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Book Selection

Edited by JOHN M. WILSON

Data Envelopment Analysis Theory, Methodology and Applications

CHARNES A, COOPER W, LEWIN AY and SEIFORD LM (eds). *Kluwer Academic Publishers, London*, 1995, xii + 513 pp. £105.00 ISBN 0 7923 9479 8

The pursuit of organizational efficiency has become something of an obsession for the modern manager. However, managers interested in identifying efficient practice have few tools available, other than the juvenilia hawked by accountants. A notable exception is the technique known as data envelopment analysis (DEA), which was introduced to the world in its modern form in 1978. The deceptively simple DEA model has since become a remarkably fertile field for both research and practice.

DEA offers an insight into the relative efficiency of comparable 'decision-making units' such as—say—schools. It offers a conservative estimate of comparative efficiency in situations in which multiple inputs and multiple outputs are found. The technique exploits limited data to its full extent, and can be used to examine technical efficiency, allocative efficiency and scale efficiency. It has proved to be immensely useful in a wide range of settings. On the downside, the technique is sensitive to data accuracy, and some DEA practitioners are guilty of stretching their analysis beyond the capacity of the data available to them.

This long awaited book seeks to summarize and codify the state of current scientific knowledge relating to DEA. It comprises three parts: an introduction to the concepts, models and computational aspects of DEA; a set of case studies; and an epilogue and bibliography. Part I first offers an intuitive insight into DEA and then develops a sequence of basic theoretical models, followed by a series of refinements and extensions. The intention is to present a unified treatment of the topic. This part of the book will enable researchers to gain an entree into the subject, and to use a common terminology in describing their work. Indeed in a noteworthy development the publishers will give permission to authors to incorporate material from these early chapters into their books. The case studies in Part II cover a wide range of topics, and are written by many of the most prominent researchers in DEA. They will undoubtedly inspire both researchers and practitioners. In Part III almost all readers will offer grateful thanks for Larry Seiford's remarkably comprehensive bibliography.

The editors hope that the text will serve as an introduction to new users and a reference for the more experienced. How does it measure up to its ambitions? It must be said that teaching DEA can give rise to unexpected difficulties. While the underlying concepts are apparently simple, the intricacies of the technique can often prove elusive, particularly to those trained in traditional statistical techniques. The editors have chosen to present the (traditional) DEA model as the culmination of more general concepts, which in my judgement is very successful. Although 'old hands' may find the ordering of the material superficially perverse, I believe the book succeeds in presenting a difficult technique in a logical and accessible fashion. No serious DEA researcher should be without the text, and indeed the project should serve as a model for authors with similar ambitions in other disciplines.

The book arises from a conference on DEA held in 1989, implying a massive delay in bringing the material to publication. While not entirely satisfactory, the hiatus has resulted in some substantial benefits. First, it has given the editors the opportunity to review all the material rigorously, in contrast to many conference proceedings. Second, the book is free of the rather exotic developments that have infiltrated some of the DEA literature in more recent years. Perhaps the one question mark concerns the price the publishers have chosen to attach to the book. Even in paperback, this is not a book for the impulse buyer.

Researchers in DEA will probably have no hesitation in finding the cash, but the price may deter masters students, which is a shame because—in spite of its limitations—DEA is one of the most distinctive and useful developments to have emerged from the management science community in recent years.

University of St. Andrews SMITH PC

Discrete Analysis and Operations Research

KORSHUNOV AD (ed).

Kluwer Academic Publishers, London, 1996, vi + 343 pp. £119.00 ISBN 0 7923 3866 9

The book has many interesting papers in it. Many of these topics will be found useful by operational research analysts. On the other hand many of the topics are better suited for a computer scientist. The book is divided between what is considered operational research and what might be considered computer science subject matter with the greater emphasis on the latter. For example, the paper entitled *An Approximation Algorithm for the Traveling Salesman Problem and its Probabilistic Analysis* is a topic that one one might expect in a book with Operations Research in its title. On the other hand the topic *The Number of Distinct Subwords of Fixed Length in the Morse-Hedlund Sequence* would be a subject near and dear to the heart of a computer scientist interested in discrete mathematics which should be no surprise as it is also in the title of the book.

Being a student of both operational research and discrete mathematics, I found the book interesting and informative. This of course being a matter of individual preferences. I am not certain that everyone shares my interests. Hence I recommend the book with a note of caution. If you enjoy both operations research and discrete mathematics, you should enjoy this book. If you are searching for a research topic, this book would provide a number of possibilities. On the other hand if you do not care to wade through a great deal of mathematics for what might be a gem or two, this is not the book for you.

University of Maryland Leake C

Evolutionary Algorithms in Management Applications

BIETHAHN J and NISSEN V (eds).

Springer, Berlin, 1995, xv + 378 pp. DM 148.00 ISBN 3 540 60382 4

This is an excellent book. It presents the field of Evolutionary Algorithms, which embraces Genetic Algorithms as well as the less well-known Genetic Programming, Evolution Strategies and Evolutionary Programming. The book comprises three sections:

- a tutorial on Evolutionary Algorithms by Nissen and Biethan, which explains how the algorithms work and the differences between them;
- a survey by Nissen of the uses to which evolutionary algorithms have been put; this lists and classifies some 500 papers up to 1995 and would be an invaluable starting point for anyone considering using an Evolutionary Algorithm;
- 19 papers describing various applications of Evolutionary Algorithms classified by domain: industry; trade; financial services; traffic management; and (school) timetabling.

