

Contents

Preface	v
Chapter 1 Fundamentals	1
1.1 Introduction	1
1.2 Fundamental Linear Algebra	6
1.3 Fundamental Analysis	12
1.4 The Classification of Minimizers	20
1.5 Sufficient Conditions for a Strong Local Minimizer	25
1.6 Convex Functions	29
1.7 Lagrange Multipliers	36
1.8 Convergence	40
Exercises	43
Chapter 2 Line Search Techniques	53
2.1 Introduction	53
2.2 Quadratic Interpolation	62
2.3 Cubic Interpolation	73
Exercises	78
Chapter 3 The Steepest Descent and Newton Methods	82
3.1 The Method of Steepest Descent	82
3.2 The Method of Newton	89
3.3 Safeguarding the Method of Newton	92
3.4 Murray's Modification of Newton's Method	99
3.5 Numerical Approximation of the Hessian	108
Exercises	110
Chapter 4 Conjugate Direction Methods	113
4.1 Introduction	113
4.2 Conjugate Directions	114
4.3 Conjugate Direction Methods	116
4.4 Conjugate Gradient Methods	120
Exercises	126
Chapter 5 Direct Search Methods	130
5.1 Introduction	130
5.2 The Method of Nelder and Mead	131
5.3 The Method of Powell	141
Exercises	157

Chapter 6 Quasi-Newton Methods	158
6.1 Introduction	158
6.2 The Method of Fletcher and Powell	161
6.3 The Method of Stewart	167
6.4 Quadratically Convergent Methods	176
6.5 A Rank One Updating Formula	193
6.6 Some Rank Two Updating Formulae	196
6.7 Gill and Murray's Implementation of Quasi-Newton Methods	209
Exercises	215
Chapter 7 The Least Squares Problem	218
7.1 Introduction	218
7.2 The Linear Least Squares Problem	220
7.3 The Gauss–Newton Method	225
7.4 The Method of Hartley	230
7.5 The Methods of Levenberg and Marquardt	233
7.6 Fletcher's Method	239
7.7 The Method of Meyer and Roth	247
7.8 Approximation of Derivatives	261
Exercises	263
Appendices	267
A. Derivation of the Cubic Interpolation Formula	267
B. Objective Functions	270
C. The Cholesky Decomposition of a Symmetric Positive Definite Matrix	275
D. The Connection Between Orthogonal and Oblique Co-ordinates	278
E. A Proof of Hadamard's Inequality	280
F. The Sherman–Morrison–Woodbury Formula	283
G. Updating the Cholesky Decomposition of a Positive Definite Matrix	284
H. Householder Transformations	293
I. The Eigenvalues of the Sum of Two Real Symmetric Matrices	299
J. A Criterion for the Convergence of a Sequence in a Compact Set of $\{R^n, \ \cdot\ \}$	306
References	307
Index	311