Preface

This book, like its companion volume *Nonlinear Optimization with Financial Applications*, is an outgrowth of undergraduate and postgraduate courses given at the University of Hertfordshire and the University of Bergamo. It deals with the theory behind numerical methods for nonlinear optimization and their application to a range of problems in science and engineering. The book is intended for final year undergraduate students in mathematics (or other subjects with a high mathematical or computational content) and exercises are provided at the end of most sections. The material should also be useful for postgraduate students and other researchers and practitioners who may be concerned with the development or use of optimization algorithms. It is assumed that readers have an understanding of the algebra of matrices and vectors and of the Taylor and mean value theorems in several variables. Prior experience of using computational techniques for solving systems of linear equations is also desirable, as is familiarity with the behaviour of iterative algorithms such as Newton's method for nonlinear equations in one variable. Most of the currently popular methods for continuous nonlinear optimization are described and given (at least) an intuitive justification. Relevant convergence results are also outlined and we provide proofs of these when it seems instructive to do so. This theoretical material is complemented by numerical illustrations which give a flavour of how the methods perform in practice.

The particular themes and emphases in this book have grown out of the author's experience at the Numerical Optimization Centre (NOC). This was established in 1968 and its staff (including Laurence Dixon, Ed Hersom, Joanna Gomulka, Sean McKeown and Zohair Maany) have made important contributions in fields as diverse as quasi-Newton methods, sequential quadratic programming, nonlinear least squares, global optimization, optimal control and automatic differentiation.

The computational results quoted in this book have been obtained using a Fortran90 module derived from the NOC's OPTIMA library. This software is not described in detail but interested readers can obtain it from an ftp site. Some of the student exercises can be attempted using OPTIMA but most can also be tackled in other ways, for example via the SOLVER tool in Microsoft Excel, the MATLAB toolbox of optimization procedures or the NAG libraries in C and Fortran.

I am indebted to many people for help in the writing of this book. Besides the NOC colleagues already mentioned, I would like to thank all the mathematics staff at the University of Hertfordshire for their support. I have also received encouragement and advice from Marida Bertocchi of the University of Bergamo, Alistair Forbes of the National Physical Laboratory, Berc Rustem of Imperial College and Ming Zuo of the University of Alberta. Any mistakes or omissions that remain are entirely my responsibility. My thanks are also due to John Martindale, Ann Kostant, Elizabeth Loew and their colleagues at Springer for encouragement and help with the preparation of the book. Finally, my deepest thanks go to my wife Nancy Mattson who, for a second time, has put up with the domestic side-effects of my preoccupation with authorship.

This book seeks to capture a view of the subject that I have acquired over a working lifetime's involvement with optimization and its applications. Optimization, by definition, is concerned with making things better. It is natural, therefore, that it should apply its own principles to itself and – in my experience, at least – this can generate a lively spirit of friendly rivalry between practitioners and algorithm developers. This spirit is worth celebrating in quasi-haiku form:

> Optimization
> means a quest for best answers
> by the best methods.
>
> Optimism means
> believing both objectives
> are achievable.

I hope readers will be stimulated by the challenge of finding more and more effective solutions to practical problems that become increasingly difficult.

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