Evolutionary Algorithms are heuristic search and optimization techniques which are motivated by analogies with the natural processes of evolution. They bear some similarities to Simulated Annealing in that the search process is stochastic and can go backwards (i.e. the objective function can worsen) so as to move away from the current area of search. The big difference is that whereas Simulated Annealing works with a single incumbent solution, Evolutionary Algorithms use a population of incumbent solutions (a *generation*) which are bred together to form the next generation of incumbent solutions.

One of the keys to success with Simulated Annealing is defining the topology of solutions, namely which solutions are in the neighbourhood of the incumbent solution. Similarly with Evolutionary Algorithms one must characterise potential solutions and specify the permitted transitions between them. But here the evolutionary paradigm comes to the fore, especially with Genetic Algorithms. A solution is characterised by its *genotype*, which is a coding of the solution as a bitstream, and its *fitness*, namely objective function value. Two solutions are selected for breeding depending on their fitness and their genotypes are mixed together to form two *offspring*, each of whose genotypes may then *mutate* with some probability. The resulting offspring of all the parents form the new generation.

The key problems in developing Evolutionary Algorithms are therefore working out how to encode solutions as genotypes and what exchanges of genetic material should take place at breeding. It is because of this that the second and third parts of this book are so useful: the latter presents a wide a variety of papers to stimulate one's thoughts while the former provides a starting point for further research.

As an instance of what can be achieved, the paper by Falkenauer describes using a Genetic Algorithm to tackle the Bin Packing Problem: given a number of items of different sizes, what is the smallest number of bins of a particular size into which they can be packed? The standard encoding techniques for Genetic Algorithms are not suitable and Falkenauer develops an elegant encoding which avoids the problem of redundancy (this occurs where a

single logical solution has many distinct genotypes). He then uses a local optimization algorithm in the course of breeding and ends up with a hybrid algorithm which combines the best features of Genetic Algorithms with specific bin-packing algorithms of Martello and Toth. This paper is valuable not only for the results which it achieves but also for showing the limitations of Genetic Algorithms and how the ideas of Genetic Algorithms can be combined with other techniques where appropriate.

Altogether this book is well worth buying if you have any interest in using Evolutionary Algorithms.

Robert Simons Ltd Simons R

Mathematical Programming for Industrial Engineers

AVRIEL M and GOLANY B (eds).

Marcel Dekker, New York, 1996, 648 pp. $175.00
ISBN 0 8247 9620 9

In this textbook for industrial engineering students, mathematical programming is divided into eight parts. Predictably, linear programming and integer programming lead the way, (over 100 pages each), followed by network problems, dynamic and nonlinear programming. The tail end (a quarter of the book) is devoted to multiobjective and stochastic programming and a short chapter on heuristics.

The strength of the work is that each of these chapters has been written by different authors, so that one is spared the patchy nature so often encountered when an expert in one field attempts to pad out a book with some obligatory chapter describing other fields. Looking at the result, it seems that the editors had given the separate authors very strong guidelines about the structure of each chapter, so that there is a pleasantly uniform treatment of each topic. As a book intended for classroom use, each chapter has a good mixture of theory and practice, with some examples and exercises to develop the ideas presented in the text. With an eye to the readership of the title, many examples are relevant to industrial engineering—with a few notable exceptions!

The fact that this is a collection, however strong the editorial hand, also leads to its weakness. The authors overlap in their treatment of some optimization problems, but there is no cross-referencing between chapters. Some topics are left out completely. The chapters make different assumptions about the depth of mathematical treatment needed in each topic, and there are variable numbers of references to cases and further books and papers. The book has a generally good subject index.

At its published price, this is a book with limited appeal to individuals (and even to academic libraries). For student use, the price would have to be much lower to compete with any of the well-established general operational research textbooks supplemented by directed reading for a more thorough treatment, but if you have a group of mathematically able students (the standard of numeracy expected is high) who are looking at optimisation models in O.R. or industrial engineering, this is a book to look at seriously.

University of Exeter Smith DK

Nonlinear Programming

BERTSEKAS DP

Athena Scientific, Belmont, Mass., 1995, x + 646 pp.
$69.00 ISBN 1 886529 14 0

In the June 1996 issue of this Journal[1], I reviewed 'Dynamic Programming and Optimal Control' by the same author, from the same publisher. It was very tempting to repeat the same review for this book with minor alterations. This, like the earlier text is a work filled with a detailed mathematical presentation of the subject. This, too, is presented in such a user-unfriendly way as to diminish the value of the contents enormously.

Bertsekas presents optimization of nonlinear functions as an essentially mathematical problem. Given an objective function, one wishes to maximise it by a suitable search method using as much information as possible about the behaviour of the function—and that information comes, almost certainly as far as this book is concerned, from mathematical analysis. Some concessions are made to the problem of computing, but these are scant, and for practical purposes the user would have to turn to other texts.

The author turns from an opening chapter on unconstrained problems to constrained ones, which allows him to include interior point methods for linear programming. This is followed by extensive treatment of Lagrange multiplier theory and applications, and the final two chapters of the book cover duality theory, again with a theoretical treatment of the applications of this. Four appendices provide some essential mathematical background for the reader.

The strength of this book is in its comprehensiveness. Where the author has chosen to include a topic, then it is well-covered. However—and that is a word that this reviewer wanted to use much more frequently in this piece—there are omissions. Very little reference is given to the significant contributions to the subject that have been made by U.K. based researchers, and to the needs of users of algorithms. The treatment of line searches is absurdly brief; methods based on complementarity do not appear.

I will use my copy to help in teaching a course on nonlinear optimization, but it will not be the first book that I turn to for such help.

University of Exeter Smith DK

Reference

1 Smith DK (1996). Review of *Dynamic Programming and Optimal Control* by Bertsekas DP *J Opl Res Soc* **47**: 833–834.