

Contents

Preface	ix
Acknowledgments	xi
Chapter 0. Introduction	1
Elementary examples	4
Chapter 1. Fundamental Concepts	9
Sets and set operations	12
Cost functions and optimization problems	15
Norms of vectors	18
Local and global solutions	21
Exercises	23
Chapter 2. Existence Theory	25
Topological properties of sets	27
Sequences	34
Bolzano-Weierstrass Theorem	42
Existence of maxima and minima	51
Exercises	54
Chapter 3. One Dimensional Block Search Techniques	57
Unimodal functions	57
Block search	60
Optimal search policies	65
Efficiency of search techniques	73
Resolution	81
Golden section search	97
Chapter 4. Linear Algebra and the Least Squares Problem	101
Matrices	104
Linear equations, inversion of matrices	114
Transpose of a matrix, symmetric matrices	120
Quadratic forms	123
Least squares problem	128
Exercises	136

Chapter 5.	Differentiation and Newton's Method	141
	Gradients and Jacobians	145
	Necessary condition for minimum	153
	Newton's method	161
	Hessian matrix	175
	Exercises	180
Chapter 6.	Convexity	183
	Convex functions and sets	183
	Sufficient condition for minimum	197
	Convexity and the Hessian	200
	Exercises	204
Chapter 7.	Bases and Eigenvectors	209
	Linear independence and dependence	209
	Subspaces of \mathbb{R}^n	213
	Eigenvalues and eigenvectors	220
	Eigenvalues as constrained extrema of quadratic forms	229
	Orthonormal basis of eigenvectors of a symmetric matrix	234
	Diagonalization	237
	Exercises	241
Chapter 8.	Gradient Methods	245
	Description of the method	245
	Contraction fixed point theorem	249
	Local convergence of gradient method	256
	Slow convergence problems	267
	Acceleration of convergence	272
	Global convergence	279
	Path of steepest descent	284
	Exercises	293
Chapter 9.	Equality Constraints: Gradient Projection	297
	Normal and tangent space	300
	Lagrange Multiplier Theorem	308
	Gradient projection method	313
	A "space age" example	324
	Exercises	337
Chapter 10.	Linear Inequality Constraints	341
	Sets described by linear inequalities	343
	The dual basis	349
	Kuhn-Tucker conditions	351
	Gradient projection technique	359
	Examples	368
	Remarks on linear programming	389
	Degeneracy	391
	Exercises	399