

CONTENTS

CHAPTER ONE

Introduction	1
1.a General Approach	1
1.b Data Analysis and Computing	2

CHAPTER TWO

Programming	5
2.a Structure of Computations in Data Analysis	5
2.b Program Evaluation	7
2.c Program Design and Structure	14
2.d Portability of Programs	19
2.e Programming Languages: General Discussion	20
2.f Programming Languages: Comparisons	22
Problems	26

CHAPTER THREE

Data Management and Manipulation	28
3.a The Management of Storage Space	28
3.b Arrays and their indexing	32
3.c Data Structures; Data Base Management	35
3.d Order Statistics: Sorting and Partial Sorting	41
3.e Searching and Table Look-up	46
3.f Using Data Base Systems for Data Analysis	52
3.g Summary and Recommendations	55
Problems	56

CHAPTER FOUR

Numerical Computations	58
4.a The Representation of Numbers; Bit-strings	58
4.b Floating-Point Operations; Error Analysis	63
4.c Operations on Arrays	66
4.d Approximation by Rational Functions	71

4.e Spline Approximations	77
4.f Evaluation of Approximations	82
4.g Numerical Integration	87
4.h Fourier Transforms; Spectral Analysis	91
4.i Parallel Computation	97
Problems	99

CHAPTER FIVE

Linear Models 101

5.a Linear Regression	101
5.b Orthogonal Bases	102
5.c Orthogonal-Triangular Decompositions	103
5.d Statistical Summaries	107
5.e Singular-Value Decomposition	111
5.f Condition; Rank; Iterative Improvement	115
5.g Cost and Accuracy	118
5.h Weighted Least-Squares	120
5.i Updating Regression	122
5.j Regression by Other Criteria; Robust Regression	124
5.k Principal Components; Canonical Analysis	125
5.l Analysis of Variance	127
5.m Summary and Recommendations	130
Problems	132

CHAPTER SIX

Nonlinear Models 134

6.a Introduction	134
6.b Optimization; Quadratic Methods	136
6.c Quasi-Newton Methods	138
6.d Other Optimization Methods	141
6.e Mathematical Properties	143
6.f Distribution of Estimates	146
6.g Nonlinear Least-Squares Estimation	149
6.h Nonlinear Equations; Fixed-Point Methods	152
6.i Constrained Optimization	156
6.j Summary and Recommendations	159

CHAPTER SEVEN

Simulation of Random Processes 161

7.a The Concept of Randomness	161
7.b Pseudorandom Uniforms	163
7.c Congruential Generators	164
7.d Other Basic Generators	170
7.e Modifying Generators	173
7.f Derived Distributions: General Methods	175
7.g Special Distributions	180
7.h Multivariate Distributions	183
7.i Monte-Carlo Methods	186
7.j Summary and Recommendations	190
Problems	191

CHAPTER EIGHT

Computational Graphics 194

8.a Graphics for Data Analysis	194
8.b Graphical Devices and Their Capabilities	197
8.c Geometry of Plotting; Two Dimensions	201
8.d Geometry of Plotting; Several Dimensions	204
8.e Plotting Curves	208
8.f Plotting Surfaces; Hidden-Line Removal	210
8.g Contour Plotting	213
8.h Scaling	218
8.i Scatter Plots	220
8.j Histograms and Probability Plots	222
8.k Summary and Recommendations	225
Problems	226

REFERENCES 228

APPENDIX

Available Algorithms 248

Index 257