

NEW COMPUTER METHODS FOR GLOBAL OPTIMIZATION

H. RATSCHKE

Professor at the Mathematics Institut der Universität
Düsseldorf, West Germany

and

J. ROKNE

Professor of Computer Science
University of Calgary, Canada



ELLIS HORWOOD LIMITED
Publishers · Chichester

Halsted Press: a division of
JOHN WILEY & SONS
New York · Chichester · Brisbane · Toronto

Contents

Preface	1
1 Some Principles of Optimization Theory	7
1.1 Introduction	7
1.2 Problem Statement	10
1.3 Optimality Conditions	12
1.4 Penalty Methods	15
1.5 Unconstrained Minimization	16
2 Principles of Interval Analysis	23
2.1 Introduction	23
2.2 Why Interval Arithmetic?	25
2.3 Interval Arithmetic Operations	27
2.4 Machine Interval Arithmetic	30
2.5 Further Notations	31
2.6 Inclusion Functions and Natural Interval Extensions	34
2.7 Centered Forms, Meanvalue Forms, Taylor Forms	39
2.8 Improved Interval Hessian Matrices	46
2.9 Interval Newton Methods	51
2.10 The Hansen-Greenberg Realization	53
2.11 Numerical Examples Using the Interval Newton Method	65

3	Global Unconstrained Optimization	73
3.1	Introduction	73
3.2	The Moore-Skelboe Algorithm	76
3.3	Termination, Approximation Errors, Rounding Errors	81
3.4	Convergence Conditions for the Moore-Skelboe Algorithm	85
3.5	Numerical Examples	89
3.6	Convergence Speed of the Moore-Skelboe Algorithm .	95
3.7	Convergence Speed with Isotone Inclusion Functions .	102
3.8	Ichida-Fujii Algorithm and its Convergence Conditions	108
3.9	Hansen's Algorithm and its Convergence Conditions .	110
3.10	Termination Criteria, Approximation Errors and Influence of Rounding Errors	116
3.11	Accelerating Devices: An Overview	118
3.12	Acceleration Devices: Detailed Description	121
3.13	Numerical Examples	127
4	Unconstrained Optimization over Unbounded Domains	133
4.1	Introduction	133
4.2	The Algorithm over Unbounded Domains	136
4.3	Convergence Properties	140
4.4	The Monotonicity Test	146
4.5	Arithmetic in \mathbf{I}_∞	148
4.6	Realization on the Computer	152
4.7	Numerical Results	155
5	Constrained Optimization	159
5.1	Introduction	159
5.2	Problem Statement	161
5.3	Constraints and Exhaustion Principle	162
5.4	Trouble with Constraints	168
5.5	The Basic Algorithm	172
5.6	Optimization Problems with Inexact Data	177

5.7	Convergence Properties	179
5.8	Accelerating Devices: Overview	183
5.9	Devices for Functions without Differentiability Properties	186
5.10	Devices for C^1 Functions	190
5.11	Devices for C^2 Functions	193
5.12	Numerical Examples	195
	Bibliography	199
	Notation	223
	Index	227