

Optimization

Edited by

G.L. Nemhauser
Georgia Institute of Technology

A.H.G. Rinnooy Kan
Erasmus University Rotterdam

M.J. Todd
Cornell University



1989
NORTH-HOLLAND
AMSTERDAM · NEW YORK · OXFORD · TOKYO

Contents

Preface

v

CHAPTER I

A View of Unconstrained Optimization

J.E. Dennis Jr. and R.B. Schnabel

1. Preliminaries	1
2. Newton's method	8
3. Derivative approximations	13
4. Globally convergent methods	35
5. Non-Taylor series methods	53
6. Some current research directions	58
References	66

CHAPTER II

Linear Programming

D. Goldfarb and M.J. Todd

1. Introduction	73
2. Geometric interpretation	78
3. The simplex method	85
4. Duality and sensitivity analysis	95
5. Exploiting structure	108
6. Column generation and the decomposition principle	120
7. The complexity of linear programming	130
8. The ellipsoid method	133
9. Karmarkar's projective scaling algorithm	141
References	165

CHAPTER III

Constrained Nonlinear Programming

P.E. Gill, W. Murray, M.A. Saunders and M.H. Wright

171

1. Equality constraints	171
2. Equality-constrained quadratic programming	176

3. Overview of methods	180
4. The quadratic penalty function	181
5. The l_1 penalty function	185
6. Sequential quadratic programming methods	186
7. Sequential linearly constrained methods	193
8. Augmented Lagrangian methods	195
9. Inequality constraints	196
10. Inequality-constrained quadratic programming	200
11. Penalty-function methods for inequalities	201
12. Sequential quadratic programming methods	202
13. Sequential linearly constrained methods	204
14. Augmented Lagrangian methods	204
15. Barrier-function methods	205
References	208

CHAPTER IV**Network Flows**

R.K. Ahuja, T.L. Magnanti and J.B. Orlin	211
1. Introduction	211
2. Basic properties of network flows	236
3. Shortest paths	249
4. Maximum flows	265
5. Minimum cost flows	287
6. Reference notes	332
Acknowledgements	360
References	360

CHAPTER V**Polyhedral Combinatorics**

W.R. Pulleyblank	371
1. Min-max relations, NP and co-NP	371
2. Weighted min-max relations and polyhedra	377
3. Basic theory of polyhedra and linear systems	383
4. Linear systems and combinatorial optimization	394
5. Separation and partial descriptions	404
6. Polarity, blocking and antiblocking	409
7. Strengthening min-max theorems I: Essential inequalities	413
8. Strengthening min-max theorems II: Dual integrality	419
9. Dimension	427
10. Adjacency	428
11. Extended formulations and projection	432
Appendix: P, NP and co-NP	437
Acknowledgements	440
References	440

CHAPTER VI	
Integer Programming	
G.L. Nemhauser and L.A. Wolsey	447
1. Introduction	447
2. Integer programming models	449
3. Choices in model formulation	456
4. Properties of integral polyhedra and computational complexity	459
5. Relaxation and valid inequalities	463
6. Duality	476
7. Cutting plane algorithms	485
8. Branch-and-bound	498
9. Heuristics	506
10. Notes	517
References	521
CHAPTER VII	
Nondifferentiable Optimization	
C. Lemaréchal	529
1. Introduction	529
2. Examples of nonsmooth problems	532
3. Failure of smooth methods	537
4. Special methods for special problems	539
5. Subgradient methods	543
6. Bundle methods	552
7. Directions for future developments	561
8. Commented bibliography	566
Bibliography	569
CHAPTER VIII	
Stochastic Programming	
R.J.-B. Wets	573
1. Introduction: The model	573
2. Expectation functionals	577
3. Anticipative models and adaptive models	588
4. Recourse problems	593
5. Optimality conditions	596
6. Approximations	600
7. Solution procedures	611
8. Stability and incomplete information	620
9. References	623