

Anthony L. Peressini
Francis E. Sullivan
J. J. Uhl, Jr.

The Mathematics of Nonlinear Programming

With 66 Illustrations



Springer-Verlag

New York Berlin Heidelberg London Paris
Tokyo Hong Kong Barcelona Budapest

Table of Contents

Preface	v
CHAPTER 1	
Unconstrained Optimization via Calculus	1
1.1. Functions of One Variable	1
1.2. Functions of Several Variables	5
1.3. Positive and Negative Definite Matrices and Optimization	13
1.4. Coercive Functions and Global Minimizers	25
1.5. Eigenvalues and Positive Definite Matrices	29
Exercises	31
CHAPTER 2	
Convex Sets and Convex Functions	37
2.1. Convex Sets	37
*2.2. Some Illustrations of Convex Sets in Economics— Linear Production Models	43
2.3. Convex Functions	45
2.4. Convexity and the Arithmetic–Geometric Mean Inequality— An Introduction to Geometric Programming	58
2.5. Unconstrained Geometric Programming	66
*2.6. Convexity and Other Inequalities	73
Exercises	77
CHAPTER 3	
Iterative Methods for Unconstrained Optimization	82
3.1. Newton's Method	83
3.2. The Method of Steepest Descent	97

3.3. Beyond Steepest Descent	105
3.4. Broyden's Method	112
3.5. Secant Methods for Minimization	121
Exercises	128
 CHAPTER 4	
Least Squares Optimization	133
4.1. Least Squares Fit	133
4.2. Subspaces and Projections	141
4.3. Minimum Norm Solutions of Underdetermined Linear Systems	145
4.4. Generalized Inner Products and Norms; The Portfolio Problem	148
Exercises	152
 CHAPTER 5	
Convex Programming and the Karush–Kuhn–Tucker Conditions	156
5.1. Separation and Support Theorems for Convex Sets	157
5.2. Convex Programming; The Karush–Kuhn–Tucker Theorem	169
5.3. The Karush–Kuhn–Tucker Theorem and Constrained Geometric Programming	188
5.4. Dual Convex Programs	199
*5.5. Trust Regions	210
Exercises	212
 CHAPTER 6	
Penalty Methods	215
6.1. Penalty Functions	215
6.2. The Penalty Method	219
6.3. Applications of the Penalty Function Method to Convex Programs	226
Exercises	235
 CHAPTER 7	
Optimization with Equality Constraints	238
7.1. Surfaces and Their Tangent Planes	240
7.2. Lagrange Multipliers and the Karush–Kuhn–Tucker Theorem for Mixed Constraints	245
7.3. Quadratic Programming	258
Exercises	266
 Index	 271