THE SEARCH FOR OPTIMIZATION AND A REVIEW OF OPTIMIZATION: FOUNDATION AND APPLICATIONS

by Ronald Miller

A BOOK REVIEW

BRADFORD ALLEN

*Florida Institute of Technology
Department of Mathematical Sciences and
Science and Mathematics Education
Melbourne, FL 32901 USA
ballen@fit.edu*

(Received April, 2001; Revised July, 2001)

Mathematical modeling is increasingly being utilized and valued in every branch of science and technology. Modeling serves as a means of analyzing, synthesizing, and evaluating an operation, process or activity while providing insights into modifications to make the process perform better. But it is not enough to improve a process through arbitrary adjustments that rarely lead to optimal solutions. Anything less than optimality is not satisfactory because the compelling goal is to make the process perform in the best possible way. In a world where small changes in performance can mean the difference between success and failure, suboptimal solutions are just cheap plausibilities and thus ought to be distrusted.

Optimization is a universal goal that has been strived after by mankind for centuries. Archimedes (287-212 B.C.E.) proposed that the circle enclosed the largest area for a given perimeter. In 1615, Kepler proved that a cube is the largest parallelepiped that could fit into a sphere. Before the development of calculus, Fermat and Descartes in the 1630's provided methods for finding maxima and minima of curves.

The development and implementation of new and improved optimization techniques has been motivated by both purely mathematical interests and by the desire to solve important applied problems. In many recently developed optimization methods, computers play a central role. But with a flood of optimization methods available, analysts must take a broader view in solving optimization problems. Attention no longer can be directed solely at finding optimal solutions. Instead, analysts now strive to meet the goal of meta-optimization. That is, analysts now try to optimize the optimization itself by achieving the best solution in the most efficient and reliable way possible.

To this end, college and university faculty, students and professional analysts in policy and decision sciences, social sciences, management, operations research, and

engineering should welcome Ronald E. Miller's new book *Optimization: Foundations and Applications* as a valuable course textbook and/or reference text. Dr. Miller is an emeritus professor, an award-winning educator, and the author of several textbooks. The field of optimization, however, is burgeoning in its diversity and complexity and a great many books are available on the subject. An Internet search found over 1600 book titles in optimization areas that ranged from abstract convex analysis to the Zen of optimization. Bestselling optimization subjects include genetic algorithms, response surface modeling, applied probability models, and dynamic optimization. Ronald Miller's text stands out, however, with its unique blend of new and classical techniques.

Throughout Ronald Miller's text, one finds the effective use of symbolic and geometric interpretations, useful and effective tables and charts, and attention to the important details needed to apply the methods. End-of-chapter problems with answers to selected exercises supplement and deepen the concepts and, moreover, help readers apply and develop extensions to the methods to solve many diverse problems from varied and unorthodox contexts. An ftp web site is also available to provide support above and beyond the text. Topics in the book include classic linear and nonlinear methods, and modern numerical approaches. The numerical approaches, while useful in their own right, are also helpful in understanding and applying computer optimization packages, their software manuals, and advertising for these packages. (For an extensive list of optimization software products, see the web site www.library.arizona.edu/users/cmacha/math/software.htm.)

Miller's book starts with chapters on unconstrained and constrained maximization and minimization problems followed with several derivative and modern non-derivative iterative methods. These topics are followed by linear programming and interior point methods. The last chapters of the book contain sections on constrained nonlinear optimization methods including various Kuhn-Tucker based approaches, nonlinear duality, and computational methods. Not included in the book, however, are dynamic optimization techniques such as calculus of variations and optimal control theory.

Because of interactions and trade-offs between competing constraints, optimization is not a piecemeal process and generally cannot be achieved simply by optimizing the component parts. But too often, sort-cut solutions are very seductive, particularly when a global solution is obscured by good partial solutions. The pitfalls of optimization are many and the ideas on productive thinking of gestalt psychologist Max Wertheimer is pertinent. Wertheimer suggests that impatient desires for a solution create an over-focused mind that may inhibit problem solving. The effect is similar to a partially-caged animal focusing on the bars in front of its face, unable to see that a simple detour would lead to the solution of the problem. Therefore, if tempted by the seduction of short-cut solutions, or blinded by an over-focused mind, the analyst may turn to the field of optimization which has grown from the desire to find structural solutions and the drive to explore, make sense of, and interpret complex and conflicting information.

Optimization: Foundations and Applications

by **Ronald Miller**

Publisher John Wiley and Sons

Publication Year 2000

ISBN 0-471-35169-5

Price: \$94.95