Aims and Scope
Optimization has been expanding in all directions at an astonishing rate during the last few decades. New algorithmic and theoretical techniques have been developed, the diffusion into other disciplines has proceeded at a rapid pace, and our knowledge of all aspects of the field has grown even more profound. At the same time, one of the most striking trends in optimization is the constantly increasing emphasis on the interdisciplinary nature of the field. Optimization has been a basic tool in all areas of applied mathematics, engineering, medicine, economics and other sciences.

The series Springer Optimization and Its Applications publishes undergraduate and graduate textbooks, monographs and state-of-the-art expository works that focus on algorithms for solving optimization problems and also study applications involving such problems. Some of the topics covered include nonlinear optimization (convex and nonconvex), network flow problems, stochastic optimization, optimal control, discrete optimization, multiobjective programming, description of software packages, approximation techniques and heuristic approaches.
OPTIMIZATION

Structure and Applications

Edited By

CHARLES PEARCE
School of Mathematical Sciences,
The University of Adelaide,
Adelaide, Australia

EMMA HUNT
School of Economics & School of Mathematical Sciences,
The University of Adelaide,
Adelaide, Australia

Springer
This volume is dedicated with great affection to the late Alex Rubinov, who was invited plenary speaker at the mini-conference. He is sorely missed.

♥
Contents

List of Figures .................................................. xv
List of Tables .................................................... xvii
Preface .......................................................... xix

Part I Optimization: Structure

1 On the nondifferentiability of cone-monotone functions in Banach spaces ........................................ 3
   Jonathan Borwein and Rafal Goebel
   1.1 Introduction .............................................. 3
   1.2 Examples ................................................ 6
   References .................................................. 13

2 Duality and a Farkas lemma for integer programs .................................................. 15
   Jean B. Lasserre
   2.1 Introduction ............................................. 15
   2.1.1 Preliminaries ......................................... 16
   2.1.2 Summary of content .................................. 17
   2.2 Duality for the continuous problems $P$ and $I$ .............. 18
      2.2.1 Duality for $P$ ..................................... 18
      2.2.2 Duality for integration ......................... 19
      2.2.3 Comparing $P, P^*$ and $I, I^*$ ............... 19
      2.2.4 The continuous Brion and Vergne formula ........ 20
      2.2.5 The logarithmic barrier function ............. 21
      2.2.6 Summary ........................................... 22
   2.3 Duality for the discrete problems $I_d$ and $P_d$ ............ 22
      2.3.1 The $\mathbb{Z}$-transform ........................... 23
      2.3.2 The dual problem $I_d^*$ ........................... 24
      2.3.3 Comparing $I^*$ and $I_d^*$ ..................... 24
2.3.4 The “discrete” Brion and Vergne formula .............. 25
2.3.5 The discrete optimization problem $P_d$ ............... 26
2.3.6 A dual comparison of $P$ and $P_d$ .................... 27
2.4 A discrete Farkas lemma .................................... 29
2.4.1 The case when $A \in \mathbb{N}^{m \times n}$ ................. 30
2.4.2 The general case ......................................... 31
2.5 Conclusion ................................................. 33
2.6 Proofs ....................................................... 34
2.6.1 Proof of Theorem 1 ........................................ 34
2.6.2 Proof of Corollary 1 ...................................... 35
2.6.3 Proof of Proposition 3.1 .................................. 36
2.6.4 Proof of Theorem 2 ....................................... 37
References .......................................................... 38

3 Some nonlinear Lagrange and penalty functions for problems with a single constraint ......................... 41
J. S. Giri and A. M. Rubinov
3.1 Introduction .................................................. 41
3.2 Preliminaries .................................................. 43
3.3 The relationship between extended penalty functions and extended Lagrange functions ......................... 44
3.4 Generalized Lagrange functions ............................ 47
3.5 Example ....................................................... 51
3.5.1 The Lagrange function approach ......................... 51
3.5.2 Penalty function approach ............................... 52
References .......................................................... 53

