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Master State Examination Timetabling

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1 Problem Statement

Master state exams take place at the Faculty of Informatics two times a year. Timetabling of the Master state exams consists of two main tasks: commissions with three examiners are created and each student is assigned to a time slot and to a commission. There is only one student assigned to each commission at any time. Master state exams typically take a week, there are about four commissions a day and about eight students for one commission. The timetable of each commission is defined by a sequence of their students split by a lunch break. Each student has his/her own supervisor and referee who may also serve as examiners. Certainly all teachers (examiners, supervisors and referees) must be available at the scheduled time of the exam. A fair assignment of examiners to commissions with respect to the number of their assigned commissions is necessary.

This base problem is very close to the Bachelor state examination timetabling we have described in [Kochaniková and Rudová(2013)]. The main difference lies in a stronger emphasis on fields of study. Each student has given its field of study and each examiner is associated with an appropriateness factor for each field of study (0–6 corresponding to required, strongly preferred, preferred, neutral, discouraged, strongly discouraged and prohibited). The primary goal of timetabling is the assignment of students to commissions with a good appropriateness factor. Actually we minimize the function

$$\sum_{s \in students} \sum_{e \in commission(s)} w(e,f)^2$$

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where $w(e, f)$ is a function giving the appropriateness factor of the examiner e for the field of study f. The sum of squares is applied to discourage the use of higher values of appropriateness factor and allow for its fairer distribution.

There are two other optimization criteria related with the supervisors and reviewers. Since some of them may be the members of commissions, it is desirable to minimize the number of students with supervisor or reviewer not being the member of his/her assigned commission. Second, we want to create sequences of students for each supervisor and/or referee such that they may appear at the state exams in the minimal number of these sequences.

2 Solution Approaches

The first author of this paper has been solving this problem manually with the help of the supportive graphical user interface [Petr(2007)] for six semesters. We have been developing two different approaches to solve the described problem. The first approach is based on the CPSolver which was applied in the International Timetabling Competition 2007 (ITC2007) where it was among finalists for all three tracks and it won two of them [Müller(2009)]. Our constraint model is defined with the help of hard constraints which must be satisfied and with the help of soft constraints to handle the optimization criteria described. The current search procedure is similar to the search in the solvers for the competition problems: The iterative forward search is applied to construct the solution where commissions with their students are created one by one, subsequent local search iteratively improves the solution.

The second approach constructively creates commissions based on the number of students and on the properties of particular fields of study and the appropriateness factor of the examiners. In the next step, students are assigned to commissions by another constructive approach with the help of various ordering heuristics based on the appropriateness factor or the number of students for examiners (being their supervisors or referees). Subsequent local search swaps students using simulated annealing. Students with the worst evaluation given by the weighted sum of optimization criteria are exchanged with other students (in the same commission or in a commission where their supervisor or their reviewer is the examiner, etc.). Also commission members can be exchanged, added or removed while keeping their fair allocation. Random local changes removing parts of the solution are also applied to escape from local minimum.

3 Conclusion

Both approaches were applied to solve experimental problems of three semesters. The base problem described here is rather complicated by various exceptions and additional constraints which must be handled in the real life. The second approach based on the local search was applied in practice to solve the

Spring 2014 problem since it was able to handle all features of the real-life problem. Still manual modifications of the generated solution were necessary to remove some troublesome hard constraint violations. Both automated approaches as well as manual solutions violate some of the hard constraints. Further study of problem characteristics and problem definition will be directed to provide a proper constraint model and data definition such that the generated solution could be easily applied in practice. The ultimate goal of this work is an application of one of the solvers to the real-life problem solved each semester.

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References

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