

Computational Mathematical Programming

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Computational Mathematical Programming

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Preface

This book contains the written versions of main lectures presented at the Advanced Study Institute (ASI) on Computational Mathematical Programming, which was held in Bad Windsheim, Germany F.R., from July 23 to August 2, 1984, under the sponsorship of NATO. The ASI was organized by the Committee on Algorithms (COAL) of the Mathematical Programming Society. Co-directors were Karla Hoffmann (National Bureau of Standards, Washington, U.S.A.) and Jan Telgen (Rabobank Nederland, Zeist, The Netherlands). Ninety participants coming from about 20 different countries attended the ASI and contributed their efforts to achieve a highly interesting and stimulating meeting.

Since 1947 when the first linear programming technique was developed, the importance of optimization models and their mathematical solution methods has steadily increased, and now plays a leading role in applied research areas. The basic idea of optimization theory is to minimize (or maximize) a function of several variables subject to certain restrictions. This general mathematical concept covers a broad class of possible practical applications arising in mechanical, electrical, or chemical engineering, physics, economics, medicine, biology, etc. There are both industrial applications (e.g. design of mechanical structures, production plans) and applications in the natural, engineering, and social sciences (e.g. chemical equilibrium problems, chromatography problems).

In most cases, a theoretical foundation which predicts the numerical performance of a mathematical programming algorithm, does not exist. Nor can one at the present time prove theoretically that one algorithm is best for a given application. As a consequence, the performance of optimization methods must be evaluated by experiments. By defining a sample, i.e. by searching for suitable test problems, and by designing a computational experiment, the efficiency, robustness, and reliability of an algorithm can be investigated. Such experimental optimization will become even more important in future years as modeling efforts attempt to solve problems related to evermore complex systems and consequently, the mathematical algorithms used to solve these problems become more and more sophisticated. The need to disseminate information about computational mathematical programming procedures was the main impulse for organizing the Advanced Study Institute.

Consequently, the general purpose of the Advanced Study Institute was to link new algorithmic developments for optimization models with practical applications. From the organizational point of view, the ASI consisted of tutorials, research seminars, and a software fair. The tutorials covered all major types of optimization models currently used in practice. Leading experts gave an introduction to the subject, provided any mathematical background, presented suitable algorithms stressing information about their computer implementations, usage and numerical performance. The topics of the tutorials ranged from linear and integer programming, networks, and various aspects of nonlinear programming to optimal control, stochastic and nonsmooth optimization. They were accomplished by about 60 research seminars of other participants leading to a more detailed insight in special individual research projects. Moreover, information material about existing optimization software was displayed at the ASI e.g. in form of user's guides or code descriptions.

The purpose of this book is to compose the tutorials and to offer them to the mathematical programming community. It is expected that only minor knowledge of mathematical theory and terminology is required to understand the most important opinions of the individual authors. In addition,

the book contains the main results of the software fair, i. e. a collection of about 50 code descriptions, with the intention to disseminate information about existing optimization programs.

The organizer of the ASI is indebted to the NATO Science Committee for the generous financial support. Other sponsors were the National Bureau of Standards of the U.S. Department of Commerce, and the Deutscher Akademischer Austauschdienst. The success of the meeting is based on the quality of the tutorials held at the ASI. Without any exception, the organizer acknowledges the extensive amount of time the invited lecturers had to spend for preparing the tutorials and, in particular, for preparing the manuscripts submitted for publication. Other individuals who deserve special thanks, are the co-directors Karla Hoffmann and Jan Telgen, furthermore Marlis and Jochem Zowe for their extensive assistance concerning all local organizational arrangements.

K. Schittkowski

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