4 Convergence of truncates in $l^1$ optimal feedback control .... 55
Robert Wenczel, Andrew Eberhard and Robin Hill
4.1 Introduction .................................................. 55
4.2 Mathematical preliminaries .................................. 58
4.3 System-theoretic preliminaries ............................. 60
4.3.1 Basic system concepts .................................... 60
4.3.2 Feedback stabilization of linear systems ............... 62
4.4 Formulation of the optimization problem in $l^1$ ........... 64
4.5 Convergence tools ............................................ 67
4.6 Verification of the constraint qualification .................. 71
4.6.1 Limitations on the truncation scheme ................. 76
4.7 Convergence of approximates ................................ 78
4.7.1 Some extensions .......................................... 85
4.8 Appendix ...................................................... 88
References .......................................................... 92
5 Asymptotical stability of optimal paths in nonconvex problems ................................................ 95
Musa A. Mamedov
5.1 Introduction and background ................................. 95
5.2 The main conditions of the turnpike theorem .......... 97
5.3 Definition of the set \( D \) and some of its properties .... 100
5.4 Transformation of Condition H3 .......................... 101
5.5 Sets of 1st and 2nd type: Some integral inequalities .... 105
5.5.1 ...................................................... 105
5.5.2 ...................................................... 106
5.5.3 ...................................................... 107
5.5.4 ...................................................... 108
5.5.5 ...................................................... 113
5.6 Transformation of the functional (5.2) ................. 117
5.6.1 ...................................................... 117
5.6.2 ...................................................... 119
5.7 The proof of Theorem 13.6 ................................ 123
5.7.1 ...................................................... 123
5.7.2 ...................................................... 129
References ...................................................... 133

6 Pontryagin principle with a PDE: a unified approach .... 135
B. D. Craven
6.1 Introduction .................................................... 135
6.2 Pontryagin for an ODE ...................................... 136
6.3 Pontryagin for an elliptic PDE ............................ 138
6.4 Pontryagin for a parabolic PDE .......................... 139
6.5 Appendix ...................................................... 140
References ...................................................... 141

7 A turnpike property for discrete-time control systems in metric spaces ........................................ 143
Alexander J. Zaslavski
7.1 Introduction .................................................... 143
7.2 Stability of the turnpike phenomenon ..................... 146
7.3 A turnpike is a solution of the problem (P) ............. 149
7.4 A turnpike result ............................................. 151
References ...................................................... 155

8 Mond–Weir Duality ............................................. 157
B. Mond
8.1 Preliminaries ................................................... 157
8.2 Convexity and Wolfe duality ............................... 158
8.3 Fractional programming and some extensions of convexity ...................................................... 159
9 Computing the fundamental matrix of an $M/G/1$–type Markov chain ............................................. 167
Emma Hunt
9.1 Introduction ............................................. 167
9.2 Algorithm H: Preliminaries ................................ 170
9.3 Probabilistic construction .................................. 172
9.4 Algorithm H ............................................. 174
9.5 Algorithm $\Pi$: Preliminaries ......................... 175
9.6 $\Pi$, G and convergence rates .......................... 178
9.7 A special case: The QBD ........................... 181
9.8 Algorithms CR and H ..................................... 185
References ....................................................... 187

10 A comparison of probabilistic and invariant subspace methods for the block $M/G/1$ Markov chain .............. 189
Emma Hunt
10.1 Introduction ............................................. 189
10.2 Error measures .......................................... 190
10.3 Numerical experiments ............................... 192
10.3.1 Experiment G1 ........................................ 193
10.3.2 Experiment G2 ........................................ 194
10.3.3 The Daigle and Lucantoni teletraffic problem ..... 196
10.3.4 Experiment G6 ........................................ 201
10.3.5 Experiment G7 ........................................ 202
References ....................................................... 204

11 Interpolating maps, the modulus map and Hadamard’s inequality .................................................. 207
S. S. Dragomir, Emma Hunt and C. E. M. Pearce
11.1 Introduction ............................................. 207
11.2 A refinement of the basic inequality .................. 210
11.3 Inequalities for $G_f$ and $H_f$ ......................... 216
11.4 More on the identric mean ........................... 217
11.5 The mapping $L_f$ ........................................ 220
References ....................................................... 223
Part II Optimization: Applications

12 Estimating the size of correcting codes using extremal graph problems .................................................. 227
Sergiy Butenko, Panos Pardalos, Ivan Sergienko, Vladimir Shylo and Petro Stetsyuk
12.1 Introduction ................................................................. 227
12.2 Finding lower bounds and exact solutions for the largest code sizes using a maximum independent set problem .... 229
12.2.1 Finding the largest correcting codes ....................... 232
12.3 Lower Bounds for Codes Correcting One Error on the Z-Channel ......................................................... 236
12.3.1 The partitioning method ............................................. 237
12.3.2 The partitioning algorithm .......................................... 239
12.3.3 Improved lower bounds for code sizes ...................... 239
12.4 Conclusions ................................................................. 241
References ........................................................................ 242

