PREFERENCES OF TEACHERS AND STUDENTS FOR AUTO GENERATION OF SENSITIVE TIMETABLE: A CASE STUDY

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Abstract

A large amount of tools are available for generating timetable based on the constraints provided by user. The tools generally consider those constraints which are insensate and which are unavoidable. They emphasize mainly on the specifications of classrooms, teachers, subjects but are not able to fit in constraints related to the human factors like fondness, placate and weakness of the major target stake holders namely teachers and students. To make system which works like humans, it might be highly beneficial to frame rules stating the personal preferences of the main stakeholders and subsequently design the timetable incorporating these rules as well.

This paper presents a survey done to find the preferences of teachers and later concludes with the rules mined using classification method. Later these rules can be utilized intelligently for an insightful timetable generation.

Keywords- Classification & Regression trees, Teacher and student timetable preferences, Soft constraints, Sensitive timetable generation

1. Introduction

The timetabling problem comes up every year in educational institutions, which has been solved by leveraging human resource for a long time. The problem is a special version of the optimization problems; it is computationally NP-hard [D.Schindl(2000)] . As a result, only the major inevitable conditions can be considered during the manual arrangement process. However the manual process takes into account soft constraints whereas automated system might not consider them. This is a major shortcoming of automated systems, wherein they don't give due importance to human feelings.

If we want to have a system which works like humans, it would be necessary to make it aware of the soft constraints of humans. Hence we propose a method to add this aspect in the timetable generation to achieve an artificial intelligent computer system more close to human. We propose to use a mechanism to mine rules which can later be incorporated in the automated system to draw its attention to the soft constraints.

2. Literature review

The Time Table Problem

During the time table generation process, numerous aspects have to be taken into consideration. Almost a week of work of an experienced person is needed to produce a timetable for even a moderately sized institution and the result is often not reasonable i.e. It does not meet all the requirements. What is more, when the preconditions change, the whole work becomes unusable, and has to be restarted from scratch.

The informal definition of timetable can be stated as "*Timetabling* is the allocation, subject to constraints, of given resources to objects being placed in space time, in such a way as to satisfy as nearly as possible a set of desirable objectives ". These problems are subject to many constraints that are usually divided into two categories: "hard" and "soft".

Time Table Constraints

1) Hard constraints: - Hard constraints have to be taken into consideration very strictly, because the timetables that violate just one of these are unusable. The finite "resources" belong to this group. The constraint that one person cannot be in two places at once or that there is a maximum number of people that can be accommodated in a particular room.[Burke and Newall(2002)] Many systems designed to treat mainly the hard constraints have been proposed, some noteworthy of them are constraint based reasoning to timetable generation [Banks(1998)] **,** hybrid approach based on heuristic [Abdullah & Hamden (2008)],based on ordering heuristics [Rehman *et al*.] ,based on genetic algorithms [Colorni *et al*(1990)] etc.

2) Soft Constraints: - The timetable that violates these constraints is still usable, but it is not convenient for either students or teachers, and it also makes more difficult to understand the lessons. The constraints under this category are teacher's soft availability, capability of teacher to handle two or more consecutive lessons, to name a few.

In real-world situations it is, usually impossible to satisfy all soft constraints[Burke and Petrovic (2002)].As a result the tools used for automated timetable generation concentrate on hard constraints ignoring the soft constraints . But when we are interested in designing a sensitive or intelligent time table generator system, it gets very important to consider these soft constraints too while designing the time table. And this in turn would necessitate having some rules to indicate the soft constraints suggestion.

Rule-based timetable generation has been suggested by [Shaikh & Al-Bastaki(2004)] and [Yuri Kochetov *et al* (2008)] have developed a mathematical model for timetabling problem and have proposed local search heuristics to solve the problem. A wide variety of other approaches to solve timetabling problems have been investigated in [Burke & Petrovic(2002)]

3. Materials and methods

Classification Trees

Classification trees are used to predict membership of cases or objects in the classes of a categorical dependent variable from their measurements on one or more predictor variables. The goal of classification trees is to predict or explain responses on a categorical dependent variable [12]. Classification trees readily lend themselves to being displayed graphically, helping to make them easier to interpret than they would be if only a strict numerical interpretation were possible. Other characteristics of decision tree are their hierarchical nature and flexibility.

