

---

# Contents

---

Preface	xix
Editor	xxiii
Contributors	xxv
<b>1 Ant Colony Optimization, Modifications, and Application</b>	<b>1</b>
<i>Pushpendra Singh, Nand K. Meena, and Jin Yang</i>	
1.1 Introduction	2
1.2 Standard ant system	2
1.2.1 Brief of ant colony optimization	2
1.2.2 How does the artificial ant select the edge to travel?	5
1.2.3 Pseudo-code of standard ACO algorithm	6
1.3 Modified variants of ant colony optimization	6
1.3.1 Elitist ant systems	6
1.3.2 Ant colony system	7
1.3.3 Max-min ant system	8
1.3.4 Rank based ant systems	9
1.3.5 Continuous orthogonal ant systems	9
1.4 Application of ACO to solve real-life engineering optimization problem	10
1.4.1 Problem description	10
1.4.2 Problem formulation	10
1.4.3 How can ACO help to solve this optimization problem?	11
1.4.4 Simulation results	12
1.5 Conclusion	13
<b>2 Artificial Bee Colony – Modifications and An Application to Software Requirements Selection</b>	<b>15</b>
<i>Bahriye Akay</i>	
2.1 Introduction	15
2.2 The Original ABC algorithm in brief	16
2.3 Modifications of the ABC algorithm	18
2.3.1 ABC with modified local search	18
2.3.2 Combinatorial version of ABC	19
2.3.3 Constraint handling ABC	21
2.3.4 Multi-objective ABC	22

2.4	Application of ABC algorithm for software requirement selection . . . . .	24
2.4.1	Problem description . . . . .	24
2.4.2	How can the ABC algorithm be used for this problem? . . . . .	24
2.4.2.1	Objective function and constraints . . . . .	24
2.4.2.2	Representation . . . . .	25
2.4.2.3	Local search . . . . .	25
2.4.2.4	Constraint handling and selection operator . . . . .	25
2.4.3	Description of the experiments . . . . .	25
2.4.4	Results obtained . . . . .	26
2.5	Conclusions . . . . .	27
	References . . . . .	27
<b>3</b>	<b>Modified Bacterial Foraging Optimization and Application</b> . . . . .	<b>29</b>
	<i>Neeraj Kanwar, Nand K. Meena, Jin Yang, and Sonam Parashar</i>	
3.1	Introduction . . . . .	30
3.2	Original BFO algorithm in brief . . . . .	31
3.2.1	Chemotaxis . . . . .	31
3.2.2	Swarming . . . . .	32
3.2.3	Reproduction . . . . .	32
3.2.4	Elimination and dispersal . . . . .	33
3.2.5	Pseudo-codes of the original BFO algorithm . . . . .	33
3.3	Modifications in bacterial foraging optimization . . . . .	34
3.3.1	Non-uniform elimination-dispersal probability distribution . . . . .	34
3.3.2	Adaptive chemotaxis step . . . . .	35
3.3.3	Varying population . . . . .	36
3.4	Application of BFO for optimal DER allocation in distribution systems . . . . .	36
3.4.1	Problem description . . . . .	36
3.4.2	Individual bacteria structure for this problem . . . . .	37
3.4.3	How can the BFO algorithm be used for this problem? . . . . .	37
3.4.4	Description of experiments . . . . .	38
3.4.5	Results obtained . . . . .	40
3.5	Conclusions . . . . .	40
<b>4</b>	<b>Bat Algorithm – Modifications and Application</b> . . . . .	<b>43</b>
	<i>Neeraj Kanwar, Nand K. Meena, and Jin Yang</i>	
4.1	Introduction . . . . .	44
4.2	Original bat algorithm in brief . . . . .	45
4.2.1	Random fly . . . . .	45
4.2.2	Local random walk . . . . .	45
4.3	Modifications of the bat algorithm . . . . .	46
4.3.1	Improved bat algorithm . . . . .	46
4.3.2	Bat algorithm with centroid strategy . . . . .	47

