A Multiphase Modular Heuristic Solver for Post Enrollment Course Timetabling

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Abstract. This document gives a brief description of the solver submitted by the authors to the Track 2 of the International Timetabling Competition 2007.

Description

We address the Post Enrollment based Course Timetabling problem as defined in [1]. The solver proposed builds on previous work by Chiarandini et al. [6] and consists of several heuristic modules that have been tuned and assembled using the automated algorithm configuration procedure ParamILS [2]. By using ParamILS throughout the development of our solver, we have been able to explore a large design space of hybrid stochastic local search algorithms and construction heuristics in a manner similar to that described by Hutter et al. [3]

At a high level our solver consists of two main procedures: a hard constraint solver and a soft constraint violation minimizer.

The *hard constraint solver* consists of a constructive phase and a stochastic local search phase. The first phase generates feasible partial assignments of events to time slots and rooms by using an approach similar to the one described by Arntzen & Løkketangen [4]. The heuristic assigns events to time slots in such a way that all 5 hard constraints are satisfied. If an event cannot be scheduled in this way, it is placed in a list of unscheduled events. The list of events is processed in a certain order and events are placed in the time slots that are feasible and that are suitable for the fewest yet unscheduled events. At each new insertion of an event in a time slot the assignment of events to rooms is recomputed by exact matching. Precedence constraints are, instead, handled by identifying topological sorted components in the event conflict graph and scheduling events in time slots if they do not violate such order. The construction is repeated a number of times varying the order in the list of events and randomizing the choice when ties arise; for easier instances this procedure is often sufficient for obtaining a complete feasible assignment. In general, however, we may be left with some unassigned events. These are handled in a second search phase, which uses a tabu search procedure based on the PARTIALCOL algorithm of Blöchliger & Zufferey [5]. At each iteration of this procedure, an unscheduled event is inserted in the best non-tabu time slot and all events in conflict with it are moved in the list of currently unscheduled events. The selection of the event to be inserted is guided by evaluating the number of students attending the unscheduled events. After a certain number of non-improving iterations, the best partial feasible solution is perturbed by applying the soft constraint violation minimizer. The procedure continues alternating tabu search on the unscheduled events and soft constraint optimization until a feasible solution is found or the time limit is reached. On the instances for which a feasible solution is found relatively quickly, we add a look ahead procedure consisting in a fast soft constraint optimization and repeat the whole procedure a number of times, before selecting the assignment to exploit for the minimization of soft constraints violations.

The *soft constraint violation minimizer* is applied to the assignment returned by the hard constraint solver. It consists of local search procedures in one exchange, two exchange, swap of time slots and Kempe chains neighborhoods; these have all been previously described by Chiarandini et al. [6] and are applied in the same order as in their work. Some of these procedures include an exact matching of rooms at every change. In its final phase, the soft constraint minimizer applies simulated annealing on the one and two exchange neighborhoods with exact room reassignment.

References

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