CART (Classification & Regression trees) is a stepwise, nonparametric procedure that uses exhaustive computerized searches and sorting techniques to identify useful tree-structures for classification of data from several groups. It provides a set of rules that can be applied to a new (unclassified) dataset to predict which records will have a given outcome. Trees are formed by a collection of rules based on values of certain variables in the modeling data set.

Rules are selected based on how well splits based on variables' values can differentiate observations based on the dependent variable Once a rule is selected and splits a node into two, the same logic is applied to each "child" node (i.e. it is a recursive procedure). Splitting stops when CART detects no further gain can be made, or some pre-set stopping rules are met. Each branch of the tree ends in a terminal node. Each observation falls into one and exactly one terminal node. Each terminal node is uniquely defined by a set of rules.

The basic idea of tree growing is to choose a split among all the possible splits at each node so that the resulting child nodes are the "purest".

4. Experimental Setup

CART analysis was performed with trial version of commercial statistics software, namely SPSS statistics 17.0 [*Online available at*:www.spss.com]. The Decision Tree procedure in this tool creates a tree-based classification model. It classifies cases into groups or predicts values of a dependent (target) variable based on values of independent (predictor) variables. The procedure provides validation tools for exploratory and confirmatory classification analysis. It provides the CART growing method wherein the data is split into segments that are as homogeneous as possible with respect to the dependent variable. A terminal node in which all cases have the same value for the dependent variable is a homogeneous, "pure" node.

Some of the major settings made to achieve valid tree are as follows: -

- Impurity measure: The extent to which a node does not represent a homogenous subset of cases is an indication of impurity. There are 3 available namely Gini,Twoing and ordered Twoing. We have selected Gini. In this measure, Splits are found that maximize the homogeneity of child nodes with respect to the value of the dependent variable. Gini is based on squared probabilities of membership for each category of the dependent variable. It reaches its minimum (zero) when all cases in a node fall into a single category. This is the default measure.

- Minimum change in improvement measure: It is the minimum decrease in impurity required to split a node. It is set to default value 0.0001.

- Growth limit measure:-It allows limiting the number of levels in the tree and controlling the minimum number of cases for parent and child nodes. Nodes that do not satisfy these criteria will not be split. Considering the collected response data size, the settings used in the teacher preference tree generation were minimum 5 cases in parent node and 2 in child node whereas for student classification it was set to 25 and 10 respectively. The maximum tree depth was set to five.

The experiment was done using the data obtained from the teachers and final year students of an engineering institute in state of Gujarat, India. A total of 20 teachers along with 60 students were given the survey questionnaire.

In teacher community, the teaching experience was considered an important factor which influences the preferences. Amongst the teacher group, 3 distinct category were identified namely high experienced (>=5 years of teaching), moderate experienced and comparatively novel to the education field (< 2 year) so low experienced.

The tips given in publication by [Taylor-Powel and Marcus Benner(2009)] are used to design the questionnaires. The major suggestions kept in mind were – Make questionnaire easy to complete, keep your audience in mind, keep the form short, protect the anonymity of respondent, *et al*. Also the steps suggested by Peterson Robert A. [Patterson(2000)] are also good guide to construct an effective questionnaire.

The questions asked to teachers were as follows:

1. In morning sessions what is preferred?
   a) Theory teaching b) Practical teaching c) No load d) any thing
2. On a particular day your lecture should be –
   a) Prior to other lectures b) in midst of other lectures (c) at end of other lectures
3. How many maximum *lectures* you can deliver *comfortably* in one day?
   a) One b) Two c) Three d) Four e) Any
4. How much maximum *total work load* you prefer in one day?
   a) One b) Two c) three d) Four e) Five
5. How many *different* subjects you can deal with *comfortably* in one semester?
   a) One b) Two c) Three d) any
6. You prefer to take *only* those lab sessions for which you take theory session?
   a)Yes b) No c) not necessarily
7. How much *minimum* time gap (in hours) you need between two sessions (lectures /labs)?
   a)One b) two c) three d) none

For the student group, their aggregate results in percentage in school (aggsch) and in undergraduate study (aggBE) were considered to be the influencing factor in timetable choices of student.

The answers to following questions were requested from students:

1. In morning sessions what is preferred?
   a) Theory learning b) Practical learning c) No study d) any thing
2. What should be complexity of subject studied at start of schedule?
   a) Hard b) Easy c) Moderate d) Any
3. You prefer which type of teacher at start of schedule?
   a)Senior teacher b) Junior teacher c)Any
4. How many *different* subjects you can study *comfortably* in one day?
   a) One b) Two c) Three d) Four e) Five f)Any

4. Experimental Findings

The response data was mined using CART method. The resultant rules framed are as follows:-

Note that only the rules having probability of greater than 0.8 are considered significant and hence rest are omitted.

