# A Case Based Heuristic Selection Prototype System for Exam Timetabling Problems

**E.K. Burke, A. Eckersley, S. Petrovic, R. Qu**

Automated Scheduling & Optimization and Planning (ASAP) Group
School of Computer Science and Information Technology
University of Nottingham, Nottingham
NG8 1BB, U.K.

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## Introduction

Timetabling problems can be defined as problems of assigning a set of events into a certain number of timeslots while satisfying a set of hard and soft constraints. During the last 4 decades, different techniques/approaches have been investigated for solving a wide range of timetabling problems [1], [2]. Exploring previous knowledge and experience of problem solving forms the motivation of the work presented here.

Case Based Reasoning (CBR) [3] is a methodology that solves new problems by using the knowledge of solving previous similar problems. In a CBR system a *case base* stores a collection of *cases* which are previously solved problems with their good solutions or problem solving strategies. To solve a new problem, *retrieval* is carried out to search through the case base and find the most similar case. The solution or problem solving strategies of the retrieved case will be applied to address the new problem.

The case based heuristic selection approach presented here investigates the benefit of employing the knowledge that is extracted from solving previous timetabling problems. In the CBR system we developed, heuristics that worked well in previous similar situations are memorised in case bases and are retrieved for solving new problems. The method described in this paper is fundamentally more general than the current state of the art. The goal is not necessarily to "beat" the specially tailored methods but to obtain comparable results by employing different heuristics as appropriate.

## The Case Based Heuristic Selection Approach

### The prototype CBR system

An interface of the CBR system we developed is presented in Figure 1. The system contains two main parts that deal with exam timetabling problems in two different ways: (1) by retrieving and applying an appropriate meta-heuristic selected; and (2) by retrieving appropriate constructive methods to construct the solutions step by step.

When a timetabling problem is input into the system, the CBR engine will either suggest a meta-heuristic for solving the overall problem, or suggest a constructive method to assign a certain number of exams into the timetable at each step until the problem is solved.

The CBR system that we have developed also has the ability of learning during its lifetime of problem solving. The newly solved problem can be stored into the case base by the users. A training process that employs knowledge discovery techniques can be carried out to learn the new

knowledge of heuristic selection in the new problem solved and fine-tune the system after storing new cases in the case base.

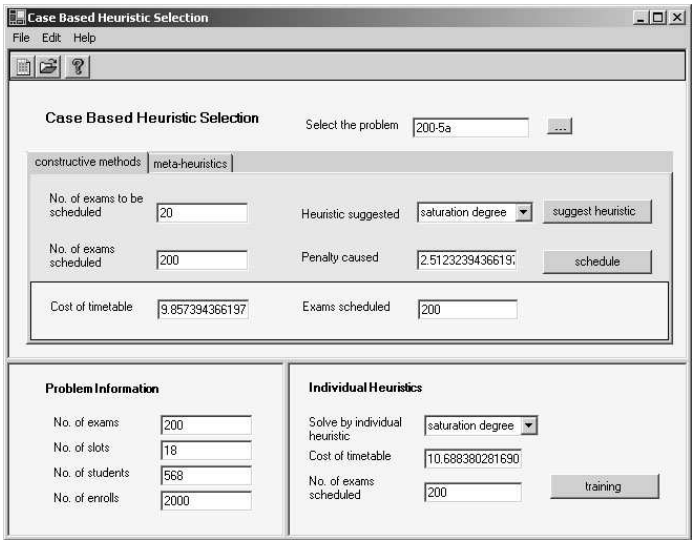


Figure 1 An Interface of the Case Based Heursitic Selection Prototype System

### Knowledge discovery in the CBR system

The retrieval which searches for the most similar case in the case base is process which uses a similarity measure to calculate the similarities between the cases in the case base and the new problem in hand. In the CBR system, we use a list of feature-value pairs to represent the cases. The similarity measure employs a nearest neighbourhood approach which calculates the sum of the differences of the values between each pair of features in the cases being compared.

Cases in the case base are collected by solving a set of exam timetabling problems beforehand to store the knowledge of heuristic selection. Two case bases are built for solving problems in two different ways (as described above). The features of the cases, which are the key issue of the case based heuristic selection approach, employs knowledge discovery techniques. The objective is to find the most relevant features to be used in the list of feature-value pairs to represent cases so that the correct meta-heuristic or constructive methods can be selected.

It is shown that the case based heuristic selection system we developed can effectively select appropriate meta-heuristics and constructive methods. Also the system can learn which heuristics work well for which particular timetabling situations by storing the new problems solved. A training process that employs knowledge discovery techniques is carried out each time a new problem is stored into the system to learn the knowledge of heuristic selection in new situations.

## Conclusions

The case based heuristic selection system that will be described in this presentation represents a flexible framework which can be applied with little effort to other timetabling and scheduling problems because little domain specific knowledge is employed. A detailed description of the system can be found in [4].

More low level meta-heuristics and constructive methods can be added to the framework to give the system more methods. Future work will also include development of more dedicated

knowledge discovery techniques to discover more accurate knowledge in timetabling for solving more general problems.

## Reference


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