

Table of Contents

1	Computational Optimization: An Overview	1
	Xin-She Yang, Slawomir Koziel	
1.1	Introduction	1
1.2	Computational Optimization	2
1.3	Optimization Procedure	3
1.4	Optimizer	4
1.4.1	Optimization Algorithms	4
1.4.2	Choice of Algorithms	7
1.5	Simulator	8
1.5.1	Numerical Solvers	8
1.5.2	Simulation Efficiency	9
1.6	Latest Developments	10
	References	10
2	Optimization Algorithms	13
	Xin-She Yang	
2.1	Introduction	13
2.2	Derivative-Based Algorithms	14
2.2.1	Newton's Method and Hill-Climbing	14
2.2.2	Conjugate Gradient Method	15
2.3	Derivative-Free Algorithms	16
2.3.1	Pattern Search	16
2.3.2	Trust-Region Method	17
2.4	Metaheuristic Algorithms	18
2.4.1	Simulated Annealling	18
2.4.2	Genetic Algorithms and Differential Evolution	19
2.4.3	Particle Swarm Optimization	21
2.4.4	Harmony Search	22
2.4.5	Firefly Algorithm	23
2.4.6	Cuckoo Search	24
2.5	A Unified Approach to Metaheuristics	26
2.5.1	Characteristics of Metaheuristics	26

2.6	Generalized Evolutionary Walk Algorithm (GEWA)	27
2.6.1	To Be Inspired or Not to Be Inspired	29
	References	29
3	Surrogate-Based Methods	33
	Slawomir Koziel, David Echeverría Ciaurri, Leifur Leifsson	
3.1	Introduction	34
3.2	Surrogate-Based Optimization	35
3.3	Surrogate Models	37
3.3.1	Design of Experiments	39
3.3.2	Surrogate Modeling Techniques	41
3.3.3	Model Validation	45
3.3.4	Surrogate Correction	45
3.4	Surrogate-Based Optimization Techniques	49
3.4.1	Approximation Model Management Optimization	50
3.4.2	Space Mapping	50
3.4.3	Manifold Mapping	52
3.4.4	Surrogate Management Framework	53
3.4.5	Exploitation versus Exploration	55
3.5	Final Remarks	55
	References	56
4	Derivative-Free Optimization	61
	Oliver Kramer, David Echeverría Ciaurri, Slawomir Koziel	
4.1	Introduction	61
4.2	Derivative-Free Optimization	63
4.3	Local Optimization	65
4.3.1	Pattern Search Methods	65
4.3.2	Derivative-Free Optimization with Interpolation and Approximation Models	67
4.4	Global Optimization	68
4.4.1	Evolutionary Algorithms	68
4.4.2	Estimation of Distribution Algorithms	72
4.4.3	Particle Swarm Optimization	73
4.4.4	Differential Evolution	73
4.5	Guidelines for Generally Constrained Optimization	74
4.5.1	Penalty Functions	74
4.5.2	Augmented Lagrangian Method	75
4.5.3	Filter Method	76
4.5.4	Other Approaches	77
4.6	Concluding Remarks	78
	References	79

5	Maximum Simulated Likelihood Estimation: Techniques and Applications in Economics	85
	Ivan Jeliazkov, Alicia Lloro	
5.1	Introduction	85
5.2	Copula Model	86
5.3	Estimation Methodology	90
5.3.1	The CRT Method	90
5.3.2	Optimization Technique	91
5.4	Application	94
5.5	Concluding Remarks	98
	References	99
6	Optimizing Complex Multi-location Inventory Models Using Particle Swarm Optimization	101
	Christian A. Hochmuth, Jörg Lässig, Stefanie Thiem	
6.1	Introduction	101
6.2	Related Work	102
6.3	Simulation Optimization	103
6.4	Multi-Location Inventory Models with Lateral Transshipments ...	105
6.4.1	Features of a General Model	105
6.4.2	Features of the Simulation Model	107
6.5	Particle Swarm Optimization	111
6.6	Experimentation	112
6.6.1	System Setup	112
6.6.2	Results and Discussion	115
6.7	Conclusion and Future Work	121
	References	122
7	Traditional and Hybrid Derivative-Free Optimization Approaches for Black Box Functions	125
	Genetha Anne Gray, Kathleen R. Fowler	
7.1	Introduction and Motivation	126
7.2	A Motivating Example	127
7.3	Some Traditional Derivative-Free Optimization Methods	130
7.3.1	Genetic Algorithms (GAs)	130
7.3.2	Deterministic Sampling Methods	132
7.3.3	Statistical Emulation	138
7.4	Some DFO Hybrids	139
7.4.1	APPS-TGP	140
7.4.2	EAGLS	142
7.4.3	DIRECT-IFFCO	144
7.4.4	DIRECT-TGP	144
7.5	Summary and Conclusion	145
	References	146

