# An Extensible Modelling Framework for Timetabling Problems

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**Abstract.** Several modelling languages have been proposed to standardize the specification, solution and data format for timetabling problems. As of now these languages have not been adopted as standards and are seen as not simplifying the modelling process, lacking features and offering little advantage over traditional programming languages. In contrast to this approach we propose a new language-independent modelling framework for general timetabling problems based on past experience of modelling the examination timetabling problem. This framework is a work in progress but demonstrates the possibilities and convenience such a model would afford.

## 1 Introduction

Timetabling is the process of assigning events, and resources, to timeslots subject to constraints [4,21]. The feasibility of a solution for a timetabling problem is determined by the violation of *constraints* that are specified for each problem. One of the most significant application areas of timetabling is educational timetabling which is a very practical challenge faced by almost all academic institutions several times every year [8,13,18,19]. Unlike many other combinatorial optimization problems, models for educational timetabling problems change from one institution to another due to changing constraints and restrictions on resources. For this reason efforts have been made to create standard modelling languages and data formats to simplify this process.

This paper discusses the rationale for proposing a modelling framework for timetabling problems in relation to existing languages designed for timetabling. Rather than proposing a new timetabling language the idea of a standard modelling framework for timetabling problems builds on the ideas found in the existing timetabling languages and also makes use of the functionality, standardization and ease of use provided by modern object-oriented modelling frameworks. The Examination Timetabling Problem (ETP) is chosen as a significant special case of timetabling to demonstrate the practical difficulties with the existing languages and also to demonstrate the abilities of our framework.

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## 2 Examination Timetabling Problem

Examination Timetabling is the problem of assigning Exams to Timeslots during a exam period respecting the given constraints [2,6,7,14]. The most important constraint for the ETP is the *clash* (or first degree student conflict) constraint which states that a student cannot be timetabled to sit more than one exam at the same time. This is an example of a *hard* constraint as a single violation renders a solution infeasible. Other examples of hard constraints are duration and room capacity constraints; i.e. exams cannot be assigned to timeslots where the duration is shorter than that of the exam.

The *consecutive* exams constraint is an example of a *soft* constraint. A consecutive constraint is violated only when a student is timetabled to sit more than one exam in immediate succession. This constraint exists in most instances of the ETP, but may not be universal. Institutions may also add their own unique constraints, such as not mixing different language exams on the same day [2]. As different institutions use very different constraints it is hard to generalize the problem in such a way that it is applicable to all cases. Any universal model for the ETP must therefore allow some flexibility in what constraints are specified. The goal in exam timetabling is to minimize the number of constraint violations over a solution. Typically a penalty is assigned to violations of soft constraints and the total cost for any solution is the sum of penalties for all the violations found.

There are many varying approaches to solving the exam timetabling problem in use at institutions and by researchers. For a comprehensive recent survey of these approaches see [14]. Some publicly available ETP data exists, such as that published by the University of Melbourne[1], and has been used for benchmarking. However, these can relate to instances of the problem over a decade old, since when many universities have seen expansion in their numbers of students and courses, especially modular courses where students take exams from many different departments. There has also been some confusion over different versions of these data sets that have appeared and been used at various times [14] and issues like this need to be avoided with any future standards.

## 3 Progress Towards a Standard Format

The need for a modelling standard and standard data format has been recognized for some time and the requirements of such a standard have been discussed in detail [5]. These properties include generality, completeness, and easy translation with existing formats. It is the authors' belief that other research areas where standard formats have become the norm have benefited from increased cooperation between researchers and better benchmarking resources which have led to advances in research. Examples of this in practice include the Travelling Salesman Problem (TSPLIB) [1,5] and the MPL (Mathematical Programming Language [9]).

[1] `http://www.or.ms.unimelb.edu.au/timetabling`