13 New perspectives on optimal transforms of random vectors ............................................................................. 245
P. G. Howlett, C. E. M. Pearce and A. P. Torokhti
13.1 Introduction and statement of the problem ...................... 245
13.2 Motivation of the statement of the problem ..................... 247
13.3 Preliminaries ................................................................. 248
13.4 Main results ................................................................. 249
13.5 Comparison of the transform $T^0$ and the GKLT ............. 251
13.6 Solution of the unconstrained minimization problem (13.3) . 252
13.7 Applications and further modifications and extensions ........ 253
13.8 Simulations ................................................................. 254
13.9 Conclusion ................................................................. 258
References ........................................................................ 258

14 Optimal capacity assignment in general queueing networks ............................................................................. 261
P. K. Pollett
14.1 Introduction ................................................................. 261
14.2 The model ................................................................. 262
14.3 The residual-life approximation ..................................... 263
14.4 Optimal allocation of effort .......................................... 264
14.5 Extensions ................................................................. 267
14.6 Data networks ................................................................. 268
14.7 Conclusions ................................................................. 271
References ........................................................................ 271
15 Analysis of a simple control policy for stormwater management in two connected dams ........................................ 273
Julia Piantadosi and Phil Howlett
15.1 Introduction .......................................................... 273
15.2 A discrete-state model ................................................. 274
  15.2.1 Problem description ............................................. 274
  15.2.2 The transition matrix for a specific control policy .... 275
  15.2.3 Calculating the steady state when $1 < m < k$ .......... 276
  15.2.4 Calculating the steady state for $m = 1$ ................. 279
  15.2.5 Calculating the steady state for $m = k$ ................. 280
15.3 Solution of the matrix eigenvalue problem using Gaussian elimination for $1 < m < k$ ................................. 280
  15.3.1 Stage 0 ......................................................... 281
  15.3.2 The general rules for stages $2$ to $m - 2$ ............. 281
  15.3.3 Stage $m - 1$ .................................................. 283
  15.3.4 The general rules for stages $m$ to $k - 2m$ .......... 284
  15.3.5 Stage $k - 2m + 1$ ........................................... 285
  15.3.6 The general rule for stages $k - 2m + 2$ to $k - m - 2$ .......................... 286
  15.3.7 The final stage $k - m - 1$ ................................. 287
15.4 The solution process using back substitution for $1 < m < k$ . 287
15.5 The solution process for $m = 1$ .................................. 290
15.6 The solution process for $m = k$ .................................. 292
15.7 A numerical example ................................................ 292
15.8 Justification of inverses ............................................. 295
  15.8.1 Existence of the matrix $W_0$ ................................ 296
  15.8.2 Existence of the matrix $W_p$ for $1 \leq p \leq m - 1$ .... 296
  15.8.3 Existence of the matrix $W_q$ for $m \leq q \leq k - m - 1$ ........................ 298
15.9 Summary .......................................................... 305
References ..................................................................... 306

16 Optimal design of linear consecutive–$k$–out–of–$n$ systems . 307
Małgorzata O’Reilly
16.1 Introduction .................................................................. 307
  16.1.1 Mathematical model ............................................. 307
  16.1.2 Applications and generalizations of linear consecutive–$k$–out–of–$n$ systems ............... 308
  16.1.3 Studies of consecutive–$k$–out–of–$n$ systems .......... 309
  16.1.4 Summary of the results ........................................ 311
16.2 Propositions for $R$ and $M$ ........................................... 312
16.3 Preliminaries to the main proposition ............................ 315
16.4 The main proposition ................................................ 318
16.5 Theorems .................................................................. 321
16.6 Procedures to improve designs not satisfying necessary conditions for the optimal design ................................................. 324
References .................................................................................. 325

17 The \((k+1)\)-th component of linear consecutive–\(k\)-out–of–\(n\) systems ................................................................................. 327
Małgorzata O’Reilly
17.1 Introduction ................................................................. 327
17.2 Summary of the results ............................................... 329
17.3 General result for \(n > 2k, k \geq 2\) .......................... 330
17.4 Results for \(n = 2k + 1, k > 2\) ............................... 334
17.5 Results for \(n = 2k + 2, k > 2\) ................................. 337
17.6 Procedures to improve designs not satisfying the necessary conditions for the optimal design ................................. 340
References .................................................................................. 341

