

## Contents

**List of Contributors** *xiii*

**Series Preface** *xv*

**Preface** *xvii*

**1 Metaheuristic Algorithms in Fuzzy Clustering** *1*

*Sourav De, Sandip Dey, and Siddhartha Bhattacharyya*

1.1 Introduction *1*

1.2 Fuzzy Clustering *1*

1.2.1 Fuzzy  $c$ -means (FCM) clustering *2*

1.3 Algorithm *2*

1.3.1 Selection of Cluster Centers *3*

1.4 Genetic Algorithm *3*

1.5 Particle Swarm Optimization *5*

1.6 Ant Colony Optimization *6*

1.7 Artificial Bee Colony Algorithm *7*

1.8 Local Search-Based Metaheuristic Clustering Algorithms *7*

1.9 Population-Based Metaheuristic Clustering Algorithms *8*

1.9.1 GA-Based Fuzzy Clustering *8*

1.9.2 PSO-Based Fuzzy Clustering *9*

1.9.3 Ant Colony Optimization-Based Fuzzy Clustering *10*

1.9.4 Artificial Bee Colony Optimization-Based Fuzzy Clustering *10*

1.9.5 Differential Evolution-Based Fuzzy Clustering *11*

1.9.6 Firefly Algorithm-Based Fuzzy Clustering *12*

1.10 Conclusion *13*

References *13*

**2 Hybrid Harmony Search Algorithm to Solve the Feature Selection for Data Mining Applications** *19*

*Laith Mohammad Abualigah, Mofleh Al-diabat, Mohammad Al Shinwan, Khaldoon Dhou, Bisan Alsalibi, Essam Said Hanandeh, and Mohammad Shehab*

2.1 Introduction *19*

2.2 Research Framework *21*

2.3 Text Preprocessing *22*

2.3.1	Tokenization	22
2.3.2	Stop Words Removal	22
2.3.3	Stemming	23
2.3.4	Text Document Representation	23
2.3.5	Term Weight (TF-IDF)	23
2.4	Text Feature Selection	24
2.4.1	Mathematical Model of the Feature Selection Problem	24
2.4.2	Solution Representation	24
2.4.3	Fitness Function	24
2.5	Harmony Search Algorithm	25
2.5.1	Parameters Initialization	25
2.5.2	Harmony Memory Initialization	26
2.5.3	Generating a New Solution	26
2.5.4	Update Harmony Memory	27
2.5.5	Check the Stopping Criterion	27
2.6	Text Clustering	27
2.6.1	Mathematical Model of the Text Clustering	27
2.6.2	Find Clusters Centroid	27
2.6.3	Similarity Measure	28
2.7	$k$ -means text clustering algorithm	28
2.8	Experimental Results	29
2.8.1	Evaluation Measures	29
2.8.1.1	F-measure Based on Clustering Evaluation	30
2.8.1.2	Accuracy Based on Clustering Evaluation	31
2.8.2	Results and Discussions	31
2.9	Conclusion	34
	References	34

### **3 Adaptive Position-Based Crossover in the Genetic Algorithm for Data Clustering 39**

*Arnab Gain and Prasenjit Dey*

3.1	Introduction	39
3.2	Preliminaries	40
3.2.1	Clustering	40
3.2.1.1	$k$ -means Clustering	40
3.2.2	Genetic Algorithm	41
3.3	Related Works	42
3.3.1	GA-Based Data Clustering by Binary Encoding	42
3.3.2	GA-Based Data Clustering by Real Encoding	43
3.3.3	GA-Based Data Clustering for Imbalanced Datasets	44
3.4	Proposed Model	44
3.5	Experimentation	46
3.5.1	Experimental Settings	46
3.5.2	DB Index	47
3.5.3	Experimental Results	49