4.3.3	Self-adaptive bat algorithm (SABA) . . . . .	47
4.3.4	Chaotic mapping based BA . . . . .	48
4.3.5	Self-adaptive BA with step-control and mutation mechanisms . . . . .	48
4.3.6	Adaptive position update . . . . .	49
4.3.7	Smart bat algorithm . . . . .	49
4.3.8	Adaptive weighting function and velocity . . . . .	49
4.4	Application of BA for optimal DNR problem of distribution system . . . . .	50
4.4.1	Problem description . . . . .	50
4.4.2	How can the BA algorithm be used for this problem? . . . . .	50
4.4.3	Description of experiments . . . . .	52
4.4.4	Results . . . . .	53
4.5	Conclusion . . . . .	53
<b>5</b>	<b>Cat Swarm Optimization - Modifications and Application</b> . . . . .	<b>57</b>
	<i>Dorin Moldovan, Adam Slowik, Viorica Chifu, and Ioan Salomie</i>	
5.1	Introduction . . . . .	58
5.2	Original CSO algorithm in brief . . . . .	58
5.2.1	Description of the original CSO algorithm . . . . .	60
5.3	Modifications of the CSO algorithm . . . . .	61
5.3.1	Velocity clamping . . . . .	61
5.3.2	Inertia weight . . . . .	61
5.3.3	Mutation operators . . . . .	62
5.3.4	Acceleration coefficient $c_1$ . . . . .	62
5.3.5	Adaptation of CSO for diets recommendation . . . . .	63
5.4	Application of CSO algorithm for recommendation of diets . . . . .	63
5.4.1	Problem description . . . . .	63
5.4.2	How can the CSO algorithm be used for this problem? . . . . .	64
5.4.3	Description of experiments . . . . .	67
5.4.4	Results obtained . . . . .	68
5.4.4.1	Diabetic diet experimental results . . . . .	68
5.4.4.2	Mediterranean diet experimental results . . . . .	69
5.5	Conclusions . . . . .	70
	References . . . . .	71
<b>6</b>	<b>Chicken Swarm Optimization - Modifications and Application</b> . . . . .	<b>75</b>
	<i>Dorin Moldovan and Adam Slowik</i>	
6.1	Introduction . . . . .	76
6.2	Original CSO algorithm in brief . . . . .	76
6.2.1	Description of the original CSO algorithm . . . . .	77
6.3	Modifications of the CSO algorithm . . . . .	79
6.3.1	Improved Chicken Swarm Optimization (ICSO) . . . . .	79
6.3.2	Mutation Chicken Swarm Optimization (MCSO) . . . . .	79

6.3.3	Quantum Chicken Swarm Optimization (QCSO) . . .	80
6.3.4	Binary Chicken Swarm Optimization (BCSO) . . . . .	80
6.3.5	Chaotic Chicken Swarm Optimization (CCSO) . . . . .	80
6.3.6	Improved Chicken Swarm Optimization - Rooster Hen Chick (ICSO-RHC) . . . . .	81
6.4	Application of CSO for detection of falls in daily living activities	81
6.4.1	Problem description . . . . .	81
6.4.2	How can the CSO algorithm be used for this problem?	82
6.4.3	Description of experiments . . . . .	83
6.4.4	Results obtained . . . . .	84
6.4.5	Comparison with other classification approaches . . .	86
6.5	Conclusions . . . . .	87
	References . . . . .	88
<b>7</b>	<b>Cockroach Swarm Optimization – Modifications and Application</b>	<b>91</b>
	<i>Joanna Kwiecien</i>	
7.1	Introduction . . . . .	91
7.2	Original CSO algorithm in brief . . . . .	92
7.2.1	Pseudo-code of CSO algorithm . . . . .	92
7.2.2	Description of the original CSO algorithm . . . . .	93
7.3	Modifications of the CSO algorithm . . . . .	95
7.3.1	Inertia weight . . . . .	95
7.3.2	Stochastic constriction coefficient . . . . .	95
7.3.3	Hunger component . . . . .	95
7.3.4	Global and local neighborhoods . . . . .	96
7.4	Application of CSO algorithm for traveling salesman problem	96
7.4.1	Problem description . . . . .	96
7.4.2	How can the CSO algorithm be used for this problem?	97
7.4.3	Description of experiments . . . . .	99
7.4.4	Results obtained . . . . .	99
7.5	Conclusions . . . . .	100
	References . . . . .	100
<b>8</b>	<b>Crow Search Algorithm - Modifications and Application</b>	<b>103</b>
	<i>Adam Slowik and Dorin Moldovan</i>	
8.1	Introduction . . . . .	103
8.2	Original CSA in brief . . . . .	104
8.3	Modifications of CSA . . . . .	105
8.3.1	Chaotic Crow Search Algorithm (CCSA) . . . . .	105
8.3.2	Modified Crow Search Algorithm (MCSA) . . . . .	106
8.3.3	Binary Crow Search Algorithm (BCSA) . . . . .	107
8.4	Application of CSA for jobs status prediction . . . . .	107
8.4.1	Problem description . . . . .	107
8.4.2	How can CSA be used for this problem? . . . . .	110