18 Optimizing properties of polypropylene and elastomer compounds containing wood flour .................................................. 343
Pavel Spiridonov, Jan Budin, Stephen Clarke and Jani Matisons
18.1 Introduction ................................................................. 344
18.2 Methodology .................................................................. 344
18.2.1 Materials ................................................................. 344
18.2.2 Sample preparation and tests ..................................... 345
18.3 Results and discussions .................................................. 345
18.3.1 Density of compounds .............................................. 345
18.3.2 Comparison of compounds obtained in a Brabender mixer and an injection-molding machine ....................... 346
18.3.3 Compatibilization of the polymer matrix and wood flour ............................................................. 349
18.3.4 Optimization of the compositions ......................... 350
18.4 Conclusions ................................................................... 352
References .................................................................................. 353

19 Constrained spanning, Steiner trees and the triangle inequality ......................................................................................... 355
Prabhu Manyem
19.1 Introduction ................................................................. 355
19.2 Upper bounds for approximation ..................................... 359
19.2.1 The most expensive edge is at most a minimum spanning tree ......................................................... 359
19.2.2 MaxST is at most \((n-1)\text{MinST}\) ............................ 359
19.3 Lower bound for a CSP approximation ......................... 360
19.3.1 E-Reductions: Definition ......................................... 360
19.3.2 SET COVER .......................................................... 361
19.3.3 Reduction from SET COVER ................................. 361
19.3.4 Feasible Solutions .................................................... 362
20 Parallel line search ........................................ 369
T. C. Peachey, D. Abramson and A. Lewis
20.1 Line searches ........................................... 369
20.2 Nimrod/O .............................................. 370
20.3 Execution time ......................................... 373
  20.3.1 A model for execution time ....................... 373
  20.3.2 Evaluation time a Bernoulli variate ............... 373
  20.3.3 Simulations of evaluation time .................... 375
  20.3.4 Conclusions ....................................... 375
20.4 Accelerating convergence by incomplete iterations .... 377
  20.4.1 Strategies for aborting jobs ....................... 377
  20.4.2 Experimental results ............................... 378
  20.4.3 Conclusions ....................................... 381
References .................................................. 381

21 Alternative Mathematical Programming Models: A Case
for a Coal Blending Decision Process ....................... 383
Ruhul A. Sarker
21.1 Introduction ........................................... 383
21.2 Mathematical programming models ..................... 385
  21.2.1 Single period model (SPM) ......................... 386
  21.2.2 Multiperiod nonlinear model (MNM) ............... 389
  21.2.3 Upper bound linear model (MLM) ................. 390
  21.2.4 Multiperiod linear model (MLM) .................. 391
21.3 Model flexibility ....................................... 392
  21.3.1 Case-1 ........................................... 392
  21.3.2 Case-2 ........................................... 394
  21.3.3 Case-3 ........................................... 395
21.4 Problem size and computation time .................... 395
21.5 Objective function values and fluctuating situation .... 396
21.6 Selection criteria ..................................... 397
21.7 Conclusions ........................................... 398
References .................................................. 398

About the Editors ........................................... 401
List of Figures

3.1 $P(f_0, f_1)$. .................................................. 52
3.2 $L(x; \frac{\delta}{2})$. ........................................... 53
3.3 $L_{s_3}^+(x; 1)$. ........................................... 53
4.1 A closed-loop control system. .................................. 62
12.1 A scheme of the Z-channel ....................................... 236
12.2 Algorithm for finding independent set partitions .......... 240
13.1 Illustration of the performance of our method. ............... 256
13.2 Typical examples of a column reconstruction in the matrix $X$ (image “Lena”) after filtering and compression of the observed noisy image (Figure 13.1b) by transforms $H$ (line with circles) and $T^0$ (solid line) of the same rank. In both subfigures, the plot of the column (solid line) virtually coincides with the plot of the estimate by the transform $T^0$. .................................................. 257
18.1 Density of (a) polypropylene and (b) SBS in elastomer compounds for different blending methods. ................. 347
18.2 Comparison of tensile strength of the compounds obtained in an injection-molding machine and in a Brabender mixer. . 348
18.3 Influence of wood flour fractions and the modifier on the tensile strength of injection-molded specimens of the (a) PP and (b) SBS compounds. ................................. 349
18.4 Relative cost of the (a) PP and (b) SBS compounds depending on the content of wood flour and maleated polymers. ......................... 351
18.5 Photographs of the PP compounds containing 40% wood flour of different fractions. ................................. 352
19.1 A Constrained Steiner Tree and some of its special cases. .... 357
19.2 A CSP$_I$ instance reduced from SET COVER (not all edges shown). .................................................. 361
19.3 Feasible solution for our instance of CSP$_I$  
(not all edges shown). ........................................ 364
20.1 A sample configuration file. .................................... 371
20.2 Architecture of Nimrod/O. ....................................... 372
20.3 Performance with Bernoulli job times. ......................... 374
20.4 Test function $g(x)$. ........................................ 375
20.5 Results of simulations. .......................................... 376
20.6 Incomplete evaluation points. ................................... 377
20.7 Strategy 1 with exponential distribution of job times. ...... 379
20.8 Strategy 1 with rectangular distribution of job times. ...... 379
20.9 Results for Strategy 2. .......................................... 380
20.10 Results for Strategy 3. ......................................... 380
21.1 Simple case problem. ........................................... 393
List of Tables

