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March 24, 2006
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DM86 Local Search Methods – Weekly Notes

Week 8, Spring 2006

Lecture March 23

The lecture focused on Timetabling and Scheduling Applications. We gave a general classification of Timetabling problems by grouping them in Educational and Workforce Timetabling. We review the terminology and problem models in both classes. On the University Course Timetabling (a special case of Educational Timetabling) we sketched a Local Search Algorithm, in its basic component: construction heuristic, solution representation and neighborhood structure. On Nurse Timetabling (a special case of Workforce Timetabling) we gave indication of a possible promising solution representation.

We then turned our attention to Scheduling Applications arising, for example, in Manufacturing Systems. We introduced the terminology and the standard problem classification. Single Machine Problems were already discussed with some detail in the previous lectures. We focused then on Local Search Methods for Flow Shop Problems. The next week we will finish the part related to Flow Shop Problems and continue with Group Shop Problems. Next, we will discuss Vehicle Routing Problems.

Literature

All material concerning Scheduling can be found in Chapter 9 of the text book.

The Timetabling is not covered in the text book. The material discussed in the lecture can be retrieved in the following publications. These may be suggested readings for those choosing a project on timetabling but are not necessary for the oral exam (the slides should suffice for that).

De Werra D. (1985). "An introduction to timetabling" European Journal of Operational Research, 19(2), pp. 151-162. [Gives the educational timetabling models and graph colouring modelling.]

Andrea Schaerf. "A survey of automated timetabling". Artificial Intelligence Review, 13(2):87-127, 1999. [Classifies educational timetabling.]

M. Chiarandini, M. Birattari, K. Socha, and O. Rossi-Doria. An effective hybrid algorithm for university course timetabling problem, 2004. Journal of Scheduling. [describes the algorithm for course timetabling discussed in the lecture.]

Arntzen H. and Lkketangen A. (2003). A tabu search heuristic for a university timetabling problem. In Proceedings of the Fifth Metaheuristics International Conference. Kyoto, Japan. [Sketches a graph colouring based heuristic for the course timetabling.]

Edmund K. Burke, Patrick De Causmaecker, Greet Vanden Berghe, Hendrik Van Landeghem: The State of the Art of Nurse Rostering. J. Scheduling 7(6): 441-499 (2004) [Places Nurse Scheduling in the context of Workforce Timetabling.]

Amnon Meisels and Andrea Schaerf. Modelling and solving employee timetabling problems. Annals of Mathematics and Artificial Intelligence, 39(1-2):41-59, 2003. [Describes the application of Local Search Methods to Employee Timetabling. It is valid also for nurse scheduling.]

Further material on timetabling can be found in the book collections:

Practice and Theory of Automated Timetabling (PATAT), Series of International Conferences, 1995, 1998, 2000, 2002, 2004. Lecture Notes in Computer Science. vol. 1153, 1408, 2079, 2740, 3616 Springer Verlag, Berlin, Germany.

Staff Scheduling and Rostering: Theory and Applications. Special Issue of Annals of Operations Research, Volumes 128-129, 2004

Exercises

Exercise 1

A first step in the solution of real life applications is searching in the literature for similar cases which have been successfully solved. Using the classification of timetabling problems given in the lecture and the literature provided above (within the University all articles should be accessible from Google Scholar or from SDUB's Electronic journals archive) search for articles concerned with local search, metaheuristic and genetic methods applied to a problem similar to the one you have in mind for your project. Devote attention to the description and modelling of the problem proposed in these publications.

Exercise 2

Consider the following simplified Course Timetabling Problem:

Find an assignment of lectures to periods and rooms such that it is feasible, ie:

- rooms are only used by one lecture at a time,
- each lecture is assigned to a suitable room,
- no student has to attend more than one lecture at once;

and good, ie:

- not more than two lectures in a row for a student,
- last period of a day is avoided,
- students do not have one single lecture in a day.

Give a possible solution representation, define a weighted evaluation function and sketch the procedure to compute this evaluation function for a given timetable.

Exercise 3

Exercises 9.2 and 9.4 from the text book.

Exercise 4

Consider the Set Covering Problem whose formulation is given in Exercise 1 of Weekly Notes 7.

- Design an application of GRASP for the SCP. In particular, give the definition of a candidate list of columns to which restricting the search (column pricing).
- Design an application of ACO. In particular define with which problem features it is more reasonable to associate the pheromone.
- Design an application of Genetic Algorithm. In particular, define a recombination operator and how to deal with infeasibility.