

# Fairness in Examination Timetabling Problems

## A Survey and the New Problem Formulation

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**Abstract** Although investigated for more than two decades, examination timetabling problems are still considered challenging and interesting problems by the timetabling research community. In our study we are investigating some issues which have not received sufficient attention within the related body of work to date. Our survey on students' preferences in relation to university exam timetabling reveals two main findings i.e. examination hardness and fairness issues. The finding on fairness leads the notion of "fairness within a course" in which fairness is measured over students within the same course as opposed to over students in the entire university. To cope with this finding, a new formulation of examination timetabling problems is introduced. This paper focuses on work to tackle fairness issues in examination timetabling problems. At the end, the result from this study is hoped to have significant contribution to fairer automated decision making for generating examination timetables in Universities.

**Keywords** Optimisation · Examination Timetabling Problem · Fairness · Hyper-heuristic · Fairness Within a Course

## 1 Introduction

Examination timetabling is a well-known and challenging optimisation problem. In addition to achieving feasibility, the quality of an examination timetable

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is measured by the extent of the soft constraint violations. A standard and often cited example of a soft constraint is where the examinations should be spread out as evenly as possible throughout the overall time period in order to give students as much time as possible for revision. However, to the best of our knowledge, existing state-of-the-art examination timetabling solvers neglect the concept of fairness among the entire students body taking examinations. Since the examination timetable contributes to the students academic achievement, we believe that it is reasonable that overall student satisfaction could be improved by increasing the fairness of treatment towards and between individual students. Thus, making balance between quality of the overall timetable and fairness to individual students becomes an important issue and indeed, this is likely to be exacerbated as more universities offer interdisciplinary degree programs.

The rest of this paper present findings from our survey on students preferences over university examination timetabling problems. Subsequently, a new examination timetabling formulation is offered taking into consideration the findings from this study along with a method to solve the new formulation.

## 2 Fairness In Examination Timetabling Problems

There is no clear definition offered within existing literature that defines what fairness means in relation to examination timetabling. Hence, in this study we ran a survey to investigate fairness from the students' perspective. A survey, the results of which are presented here, was conducted by researchers from the University of Nottingham using a standard questionnaire methodology. Targeted students were both from undergraduate and postgraduate background.

### 2.1 Fairness from Students Perspective

With regard to examination timetable, the survey enquired about students preferences in relation to how their examinations were timetabled. To be more specific, the survey also asked students their views on what the definition of fairness should be. The questions include whether the fairness issue does really matter in the existing examination timetables. If fairness does matter, then to what extent fairness played a role was also investigated. Whether the examination timetable should be fair among all students in the university or only students in the same course is an important question to be addressed in defining the notion of fairness in examination timetabling problems.

In addition to investigating fairness, the survey also investigated other issues on to students preferences relating to examination timetabling. Although surveys on examination timetabling in practice have been conducted by prior works such as [1], and [2] there are other important issues that, in our view, have not been adequately covered. In [1] the survey was conducted through University registrars as opposed to directly to University students. While in [2],

the survey was directed at students and invigilators though details on student preferences were not adequately covered. Our survey is also trying to seek in-depth understanding on the preferences of students over their examination timetables such as preferences on how hard and easy examinations are timetabled.

Our pilot survey result shows that students believed that some examinations are harder than the others. For harder examinations they admitted that they need more time for preparation. Thus, special attention should be given e.g. by allocating wider gap before these examinations. Although the way how one determine students perception on hardness of examinations is debatable, but the data of hardness of examinations can be collected from students opinion after taking the examination or by asking students to nominate which examinations needing more preparation time.

The survey result also shows that all students agreed that fairness should be taken into account. An interesting fact from the survey is that while all students think that fairness should matter among students in the same course, only some think that it does matter among students from differing courses. It suggest that fairness should be defined over students from the same course rather than over the entire students. We term this notion as "fairness within a course".

## 2.2 Proposed Method

This study extends our prior work [4]. To enforce fairness, such as in [4], instead of using standard linear summation of soft constraints violation, a new objective function is introduced. However, different from our prior work, in this work fairness is measured within each single course rather than within the entire university. Then, optimising fairness within each course over the entire university could be treated as multi-objective optimisation fashion. By doing so, students from small course do not necessarily suffer as much from the influence of the larger courses as it happened in our prior work.

To cope with the survey finding in this study, we are still working on formulating what we term as fairness within a course. We are also working on how to measure this kind of fairness that would be the modification of Jain Fairness Index (JFI) [3]. The index should be bounded between 0-1 to indicate the level of fairness. A method to enforce fairness within a course that would be the modification of Sum Of Powers is also still in progress. To show how Sum Of Powers work, let  $s$  is number of students,  $x$  is any positive integer greater than or equal 2, and  $p_1, p_2, \dots, p_s$  be the total penalty received by students respectively. As opposed to standard linear summation, equation(1) is applied. This objective function will make  $F(3, 4, 3)$ , which is fairer, preferable than  $F(1, 6, 3)$  although both linear summation are the same.

$$F(p_1, p_2, \dots, p_s) = (p_s)^x \quad (1)$$

### 3 Conclusion

This study could potentially lead to propose new exam timetabling examination problem formulations that are more focused on students' preferences and other issues that lack of attention from state-of-the-art problem formulation e.g. fairness. The new conception about fairness in examination timetabling problems i.e. fairness among students within the same course rather than the entire students as well as showing that hyper-heuristics could solve examination timetabling problems with fairness in multi-objective fashion will be the main contribution of this paper. In future works, the new model will be solved using hyper-heuristics within HyFlex 2014 framework. The experiment will be conducted over two mostly used data set in examination timetabling problems i.e. Carter and ITC 2007 data set. It is hoped that this work will contribute to an improved student-oriented decision making methodology in the process of generating high quality examination timetables for Universities.

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