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BOOK REVIEW

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# Andrzej P. Ruszczyński: Nonlinear optimization

## Princeton University Press, 2006, ISBN: 0-691-11915-5, 464 pp., Cloth, $ 59.50, £38.95

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According to the table of contents this book looks very similar to other introductory level books written about nonlinear programming during the recent years. This is not a surprise because at this level the basic theory and the methodology has been remained pretty much unchanged. However, closer examination reveals that this book has potential to be something different. The first noticeable difference is that this book contains theory and methods related to both differentiable and nondifferentiable problems. The second distinctive characteristic is the compact style and balanced layout which makes the text enjoyable to read.

The book begins with a short introductory chapter containing a couple of example applications demonstrating what nonlinear programming is all about. The rest of the book is divided into two separate parts: theory and methods. In the first part of the book the author carefully develops a theoretical framework starting from convex analysis and ending up to optimality conditions, and Lagrange duality. In the second part of the book the presented theory is used to formulate and analyze the basic methods designed to solve differentiable and nondifferentiable nonlinear optimization problems.

The theory part is extensive and every needed result is built from the beginning very systematically making the book in this sense self contained. In the second part, the most classic methods are presented using the results from the theory part. The convergence properties of the presented methods as well as connections to optimality conditions are usually discussed in detail. However, because this is an introductory text not every possible nuance or extension of the presented methods is covered. For example ideas related to constrained or nonconvex nondifferentiable problems are discussed only very briefly.

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Even if theory and methods are presented for both differentiable and nondifferentiable cases these topics are developed in a parallel way. In this way the reader can easily concentrate only on theory and methods related to the differentiable case and possibly later on study more general nondifferentiable results.

Throughout the book the writing style is very clear, compact and easy to follow, but at the same time mathematically rigorous. Even if the presentation usually follows the formula definition–theorem–proof the writing style is far from dry. The proofs are easy to follow because the author usually carefully explains every move. In addition the meaning of the most central results is usually demonstrated with examples and in many cases explanations are also supported by visualizations. The combination of previous facts makes the text easy to read, especially for those readers who do not necessarily have a strong background in mathematics.

At the end of every chapter there is a collection of exercises that are clarifying and extending the presented ideas even further. Most of the examples and exercises are more theoretical, where the reader is for example asked to prove some statement, but in addition to this there are also application related examples which give an idea how the presented results can be and are utilized in real problems.

All major proofs are given in full length and none of these are left for the reader, which in my opinion increases the value of this book as a reference. This is nice especially when you just want to see how something is proved but not necessarily have time or interest to figure it out by your self. Exercises challenge the reader to prove some minor results which usually offer some additional insight to major proofs.

The text in the chapters does not contain any direct references to the existing literature. All the references are shortly listed and commented in a separate chapter located at the end of the book. On the one hand this makes the text, containing lots of mathematical symbols, a bit easier to read but on the other hand it might be occasionally nice to see citations directly in the context.

From the self-study point of view I think that the exercises are placed too sparsely. With the current structure you first read something like seventy pages, for instance, about convex analysis and then try to do twenty exercises related to the whole chapter. It might be more efficient to locate exercises more densely closer to topics they are related to.

Overall, this book offers a very good introduction to differentiable and nondifferentiable nonlinear optimization theory and methods. With no doubt the major strength of this book is the clear and intuitive structure and systematic style of presentation. This book can be recommended as a material for both self study and teaching purposes, but because of its rigorous style it works also as a valuable reference for research purposes.