

# Contents

## Part I Fundamentals

<b>1</b>	<b>Introduction</b>	3
1.1	Why to Optimize?	3
1.2	Kinds of Optimization Problems	5
1.3	How to Optimize?	6
	References	10
<b>2</b>	<b>Global Optimization and Its Applications</b>	11
2.1	Introduction	11
2.2	Stochastic or Deterministic ?	12
2.3	Considerations about General Global Optimization Tasks	13
2.4	Some Popular Approaches and Final Comments	18
	References	20
<b>3</b>	<b>Metaheuristic Methods</b>	21
3.1	Introduction	21
3.2	Genetic Algorithms	23
3.3	Particle Swarm Optimization	24
3.4	Differential Evolution	25
3.5	Cross-Entropy Method	26
3.6	Simulated Annealing	27
	References	30

## Part II ASA, Fuzzy ASA and Their Characteristics

<b>4</b>	<b>Adaptive Simulated Annealing</b>	33
4.1	Introduction	33
4.1.1	LICENSE and Contributions	34
4.1.2	Organization of Chapter	34
4.2	Theoretical Foundations of Adaptive Simulated Annealing (ASA)	35

4.2.1	Shades of Simulated Annealing .....	35
4.2.2	Critics of SA .....	36
4.2.3	“Standard” Simulated Annealing (SA) .....	36
4.2.4	Boltzmann Annealing (BA) .....	36
4.2.5	Simulated Quenching (SQ) .....	39
4.2.6	Fast Annealing (FA) .....	40
4.2.7	Adaptive Simulated Annealing (ASA) .....	40
4.2.8	VFSR and ASA .....	44
4.3	Practical Implementation of ASA .....	44
4.3.1	Generating Probability Density Function .....	44
4.3.2	Acceptance Probability Density Function .....	45
4.3.3	Reannealing Temperature Schedule .....	45
4.3.4	QUENCH_PARAMETERS=FALSE .....	46
4.3.5	QUENCH_COST=FALSE .....	47
4.3.6	QUENCH_COST_SCALE=TRUE .....	47
4.4	Tuning Guidelines .....	47
4.4.1	The Necessity for Tuning .....	47
4.4.2	Construction of the Code .....	48
4.4.3	Motivations for Tuning Methodology .....	50
4.4.4	Some Rough But Useful Guidelines .....	50
4.4.5	Quenching .....	52
4.4.6	Options for Large Spaces .....	53
4.4.7	Shunting to Local Codes .....	54
4.4.8	Judging Importance-Sampling .....	55
4.4.9	User References .....	55
4.5	Adaptive OPTIONS .....	56
4.5.1	VFSR .....	56
4.5.2	ASA_FUZZY .....	56
4.6	Multiple Systems .....	56
4.6.1	SELF_OPTIMIZE .....	56
4.6.2	ASA_PARALLEL .....	57
4.6.3	TRD Example of Multiple Systems .....	57
4.7	Conclusion .....	58
	References .....	59
5	<b>Unconstrained Optimization .....</b>	63
5.1	Fuzzy ASA .....	63
5.2	Unconstrained (or Rectangular Constrained) Optimization Examples .....	67
5.2.1	Rastrigin Function .....	70
5.2.2	Schwefel Function .....	73
5.2.3	Ackley Function .....	76
5.2.4	Krishnakumar Function .....	78
5.2.5	Rosenbrock Function .....	80
5.2.6	Griewangk Function .....	83

5.2.7	Special Function 1 .....	85
5.2.8	Special Function 2 .....	88
5.3	Conclusion .....	92
	References .....	93
<b>6</b>	<b>Constrained Optimization</b> .....	95
6.1	Introduction .....	95
6.2	Constrained Global Optimization Using ASA and Fuzzy ASA .....	97
6.2.1	Function G01 .....	98
6.2.2	Function G02 .....	102
6.2.3	Function G03 .....	105
6.2.4	Function G04 .....	106
6.2.5	Function G05 .....	107
6.2.6	Function G06 .....	107
6.2.7	Function G07 .....	108
6.2.8	Function G08 .....	109
6.2.9	Function G09 .....	110
6.2.10	Function G10 .....	111
6.2.11	Function G11 .....	112
6.2.12	Function G12 .....	113
6.2.13	Function G13 .....	113
6.3	Conclusion .....	114
	References .....	115

### Part III Applications

<b>7</b>	<b>Applications to Signal Processing - Blind Source Separation</b> .....	119
7.1	Introduction .....	119
7.2	Implementation .....	124
7.3	Results .....	124
7.3.1	Example 1 - Separation by TSK MIMO System .....	124
7.3.2	Example 2 - Separation by TSK MIMO System .....	127
7.3.3	Example 3 - Separation by TSK MIMO System .....	128
7.3.4	Example 4 - Separation by TSK MIMO System .....	129
7.3.5	Example 5 - Mixture by PNL Model .....	132
7.4	Conclusion .....	137
	References .....	138
<b>8</b>	<b>Fuzzy Modeling with Fuzzy Adaptive Simulated Annealing</b> .....	139
8.1	Introduction .....	139
8.2	Affine Takagi-Sugeno Fuzzy Systems .....	140
8.3	The Fuzzy Modeling Problem .....	141
8.3.1	Approximation in Lower Dimensions .....	141
8.3.2	Approximation in Higher Dimensions .....	144

8.4 Ideas for Fuzzy Clustering Using ASA .....	145
8.5 Conclusions about the Presented Methods .....	147
References .....	148
<b>9 Statistical Estimation and Global Optimization .....</b>	<b>149</b>
9.1 Introduction .....	149
9.2 Maximum Likelihood Estimation with ASA .....	150
9.3 Implementation and Experiments .....	151
9.3.1 Exponential Distribution .....	152
9.3.2 Normal Distribution .....	156
9.3.3 Lognormal Distribution .....	157
9.3.4 Cauchy Distribution .....	158
9.3.5 Triangular Distribution .....	160
9.3.6 Mixture (Laplace and Uniform) Distribution .....	164
9.3.7 Gamma Distribution .....	164
9.4 Conclusions .....	166
References .....	167
<b>10 Nonlinear Equation Solving .....</b>	<b>169</b>
10.1 Introduction .....	169
10.2 Statement of the Problem .....	170
10.3 The Algorithm .....	171
10.4 Examples .....	172
10.4.1 Example 1 .....	172
10.4.2 Example 2 .....	176
10.4.3 Example 3 .....	178
10.4.4 Example 4 .....	181
10.4.5 Example 5 .....	181
10.4.6 Example 6 .....	182
10.4.7 Example 7 .....	184
10.5 Conclusions .....	184
References .....	187
<b>11 Space-Filling Curves and Fuzzy ASA .....</b>	<b>189</b>
11.1 Introduction .....	189
11.2 Key Results from General Topology, Ergodic and Measure Theories .....	190
11.3 Composing Space-Filling Curves and ASA .....	196
11.3.1 Algorithm Description .....	196
11.4 Experiments .....	197
11.5 Conclusions .....	199
References .....	201
<b>12 Epilogue .....</b>	<b>203</b>
12.1 Final Thoughts .....	203
<b>Index .....</b>	<b>205</b>