8	Simulation-Driven Design in Microwave Engineering: Methods	153
	Slawomir Koziel, Stanislav Ogurtsov	
8.1	Introduction	153
8.2	Direct Approaches	154
8.3	Surrogate-Based Design Optimization	156
8.4	Surrogate Models for Microwave Engineering	158
8.5	Microwave Simulation-Driven Design Exploiting Physically-Based Surrogates	161
8.5.1	Space Mapping	162
8.5.2	Simulation-Based Tuning and Tuning Space Mapping	163
8.5.3	Shape-Preserving Response Prediction	167
8.5.4	Multi-fidelity Optimization Using Coarse-Discretization EM Models	170
8.5.5	Optimization Using Adaptively Adjusted Design Specifications	172
8.6	Summary	175
	References	175
9	Variable-Fidelity Aerodynamic Shape Optimization	179
	Leifur Leifsson, Slawomir Koziel	
9.1	Introduction	179
9.2	Problem Formulation	182
9.3	Computational Fluid Dynamic Modeling	185
9.3.1	Governing Equations	185
9.3.2	Numerical Modeling	188
9.4	Direct Optimization	195
9.4.1	Gradient-Based Methods	196
9.4.2	Derivative-Free Methods	197
9.5	Surrogate-Based Optimization	197
9.5.1	The Concept	197
9.5.2	Surrogate Modeling	198
9.5.3	Optimization Techniques	200
9.6	Summary	204
	References	205
10	Evolutionary Algorithms Applied to Multi-Objective Aerodynamic Shape Optimization	211
	Alfredo Arias-Montaño, Carlos A. Coello Coello, Efrén Mezura-Montes	
10.1	Introduction	212
10.2	Basic Concepts	213
10.2.1	Pareto Dominance	214
10.2.2	Pareto Optimality	214
10.2.3	Pareto Front	215
10.3	Multi-Objective Aerodynamic Shape Optimization	215
10.3.1	Problem Definition	215

10.3.2	Surrogate-Based Optimization	216
10.3.3	Hybrid MOEA Optimization	219
10.3.4	Robust Design Optimization	220
10.3.5	Multi-Disciplinary Design Optimization	222
10.3.6	Data Mining and Knowledge Extraction	224
10.4	A Case Study	226
10.4.1	Objective Functions	226
10.4.2	Geometry Parameterization	226
10.4.3	Constraints	229
10.4.4	Evolutionary Algorithm	229
10.4.5	Results	233
10.5	Conclusions and Final Remarks	236
	References	237
11	An Enhanced Support Vector Machines Model for Classification and Rule Generation	241
	Ping-Feng Pai, Ming-Fu Hsu	
11.1	Basic Concept of Classification and Support Vector Machines	241
11.2	Data Preprocessing	245
11.2.1	Data Cleaning	245
11.2.2	Data Transformation	245
11.2.3	Data Reduction	246
11.3	Parameter Determination of Support Vector Machines by Meta-heuristics	247
11.3.1	Genetic Algorithm	247
11.3.2	Immune Algorithm	248
11.3.3	Particle Swarm Optimization	249
11.4	Rule Extraction Form Support Vector Machines	250
11.5	The Proposed Enhanced SVM Model	252
11.6	A Numerical Example and Empirical Results	253
11.7	Conclusion	255
	References	256
12	Benchmark Problems in Structural Optimization	259
	Amir Hossein Gandomi, Xin-She Yang	
12.1	Introduction to Benchmark Structural Design	259
12.1.1	Structural Engineering Design and Optimization	260
12.2	Classifications of Benchmarks	261
12.3	Design Benchmarks	262
12.3.1	Truss Design Problems	262
12.3.2	Non-truss Design Problems	268
12.4	Discussions and Further Research	278
	References	279
	Author Index	283