. These levels are represented respectively by , , , , and .

1. Objective Function

The objective function is to minimize the number of weighted deviations from the appropriate goals. Note the goal 1 specifically minimizes unnecessary overtime and hence the appropriate costs. The expression of objective function is given by:

1. Final Result

Goal programming models in this scheduling are solved with lindo software and obtains as below:

1. Recapitulation of Tutor Scheduling

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Day** | **Session** | **Class** | | | |
| **6B** | **6C** | **6D** | **6E** |
| **Monday** | I | 2 | 6 | 1 | 3 |
| II | 4 | 2 | 3 | 5 |
| III | 6 | 4 | 5 | 3 |
| **Tuesday** | I | 1 | 2 | 4 | 5 |
| II | 4 | 6 | 1 | 3 |
| III | 6 | 2 | 5 | 1 |
| **Wednesday** | I | 4 | 6 | 3 | 5 |
| II | 6 | 4 | 1 | 3 |
| III | 4 | 6 | 3 | 5 |
| **Thursday** | I | 4 | 2 | 3 | 5 |
| II | 2 | 4 | 1 | 3 |
| III | 6 | 1 | 5 | 2 |
| **Friday** | I | 2 | 6 | 1 | 5 |
| II | 4 | 2 | 3 | 1 |
| III | 6 | 1 | 5 | 4 |
| **Saturday** | I | 2 | 6 | 1 | 5 |
| II | 4 | 2 | 3 | 1 |
| III | 6 | 3 | 5 | 2 |

1. Conclusions

In this study, goal programming model is made for scheduling tutors at a tutoring institution that cooperates with a secondary school. Actually, the head of tutoring institution made a manual scheduling for tutors by trial and errors approach. Scheduling is done by considering fairness, tutor preferences and staffing requirements both in quality and quantity. This manual scheduling not only consumes a lot of cost and time, but is also inefficient in producing the best scheduling. The purpose of this modeling is to make the best tutor scheduling using goal programming and reducing the error.

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