8.4.3	Experiments description . . . . .	112
8.4.4	Results . . . . .	114
8.5	Conclusions . . . . .	115
	References . . . . .	116
<b>9</b>	<b>Cuckoo Search Optimisation – Modifications and Application</b>	<b>119</b>
	<i>Dhanraj Chitara, Nand K. Meena, and Jin Yang</i>	
9.1	Introduction . . . . .	120
9.2	Original CSO algorithm in brief . . . . .	120
9.2.1	Breeding behavior of cuckoo . . . . .	120
9.2.2	Levy flights . . . . .	121
9.2.3	Cuckoo search optimization algorithm . . . . .	121
9.3	Modified CSO algorithms . . . . .	123
9.3.1	Gradient free cuckoo search . . . . .	123
9.3.2	Improved cuckoo search for reliability optimization problems . . . . .	123
9.4	Application of CSO algorithm for designing power system stabilizer . . . . .	124
9.4.1	Problem description . . . . .	124
9.4.2	Objective function and problem formulation . . . . .	124
9.4.3	Case study on two-area four machine power system . . . . .	126
9.4.4	Eigenvalue analysis of TAFM power system without and with PSSs . . . . .	126
9.4.5	Time-domain simulation of TAFM power system . . . . .	127
9.4.6	Performance indices results and discussion of TAFM power system . . . . .	128
9.5	Conclusion . . . . .	129
<b>10</b>	<b>Improved Dynamic Virtual Bats Algorithm for Identifying a Suspension System Parameters</b>	<b>133</b>
	<i>Ali Osman Topal</i>	
10.1	Introduction . . . . .	133
10.2	Original Dynamic Virtual Bats Algorithm (DVBA) . . . . .	134
10.3	Improved Dynamic Virtual Bats Algorithm (IDVBA) . . . . .	136
10.3.1	The weakness of DVBA . . . . .	136
10.3.2	Improved Dynamic Virtual Bats Algorithm (IDVBA) . . . . .	136
10.4	Application of IDVBA for identifying a suspension system . . . . .	138
10.5	Conclusions . . . . .	142
<b>11</b>	<b>Dispersive Flies Optimisation: Modifications and Application</b>	<b>145</b>
	<i>Mohammad Majid al-Rifaie, Hooman Oroojeni M. J., and Mihalis Nicolaou</i>	
11.1	Introduction . . . . .	145
11.2	Dispersive flies optimisation . . . . .	147