3.6	Conclusion	51
	References	57
<b>4</b>	<b>Application of Machine Learning in the Social Network</b>	<b>61</b>
	<i>Belfin R. V., E. Grace Mary Kanaga, and Suman Kundu</i>	
4.1	Introduction	61
4.1.1	Social Media	61
4.1.2	Big Data	62
4.1.3	Machine Learning	62
4.1.4	Natural Language Processing (NLP)	63
4.1.5	Social Network Analysis	64
4.2	Application of Classification Models in Social Networks	64
4.2.1	Spam Content Detection	65
4.2.2	Topic Modeling and Labeling	65
4.2.3	Human Behavior Analysis	67
4.2.4	Sentiment Analysis	68
4.3	Application of Clustering Models in Social Networks	68
4.3.1	Recommender Systems	69
4.3.2	Sentiment Analysis	70
4.3.3	Information Spreading or Promotion	70
4.3.4	Geolocation-Specific Applications	70
4.4	Application of Regression Models in Social Networks	71
4.4.1	Social Network and Human Behavior	71
4.4.2	Emotion Contagion through Social Networks	73
4.4.3	Recommender Systems in Social Networks	74
4.5	Application of Evolutionary Computing and Deep Learning in Social Networks	74
4.5.1	Evolutionary Computing and Social Network	75
4.5.2	Deep Learning and Social Networks	75
4.6	Summary	76
	Acknowledgments	77
	References	78
<b>5</b>	<b>Predicting Students' Grades Using CART, ID3, and Multiclass SVM Optimized by the Genetic Algorithm (GA): A Case Study</b>	<b>85</b>
	<i>Debanjan Konar, Ruchita Pradhan, Tania Dey, Tejaswini Sapkota, and Prativa Rai</i>	
5.1	Introduction	85
5.2	Literature Review	87
5.3	Decision Tree Algorithms: ID3 and CART	88
5.4	Multiclass Support Vector Machines (SVMs) Optimized by the Genetic Algorithm (GA)	90
5.4.1	Genetic Algorithms for SVM Model Selection	92
5.5	Preparation of Datasets	93

5.6	Experimental Results and Discussions	95
5.7	Conclusion	96
	References	96
<b>6</b>	<b>Cluster Analysis of Health Care Data Using Hybrid Nature-Inspired Algorithms</b>	<b>101</b>
	<i>Kauser Ahmed P, Rishabh Agrawal</i>	
6.1	Introduction	101
6.2	Related Work	102
6.2.1	Firefly Algorithm	102
6.2.2	k-means Algorithm	103
6.3	Proposed Methodology	104
6.4	Results and Discussion	106
6.5	Conclusion	110
	References	111
<b>7</b>	<b>Performance Analysis Through a Metaheuristic Knowledge Engine</b>	<b>113</b>
	<i>Indu Chhabra and Gunmala Suri</i>	
7.1	Introduction	113
7.2	Data Mining and Metaheuristics	114
7.3	Problem Description	115
7.4	Association Rule Learning	116
7.4.1	Association Mining Issues	116
7.4.2	Research Initiatives and Projects	116
7.5	Literature Review	117
7.6	Methodology	119
7.6.1	Phase 1: Pattern Search	120
7.6.2	Phase 2: Rule Mining	120
7.6.3	Phase 3: Knowledge Derivation	121
7.7	Implementation	121
7.7.1	Test Issues	121
7.7.2	System Evaluation	121
7.7.2.1	Indicator Matrix Formulation	122
7.7.2.2	Phase 1: Frequent Pattern Derivation	123
7.7.2.3	Phase 2: Association Rule Framing	123
7.7.2.4	Phase 3: Knowledge Discovery Through Metaheuristic Implementation	123
7.8	Performance Analysis	124
7.9	Research Contributions and Future Work	125
7.10	Conclusion	126
	References	126

<b>8</b>	<b>Magnetic Resonance Image Segmentation Using a Quantum-Inspired Modified Genetic Algorithm (QIANA) Based on FRCM</b>	<b>129</b>
	<i>Sunanda Das, Sourav De, Sandip Dey, and Siddhartha Bhattacharyya</i>	
8.1	Introduction	129
8.2	Literature Survey	131
8.3	Quantum Computing	133
8.3.1	Quoit-Quantum Bit	133
8.3.2	Entanglement	133
8.3.3	Measurement	133
8.3.4	Quantum Gate	134
8.4	Some Quality Evaluation Indices for Image Segmentation	134
8.4.1	F(I)	134
8.4.2	F'(I)	135
8.4.3	Q(I)	135
8.5	Quantum-Inspired Modified Genetic Algorithm (QIANA)-Based FRCM	135
8.5.1	Quantum-Inspired MEGA (QIANA)-Based FRCM	136
8.6	Experimental Results and Discussion	139
8.7	Conclusion	147
	References	147
<b>9</b>	<b>A Hybrid Approach Using the <i>k</i>-means and Genetic Algorithms for Image Color Quantization</b>	<b>151</b>
	<i>Marcos Roberto e Souza, Anderson Carlos Sousa e Santos, and Helio Pedrini</i>	
9.1	Introduction	151
9.2	Background	152
9.3	Color Quantization Methodology	154
9.3.1	Crossover Operators	157
9.3.2	Mutation Operators	158
9.3.3	Fitness Function	158
9.4	Results and Discussions	159
9.5	Conclusions and Future Work	168
	Acknowledgments	168
	References	168
	<b>Index</b>	<b>173</b>