9.1 The interlacing property ....................................... 184
10.1 Experiment G1 ................................................... 194
10.2 Experiment G2 ................................................... 195
10.3 Experiment G2 continued ......................................... 196
10.4 Iterations required with various traffic levels: Experiment G3 198
10.5 Iterations required with various traffic levels: Experiment G3 continued .......................................... 199
10.6 Experiment G4 ................................................... 200
10.7 Experiment G4 continued ......................................... 200
10.8 Experiment G5 ................................................... 202
10.9 Experiment G6 ................................................... 202
10.10 Experiment G7: a transient process ......................... 204
12.1 Lower bounds obtained ........................................ 231
12.2 Exact algorithm: Computational results .................... 235
12.3 Exact solutions found .......................................... 236
12.4 Lower bounds obtained in: a [27]; b [6]; c [7]; d [12]; e (this chapter) ................................................... 237
12.5 Partitions of asymmetric codes found ....................... 240
12.6 Partitions of constant weight codes obtained in: a (this chapter); b [4]; c [12] ........................................... 241
12.7 New lower bounds. Previous lower bounds were found in:
a [11]; b [12] ......................................................... 241
13.1 Ratios $\rho_{ij}$ of the error associated with the GKLT $H$ to that of the transform $T^0$ with the same compression ratios .... 255
15.1 Overflow lost from the system for $m = 1, 2, 3, 4$ .............. 295
16.1 Invariant optimal designs of linear consecutive–$k$–out–of–$n$ systems ....................................................... 310
18.1 Physical characteristics of the wood flour fractions .......... 345
19.1 Constrained Steiner Tree and special cases: References .... 358
19.2 E-Reduction of a SET COVER to a CSP$_I$: Costs and delays of edges in $G$ ................................................... 362
21.1 Relative problem size of ULM, MLM and MNM ............... 395
21.2 Objective function values of ULM, MLM and MNM ........ 397
Preface

This volume comprises a selection of material based on presentations at the Eighth Australian Optimization Day, held in McLaren Vale, South Australia, in September 2001, and some additional invited contributions by distinguished colleagues, here and overseas. Optimization Day is an annual mini-conference in Australia which dates from 1994. It has been successful in bringing together Australian researchers in optimization and related areas for the sharing of ideas and the facilitation of collaborative work. These meetings have also attracted some collaborative researchers from overseas.

This particular meeting was remarkable in the efforts made by some of the participants to ensure being present. It took place within days of the September 11 tragedy in New York and the financial collapse of a major Australian airline. These events left a number of us without air tickets on the eve of the conference. Some participants arrived in South Australia by car, having driven up to several thousand kilometers to join the meeting.