11.3	Modifications in DFO	149
11.3.1	Update equation	149
11.3.2	Disturbance threshold, $\Delta$	150
11.4	Application: Detecting false alarms in ICU	151
11.4.1	Problem description	152
11.4.2	Using dispersive flies optimisation	153
11.4.3	Experiment setup	154
11.4.3.1	Model configuration	154
11.4.3.2	DFO configuration	155
11.4.4	Results	156
11.5	Conclusions	158
	References	158
<b>12</b>	<b>Improved Elephant Herding Optimization and Application</b>	<b>163</b>
	<i>Nand K. Meena and Jin Yang</i>	
12.1	Introduction	163
12.2	Original elephant herding optimization	164
12.2.1	Clan updating operator	165
12.2.2	Separating operator	165
12.3	Improvements in elephant herding optimization	165
12.3.1	Position of leader elephant	166
12.3.2	Separation of male elephant	166
12.3.3	Chaotic maps	166
12.3.4	Pseudo-code of improved EHO algorithm	167
12.4	Application of IEHO for optimal economic dispatch of microgrids	168
12.4.1	Problem statement	168
12.4.2	Application of EHO to solve this problem	170
12.4.3	Application in Matlab and source-code	170
12.5	Conclusions	172
	Acknowledgement	173
	References	173
<b>13</b>	<b>Firefly Algorithm: Variants and Applications</b>	<b>175</b>
	<i>Xin-She Yang</i>	
13.1	Introduction	175
13.2	Firefly algorithm	176
13.2.1	Standard FA	176
13.2.2	Special cases of FA	177
13.3	Variants of firefly algorithm	178
13.3.1	Discrete FA	178
13.3.2	Chaos-based FA	179
13.3.3	Randomly attracted FA with varying steps	180
13.3.4	FA via Lévy flights	180
13.3.5	FA with quaternion representation	181

13.3.6 Multi-objective FA . . . . .	181
13.3.7 Other variants of FA . . . . .	182
13.4 Applications of FA and its variants . . . . .	183
13.5 Conclusion . . . . .	184
References . . . . .	184
<b>14 Glowworm Swarm Optimization - Modifications and Applications</b>	<b>187</b>
<i>Krishnanand Kaipa and Debasish Ghose</i>	
14.1 Introduction . . . . .	187
14.2 Brief description of GSO . . . . .	188
14.3 Modifications to GSO formulation . . . . .	189
14.3.1 Behavior switching modification . . . . .	189
14.3.2 Local optima mapping modification . . . . .	191
14.3.3 Coverage maximization modification . . . . .	192
14.3.4 Physical robot modification . . . . .	193
14.4 Engineering applications of GSO . . . . .	194
14.4.1 Application of behavior switching to multiple source localization and boundary mapping . . . . .	194
14.4.2 Application of local optima mapping modification to clustering . . . . .	196
14.4.3 Application of coverage maximization modification to wireless networks . . . . .	196
14.4.4 Application of physical robot modification to signal source localization . . . . .	197
14.5 Conclusions . . . . .	199
References . . . . .	200
<b>15 Grasshopper Optimization Algorithm - Modifications and Applications</b>	<b>203</b>
<i>Szymon Łukasik</i>	
15.1 Introduction . . . . .	203
15.2 Description of the original Grasshopper Optimization Algorithm . . . . .	204
15.3 Modifications of the GOA technique . . . . .	206
15.3.1 Adaptation to other optimization domains . . . . .	206
15.3.2 Structural modifications . . . . .	207
15.3.3 Hybrid algorithms . . . . .	207
15.4 Application example: GOA-based clustering . . . . .	208
15.4.1 Clustering and optimization . . . . .	208
15.4.2 Experimental setting and results . . . . .	209
15.5 Conclusion . . . . .	211
References . . . . .	212

