Academic Timetabling: Linking Research and Practice

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The timetabling of courses and examinations is a challenging problem faced by many institutions across the world on an ongoing basis. The difficulty arises from a combination of factors e.g. variation within institutional requirements, the range of constraints that have to be captured in the model, political considerations within the institution, software and associated support etc. Recently, the subject of an international competition (ITC2007), many aspects of the overall problem model have been reported along with the effectiveness of the application of particular search methodologies and techniques (McCollum 2008). Building on this important work, further effort is required in bridging the gap which currently exists between research and

practice in this difficult problem area (McCollum 2007a). The work reported here approaches this central theme by combining research and practice in the planned provision of an overall solution. One of the main issues relating to institutional timetabling lies in the provision of software which is able to provide both effective decision support and intelligent automation. Commercial, or in-house, software based timetabling systems often suffer from drawbacks such as inadequate optimization techniques, poor user interfaces and the inability to provide sufficient feedback to the user in helping to focus on good quality solutions. Although the use of software is only part of the required overall solution in providing effective institutional timetabling, these issues often exasperate the difficulties associated with the overall implementation process.

CELCAT® and EventMAP Limited have recently joined forces in the creation of a software aided solution. The new product will draw on the strengths of both companies. CELCAT's *Timetabler*, which will be underpinned by the Optime Scheduling Engine™, aims to provide institutions with a powerful, intuitive user friendly environment for creating and improving efficient institutional timetables. We believe that this partnership will significantly add to the user experience of utilising automation within the timetable creation and management process. In addition to the user perspective, in developing this solution, the companies will jointly address the acknowledged gap which currently exists between research and practice in timetabling research. Moreover, this partnership will allow large scale implementation details on how institutions deal with timetabling issues to be directly fed back to the research community.

Specifically the resultant solution offered by the partnership will integrate leading edge optimisation algorithms within a large management information system capable of managing and directing the user in how best to make use of resources within their institution. CELCAT® *Timetabler* has been developed over the last 20 years. Its strengths are its flexibility and easy to use graphical interface, as is indicated by its large and loyal user base. The integration of leading edge research based automation will enhance the current product offering to both existing and potential new customers. The use of the Optime Scheduling Engine™ allows the user to make both macro and micro decisions on how the academic timetable should be constructed (McCollum 2003) while making best use of their teaching space (McCollum 2007b) as well as delivering flexibility to students and staff alike. This includes feedback mechanisms in terms of (i) solution quality measurement (including the application of "what-if" scenario building), and (ii) decision support for semi-automatic use. Initially it is envisaged there will be three aspects to the integration of this component based solution.

Firstly, during an initial phase, a methodology will be developed to help understand the needs and aspirations of the institution in terms of already established and newly proposed procedures. This will establish what, and where, the data sources are, how constraints should be modeled and how they should interact, how the quality of any solution will be measured and an indication of high level heuristics which should be implemented, e.g. centralised space usage strategies. In essence, this will build the Institutional Model (McCollum 2007a) in relation to requirements and priorities. It is envisaged a generic problem model will be developed and added to as implementations proceed.

Secondly, the development of an intuitive interface between the Optime Scheduling Engine™ and CELCAT® *Timetabler* software will be developed. The aim is to ensure that data, constraints and flexibility measures are effectively represented and shared between both of the current software solutions, with the aim of producing an effective timetable solution. A number of scheduling algorithms will be made available incorporating recent leading edge research, e.g. use of Extended Great Deluge which incorporates intelligent local search heuristics, optimized to the minimum practical time to reach a solution (McMullan 2007). Reinforcement Learning (Lou 2007), Neural Network (Corr 2006) and fuzzy based construction techniques (Asmuni 2008) will be investigated. In addition, hyperheuristic based techniques (Burke 2007a) will be investigated with the aim of adaptively selecting algorithms to be used based on the problem model presented.

Thirdly, the development of an intelligent interface allowing intuitive modeling of constraints and understanding of solution quality, e.g. Fuzzy techniques (Asmuni 2007), Multi-objective techniques (Burke 2008), adaptive construction algorithms (Yellen 2007, Burke 2007b) and innovative user interface methodologies (Yellen 2008). Multi-Objective evaluation strategies (McCollum 2007) will be evaluated in relation to the most appropriate visual representation in aiding the user to choose the 'best' solution. It is envisaged this work will build on the approach introduced in (Ahmadi 2002).

At the conference, progress on the integration will be outlined within the overall aim of bridging the identified gap between leading edge research technique and practical implementations. It is expected that this relationship between academia and industry will be highly productive in setting the research and commercial agenda for the timetabling community in the future.

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