Table of Contents

Foreword viii

Preface x

Acknowledgment xvii

Section 1
Theory and Methods

Chapter 1
Introduction 1
What is Optimization? 1
Types of Optimization Problems 3
Classification of Optimization Algorithms 6
The Development of Evolutionary Computation 8
Fundamental Evolutionary Operations 12
Swarm Intelligence 16
The No-Free-Lunch Theorem 19
Chapter Synopsis 19
References 20

Chapter 2
Particle Swarm Optimization 25
Main Inspiration Source 25
Early Variants of PSO 26
Further Refinement of PSO 31
Contemporary Standard PSO 37
Chapter Synopsis 40
References 40

Chapter 3
Theoretical Derivations and Application Issues **42**
Initialization Techniques 42
Theoretical Investigations and Parameter Selection 47
Design of PSO Algorithms Using Computational Statistics 63
Termination Conditions 80
Chapter Synopsis 84
References 84

Chapter 4
Established and Recently Proposed Variants of Particle Swarm Optimization **88**
Unified Particle Swarm Optimization 89
Memetic Particle Swarm Optimization 99
Vector Evaluated Particle Swarm Optimization 108
Composite Particle Swarm Optimization: A Meta-Strategy Approach 109
Guaranteed Convergence Particle Swarm Optimization 114
Cooperative Particle Swarm Optimization 116
Niching Particle Swarm Optimization 119
Tribes 121
Quantum Particle Swarm Optimization 125
Chapter Synopsis 127
References 128

Chapter 5
Performance-Enhancing Techniques **133**
Introduction 133
The Stretching Technique for Alleviating Local Minimizers 135
The Deflection Technique for Detecting Several Minimizers 137
The Repulsion Technique 140
The Penalty Function Technique for Constrained Optimization Problems 142
Rounding Techniques for Integer Optimization 144
Chapter Synopsis 145
References 146

Section 2
Applications of Particle Swarm Optimization

Chapter 6
Applications in Machine Learning **149**
Introduction 149
Training Artificial Neural Networks with PSO 150
Further Applications 153
Fuzzy Cognitive Maps Learning with PSO 154

Chapter Synopsis 164
References 165

Chapter 7
Applications in Dynamical Systems **168**
Introduction 168
Detection of Periodic Orbits of Nonlinear Mappings Using PSO 169
Detection of Periodic Orbits in 3-Dimensional Galactic Potentials Using PSO 175
Chapter Synopsis 181
References 182

Chapter 8
Applications in Operations Research **185**
Introduction 185
Scheduling Problems 186
Continuous Review Inventory Optimization 189
Game Theory Problems 195
Chapter Synopsis 200
References 200

Chapter 9
Applications in Bioinformatics and Medical Informatics **204**
Introduction 204
Calibrating Probabilistic Neural Networks 205
Tackling Magnetoencephalography Problems 212
Chapter Synopsis 218
References 219

Chapter 10
Applications in Noisy and Dynamic Environments **222**
Optimization in the Presence of Noise 222
Optimization in Continuously Changing Environments 236
Chapter Synopsis 238
References 240

Chapter 11
Applications in Multiobjective, Constrained and Minimax Problems **245**
Application in Multiobjective Optimization 245
Application in Constrained Optimization 258
Application in Minimax Optimization 260
Chapter Synopsis 263
References 263

Chapter 12
Afterword **269**
Theoretical Analysis 270
Strategies and Operators 270
Self-Adaptive Models 271
New Variants Suited to Modern Computation Systems 271
New and More Fascinating Applications 272

Appendix A 273

Appendix B 296

About the Authors 303

Index 305