<b>16 Grey Wolf Optimizer – Modifications and Applications</b>	<b>215</b>
<i>Ahmed F. Ali and Mohamed A. Tawhid</i>	
16.1 Introduction . . . . .	216
16.2 Original GWO algorithm in brief . . . . .	216
16.2.1 Description of the original GWO algorithm . . . . .	217
16.3 Modifications of the GWO algorithm . . . . .	218
16.3.1 Chaotic maps . . . . .	218
16.3.2 Chaotic grey wolf operator . . . . .	218
16.4 Application of GWO algorithm for engineering optimization problems . . . . .	219
16.4.1 Engineering optimization problems . . . . .	219
16.4.1.1 Welded beam design problem . . . . .	219
16.4.1.2 Pressure vessel design problem . . . . .	220
16.4.1.3 Speed reducer design problem . . . . .	221
16.4.1.4 Three-bar truss design problem . . . . .	222
16.4.1.5 Tension compression spring problem . . . . .	223
16.4.2 Description of experiments . . . . .	223
16.4.3 Convergence curve of CGWO with engineering optimization problems . . . . .	223
16.4.4 Comparison between CGWO and GWO with engineering optimization problems . . . . .	224
16.5 Conclusions . . . . .	225
References . . . . .	225
<b>17 Hunting Search Optimization Modification and Application</b>	<b>229</b>
<i>Ferhat Erdal, Osman Tunca, and Erkan Dogan</i>	
17.1 Introduction . . . . .	229
17.2 Original HuS algorithm in brief . . . . .	230
17.2.1 Description of the original hunting search algorithm . . . . .	230
17.3 Improvements in the hunting search algorithm . . . . .	234
17.4 Applications of the algorithm to the welded beam design problem . . . . .	234
17.4.1 Problem description . . . . .	234
17.4.2 How can the hunting search algorithm be used for this problem? . . . . .	235
17.4.3 Description of experiments . . . . .	237
17.4.4 Result obtained . . . . .	237
17.5 Conclusions . . . . .	239
References . . . . .	239
<b>18 Krill Herd Algorithm – Modifications and Applications</b>	<b>241</b>
<i>Ali R. Kashani, Charles V. Camp, Hamed Tohidi, and Adam Slowik</i>	
18.1 Introduction . . . . .	242
18.2 Original KH algorithm in brief . . . . .	242
18.3 Modifications of the KH algorithm . . . . .	244



18.3.1	Chaotic KH . . . . .	244
18.3.2	Levy-flight KH . . . . .	245
18.3.3	Multi-stage KH . . . . .	246
18.3.4	Stud KH . . . . .	247
18.3.5	KH with linear decreasing step . . . . .	247
18.3.6	Biography-based krill herd . . . . .	248
18.4	Application of KH algorithm for optimum design of retaining walls . . . . .	249
18.4.1	Problem description . . . . .	249
18.4.2	How can KH algorithm be used for this problem? . . .	250
18.4.3	Description of experiments . . . . .	252
18.4.4	Results obtained . . . . .	252
18.5	Conclusions . . . . .	254
	References . . . . .	254
<b>19</b>	<b>Modified Monarch Butterfly Optimization and Real-life Applications</b>	<b>257</b>
	<i>Pushpendra Singh, Nand K. Meena, and Jin Yang</i>	
19.1	Introduction . . . . .	258
19.2	Monarch butterfly optimization . . . . .	259
19.2.1	Migration operator . . . . .	259
19.2.2	Butterfly adjusting operator . . . . .	260
19.3	Modified monarch butterfly optimization method . . . . .	260
19.3.1	Modified migration operator . . . . .	261
19.3.2	Modified butterfly adjustment operator . . . . .	261
19.4	Algorithm of modified MBO . . . . .	262
19.5	Matlab source-code of GCMBO . . . . .	264
19.6	Application of GCMBO for optimal allocation of distributed generations . . . . .	265
19.6.1	Problem statement . . . . .	265
19.6.2	Optimization framework for optimal DG allocation . .	267
19.7	Conclusion . . . . .	269
<b>20</b>	<b>Particle Swarm Optimization – Modifications and Application</b>	<b>273</b>
	<i>Adam Slowik</i>	
20.1	Introduction . . . . .	273
20.2	Original PSO algorithm in brief . . . . .	274
20.2.1	Description of the original PSO algorithm . . . . .	274
20.3	Modifications of the PSO algorithm . . . . .	277
20.3.1	Velocity clamping . . . . .	277
20.3.2	Inertia weight . . . . .	277
20.3.3	Constriction coefficient . . . . .	278
20.3.4	Acceleration coefficients $c_1$ and $c_2$ . . . . .	278
20.4	Application of PSO algorithm for IIR digital filter design . .	279

