

Chapter 24

Theoretical and Practical Aspects of Combinatorial Problem Solving

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The challenge of combinatorial optimization - considered as a branch of applied mathematics - is to provide methods that "solve" problem instances of the type and size appearing in the real world on the existing machines and the available computer time.

Depending on the needs of practice, "solve" can mean to produce a feasible solution, which is believed to be reasonable, within a short period of computation time, can mean to determine upper and lower bounds for the optimum value within predefined ranges, or it can mean to compute an optimum solution. I will describe applications, where fast heuristic solutions where needed, or good bounds the target, or where exact solutions were required.

A major difficulty in dealing with real environments is that usually problems are not well-defined - at least from a mathematical point of view. The true goal cannot be quantified and may change throughout time and may vary from person to person involved. Moreover, data may not be as available as needed. A scientifically interesting aspect is that faithful models of practical problems often lead to problem types that have not been studied in the literature and thus provide new mathematical challenges.

In this talk I will report on projects of this particular type that have been carried out within my research group. I will outline, among other subjects, the design of cost-effective survivable communication networks, the dispatching of taxis in a dial-a-ride system, the control of CNC-machines, and the control of a stacker crane in an automatic storage system.

Furthermore, I will discuss modelling issues that have been solved in close cooperation with the engineers involved, as well as theoretical and algorithmical issues that have come up in the analysis of these models. A significant factor for the success of such projects is a psychological one: the quality of the team work of people with different backgrounds combined with their ability to respect each other's work and contribution to this team. I will also mention a few positive and negative experiences in this regard.

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