A) Student preferences:-

- *If* (aggsch>76.5) & (aggBE>64) *then* subject complexity in morning=hard [Probability = 0.8]

- *If* (aggsc>80) & (aggBE>57) *then*
  prefererece of teacher in morning session=senior teacher [Probability=0.9]
- *If* aggBE<63 & aggsh<82 *then*
  maximum different subjects preferred to study in one day= three
  [Probability=0.9]

B) Teacher preferences:-

- *If* teaching experience high or medium and minimum recess =1hour and gender=male
  then preference in morning session=theory teaching [Probability =0.8]
- *If* teaching experience high or low and gender=female
  then preference in morning session=theory teaching [Probability =1]
- *If* teaching experience high or medium and max teaching load preferred=three
  then prefer lecture should be = in midst of other lectures [Probability =1]
- *If* teaching experience low and labs same as lectures =yes and maximum teaching load =four/five hours
  then preference for maximum lectures in one day=two [Probability =1]
- *If* teaching experience low and maximum teaching load =three hours
  then preference for maximum lectures in one day=one [Probability =1]
- *If* teaching experience high
  then preference for maximum lectures in one day=two [Probability =1]
- *If* teaching experience high or medium and gender=male and preference of lecture =midst of other lectures
  then maximum teaching load =3 hours [Probability =1]
- *If* teaching experience medium and lecture prior to other lectures
  then maximum teaching load =4 hours [Probability =1]
- *If* different subjects=2
  then recess =one [Probability =1]

These rules can now be incorporated for automatic generation of timetable. Also as the probability is greater than 80%, hence the rules mined can be considered dependable.

5. Results & Discussion

The grading system normally employed in education system in Indian universities and institutes [13] , is mentioned in Table I.

Table I. Common grading system in India

Percentage	Classification
81-100	Distinction*
61-80	First Class
51-60	Second Class
33-50	Third Class
<33	Fail **

*some institutes with difficult curriculam give 70% scoring as distinction
**some institutes need minimum 50% or 60% to pass.

Based on the feedback collected, it can be suggested that students having distinction or first class in school prefer hard subjects in morning session. Also if a student was getting distinction in school but in college is able to get only second class, then he would prefer some senior teacher teaches them in morning. Another interesting observation is that if student is not getting distinction in school and college, i.e. he is not exceptional student then he can study only 3 maximum subjects comfortably in one day. So it might be strongly suggested that the timetable generated should be such that in lab, such a student does practices for only those subjects for whom he/she had learnt theory that day.

As far as teacher preferences are concerned, from the data collected, it can be speculated that all faculties who are not new to teaching field, like to take theory sessions in morning, with only exception of female faculties having moderate experience.

For low experienced faculty, if in lab sessions they have to teach same subject for which they had taught theory on that day , it can be recommended that timetable generator give 2 lectures of in one day, if total load to be given to that faculty is 4 to 5 hours . Otherwise,in case when the course of lab session is different then what they had covered in theory sessions, they can be given only 1 lecture and 2 hours of lab session, totaling to maximum 3 hours work load. So effectively a low experienced faculty can handle only two different subjects in a day.

For a highly experienced person, timetable generator can give 2 distinct subject lectures to the faculty, and if the lecture is not scheduled at start or end of schedule, the count can be increased to 3 also.

All faculties prefer to have one hour relaxation time between teaching 2 different subjects.

6. Conclusion & Future Work

The rules mined can be incorporated in a system for auto generation of the timetable schedule for the particular university where the survey was conducted. Similar procedure can be followed in any institute to get such interesting rules mined and can be later fed to timetable generator software.

Consequently, this method would prove to be beneficial to achieve a sensitive, comfortable, and friendly timetable for the teachers as well as students of an institute.

In future it would be interesting to collect and analyze the feedback of the intelligent and sensitive timetable generated.Also it would help to understand the impact of an artificial intelligent timetable on the overall productivity and working capabilities of the stake holders of this asset.

In current paper, only university timetabling problem is addressed,however it would be expanded to other timetabling problems such as employee timetabling,timetabling of sports fixture etc.

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