This volume has two parts, one concerning mathematical structure and the other applications. The first part begins with a treatment of nondifferentiability of cone-monotone functions in Banach spaces, showing that whereas several regularity properties of cone-monotone functions in finite-dimensional spaces carry over to a separable Banach space provided the cone has an interior, further generalizations are not readily possible. The following chapter concerns a comparison between linear and integer programming, particularly from a duality perspective. A discrete Farkas lemma is provided and it is shown that the existence of a nonnegative integer solution to a linear equation can be tested via a linear program. Next, there is a study of connections between generalized Lagrangians and generalized penalty functions for problems with a single constraint. This is followed by a detailed theoretical analysis of convergence of truncates in $\ell_1$ optimal feedback control. The treatment permits consideration of the frequently occurring case of an objective function lacking interiority of domain. The optimal control theme continues with a study of asymptotic stability of optimal paths in nonconvex problems. The purpose of the chapter is to avoid the convexity conditions usually
assumed in turnpike theory. The succeeding chapter proposes a unified approach to Pontryagin’s principle for optimal control problems with dynamics described by a partial differential equation. This is followed by a study of a turnpike property for discrete-time control systems in metric spaces. A treatment of duality theory for nonlinear programming includes comparisons of alternative approaches and discussion of how Mond–Weir duality and Wolfe duality may be combined. There are two linked chapters centered on the use of probabilistic structure for designing an improved algorithm for the determination of the fundamental matrix of a block-structured $M/G/1$ Markov chain. The approach via probabilistic structure makes clear in particular the nature of the relationship between the cyclic reduction algorithms and the Latouche–Ramaswami algorithm in the QBD case. Part I concludes with a chapter developing systematic classes of refinements of Hadamard’s inequality, a cornerstone of convex analysis.

Although Part II of this volume is concerned with applications, a number of the chapters also possess appreciable theoretical content. Part II opens with the estimation of the sizes of correcting codes via formulation in terms of extremal graph problems. Previously developed algorithms are used to generate new exact solutions and estimates. The second chapter addresses the issue of optimal transforms of random vectors. A new transform is presented which has advantages over the Karhunen–Loève transform. Theory is developed and applied to an image reconstruction problem. The following chapter considers how to assign service capacity in a queueing network to minimize expected delay under a cost constraint. Next there is analysis of a control policy for stormwater management in a pair of connected tandem dams, where a developed mathematical technology is proposed and exhibited. Questions relating to the optimal design of linear consecutive-$k$-out-of-$n$ systems are treated in two related chapters. There is a study of optimizing properties of plastics containing wood flour; an analysis of the approximation characteristics of constrained spanning and Steiner tree problems in weighted undirected graphs where edge costs and delays satisfy the triangle inequality; heuristics for speeding convergence in line search; and the use of alternative mathematical programming formulations for a real-world coal-blending problem under different scenarios.

All the contributions to this volume had the benefit of expert refereeing. We are grateful to the following reviewers for their help:

Mirta Inés Aranguren (Universidad Nacional de Mar del Plata, Argentina), Eduardo Casas (Universidad de Cantabria, Spain), Aurelian Cernea (University of Bucharest), Pauline Coolen–Schrijner (University of Durham), Bruce Craven (University of Melbourne), Yu-Hong Dai (Chinese Academy of Sciences, Beijing), Sever Dragomir (Victoria University of Technology, Melbourne), Elfadl Khalifa Elsheikh (Cairo University), Christopher Frey (N. Carolina State University), Frank Kelly (University of Cambridge), Peter Kloeden (Johann Wolfgang Goethe-Universität, Frankfurt), Denis Lander (RMIT University), Roy Leipnik (UCSB), Musa Mamedov (University of
Ballarat), Jie Mi (Florida International University), Marco Muselli (Institute of Electronics, Computer and Telecommunication Engineering, Genova), Małgorzata O’Reilly (University of Tasmania), Stavros Papastavridis (University of Athens), Serpil Pehlivan (Süleyman Demirel University, Turkey), Danny Ralph (Cambridge University), Sekharipuram S. Ravi (University at Albany, New York), Dan Rosenkrantz (University at Albany, New York), Alexander Rubinov (University of Ballarat), Hanif D. Sherali (Virginia Polytechnic Institute), Moshe Sniedovich (University of Melbourne), Nicole Stark (USDA Forest Products Laboratory, Madison), Nasser Hassan Sweilam (Cairo University), Fredi Tröltzsch (Technische Universität, Berlin), Erik van Doorn (University of Twente, Netherlands), Frank K. Wang (National Chiao University, Taiwan, R.O.C.), Jianxing Yin (SuDa University, China), Alexander Zaslavski (Technion-Israel Institute of Technology), and Ming Zuo (University of Alberta).

We wish to thank John Martindale for his involvement in bringing about a firm arrangement for publication of this volume with Kluwer; Elizabeth Loew for shepherding the book through to publication with Springer following the Kluwer–Springer merger; and Panos Pardalos for his support throughout. A special thank you is due to Jason Whyte, through whose technical skill, effort and positive morale many difficulties were overcome.

Charles Pearce & Emma Hunt