Solving the General High School Timetabling Problem
Abstract

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A set of instances of the high school timetabling problem, taken from a number of countries, has recently appeared (Post 2009). These instances are expressed in complete detail in a common XML format (Post et al. 2008, 2010). They make it possible, for the first time, to tackle the high school timetabling problem in its full generality, that is, as it really exists in high schools around the world.

This abstract describes work in progress on KHE, a general solver for high school timetabling problems. KHE is a software library, written in C, that will eventually be released under a GNU public licence. It brings together several themes from the author's previous work and elsewhere.

KHE follows the XML format closely. Its data types parallel the categories of the format (including instances, times, resources, events, and constraints), so that building an internal representation of an XML instance is straightforward. It offers several basic operations for modifying solutions, including assigning and deassigning times and resources, changing the domains of time and resource variables, and splitting and merging events. Tree searches, local searches, and other algorithms may be built on these basic operations. An efficient hand-coded constraint network monitors the solution state and reports its current badness in terms of violations of the constraints defined by the instance.

The spread of multi-processor computers has made it important to allow for coarse-grained parallelism when solving timetabling problems. KHE does this by ensuring that instances are immutable after creation (so that they may be shared) and that multiple solutions can be created and operated on independently in parallel.

KHE supports the features of the author's KTS timetabling system (Kingston 2007a) as well as the XML format, and will eventually replace the current KTS solver. Internally it is

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based on the author's layer tree data structure (Kingston 2007b) for hierarchical timetabling, enhanced with operations for assigning resources as well as times (Kingston 2008).

Compared to the author's earlier general solver (Kingston 2001), KHE is more efficient, being written in C and employing ordinary function calls instead of command objects to carry out its basic operations. And whereas the earlier solver handled assignment-type problems generally, KHE benefits from a specific focus on high school timetabling.

A major question raised by this work is whether the XML format can be supported in full generality without an unacceptable loss of efficiency. For example, layer trees use unweighted bipartite matching to monitor resource assignment, but the XML format allows each possible resource assignment to have its own integer cost, so that the equivalent monitoring requires edge-weighted bipartite matching, which is significantly more expensive. New kinds of constraints, such as limits on idle times, call for incremental algorithms which evaluate them efficiently as the solution changes.

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