20.4.1	Problem description . . . . .	279
20.4.2	How can the PSO algorithm be used for this problem? . . . . .	280
20.4.3	Description of experiments . . . . .	282
20.4.4	Results obtained . . . . .	282
20.5	Conclusions . . . . .	283
	References . . . . .	283
<b>21</b>	<b>Salp Swarm Algorithm: Modification and Application</b>	<b>285</b>
	<i>Essam H. Houssein, Ibrahim E. Mohamed , and Aboul Ella Hassanien</i>	
21.1	Introduction . . . . .	286
21.2	Salp Swarm Algorithm (SSA) in brief . . . . .	287
21.2.1	Inspiration analysis . . . . .	287
21.2.2	Mathematical model for salp chains . . . . .	287
21.3	Modifications of SSA . . . . .	289
21.3.1	Fuzzy logic . . . . .	289
21.3.2	Robust . . . . .	290
21.3.3	Simplex . . . . .	290
21.3.4	Weight factor and adaptive mutation . . . . .	290
21.3.5	Levy flight . . . . .	290
21.3.6	Binary . . . . .	291
21.3.7	Chaotic . . . . .	291
21.3.8	Multi-Objective Problems (MOPS) . . . . .	292
21.4	Application of SSA for welded beam design problem . . . . .	292
21.4.1	Problem description . . . . .	292
21.4.2	How can SSA be used to optimize this problem? . . . . .	293
21.4.3	Result obtained . . . . .	295
21.5	Conclusion . . . . .	295
	References . . . . .	296
<b>22</b>	<b>Social Spider Optimization – Modifications and Applications</b>	<b>301</b>
	<i>Ahmed F. Ali and Mohamed A. Tawhid</i>	
22.1	Introduction . . . . .	301
22.2	Original SSO algorithm in brief . . . . .	302
22.2.1	Description of the original SSO algorithm . . . . .	302
22.3	Modifications of the SSO algorithm . . . . .	305
22.3.1	Chaotic maps . . . . .	305
22.3.2	Chaotic female cooperative operator . . . . .	306
22.3.3	Chaotic male cooperative operator . . . . .	306
22.4	Application of SSO algorithm for an economic load dispatch problem . . . . .	306
22.4.1	Economic load dispatch problem . . . . .	306
22.4.2	Problem Constraints . . . . .	307
22.4.3	Penalty function . . . . .	307
22.4.4	How can the SSO algorithm be used for an economic load dispatch problem? . . . . .	308

22.4.5	Description of experiments	308
22.4.6	Results obtained	309
22.5	Conclusions	311
	References	311
<b>23</b>	<b>Stochastic Diffusion Search: Modifications and Application</b>	<b>313</b>
	<i>Mohammad Majid al-Rifaie and J. Mark Bishop</i>	
23.1	Introduction	313
23.2	SDS algorithm	314
23.3	Further modifications and adjustments	315
23.3.1	Recruitment Strategies	315
23.3.1.1	Passive recruitment mode	315
23.3.1.2	Active recruitment mode	316
23.3.1.3	Dual recruitment mode	316
23.3.1.4	Context sensitive mechanism	317
23.3.1.5	Context free mechanism	318
23.3.2	Initialisation and termination	318
23.3.3	Partial function evaluation	319
23.4	Application: Identifying metastasis in bone scans	320
23.4.1	Experiment setup	321
23.4.2	Results	322
23.4.3	Concluding remarks	324
23.5	Conclusion	325
	References	325
<b>24</b>	<b>Whale Optimization Algorithm – Modifications and Applications</b>	<b>331</b>
	<i>Ali R. Kashani, Charles V. Camp, Moein Armanfar, and Adam Slowik</i>	
24.1	Introduction	332
24.2	Original WOA algorithm in brief	332
24.3	Modifications of WOA algorithm	334
24.3.1	Chaotic WOA	334
24.3.2	Levy-flight WOA	334
24.3.3	Binary WOA	336
24.3.4	Improved WOA	337
24.4	Application of WOA algorithm for optimum design of shallow foundation	338
24.4.1	Problem description	338
24.4.2	How can WOA algorithm be used for this problem?	340
24.4.3	Description of experiments	341
24.4.4	Results obtained	342
24.5	Conclusions	343
	References	343
	<b>Index</b>	<b>345</b>