
Contents

1 Swarm Intelligence in Data Mining

<i>Crina Grosan, Ajith Abraham and Monica Chis</i>	1
1.1 Biological Collective Behavior	1
1.2 Swarms and Artificial Life	4
1.2.1 Particle Swarm Optimization (PSO)	4
1.2.2 Ant Colonies Optimization	9
1.3 Data mining	10
1.3.1 Steps of Knowledge Discovery.....	10
1.4 Swarm Intelligence and Knowledge Discovery	11
1.5 Ant Colony Optimization and Data mining	15
1.6 Conclusions	16
References	16

2 Ants Constructing Rule-Based Classifiers

<i>David Martens, Manu De Backer, Raf Haesen, Bart Baesens, Tom Holvoet</i>	21
2.1 Introduction	21
2.2 Ant Systems and Data Mining	22
2.2.1 Ant Systems	22
2.2.2 Data Mining	24
2.2.3 Data Mining with Ant Systems	25
2.3 AntMiner+	27
2.3.1 The Construction Graph	28
2.3.2 Edge Probabilities	29
2.3.3 Heuristic Value	29
2.3.4 Pheromone Updating	30
2.3.5 Early Stopping	32
2.4 Distributed Data Mining With AntMiner+:	
a Credit Scoring Case	33
2.5 Experiments and Results	34
2.5.1 Experimental Set-Up	34
2.5.2 Datasets	35

Credit Scoring	35
Toy Problems	36
2.5.3 Software Implementation	38
2.5.4 Discussion	39
2.6 Conclusion and Future Research	40
References	41
3 Performing Feature Selection with ACO	
<i>Richard Jensen</i>	45
3.1 Introduction	45
3.2 Rough Feature Selection	47
3.2.1 Theoretical Background	47
3.2.2 Reduction Method	48
3.3 Fuzzy-Rough Feature Selection	50
3.3.1 Fuzzy Equivalence Classes	50
3.3.2 Fuzzy Lower and Upper Approximations	51
3.3.3 Fuzzy-Rough Reduction Method	52
3.3.4 A Worked Example	53
3.4 Ant-based Feature Selection	56
3.4.1 ACO Framework	57
3.4.2 Feature Selection	58
Selection Process	59
Complexity Analysis	59
Pheromone Update	60
3.5 Crisp Ant-based Feature Selection Evaluation	60
3.5.1 Experimental Setup	61
3.5.2 Experimental Results	62
3.6 Fuzzy Ant-based Feature Selection Evaluation	63
3.6.1 Web Classification	63
System Overview	63
Experimentation and Results	65
3.6.2 Systems Monitoring	66
Comparison of Fuzzy-Rough Methods	68
Comparison with Entropy-based Feature Selection	69
Comparison with the use of PCA	70
Comparison with the use of a Support Vector Classifier	70
3.7 Conclusion	71
References	72
4 Simultaneous Ant Colony Optimization Algorithms for Learning Linguistic Fuzzy Rules	
<i>Michelle Galea, Qiang Shen</i>	75
4.1 Introduction	75
4.2 Background	76
4.2.1 Fuzzy Rules and Rule-Based Systems	76

Fuzzy Sets and Operators	77
Linguistic Variables and Fuzzy Rules	78
Classification using Fuzzy Rules	79
A Rule-Matching Example	80
4.2.2 Ant Colony Optimization and Rule Induction	81
4.3 Simultaneous Fuzzy Rule Learning	84
4.3.1 Why Simultaneous Rule Learning	84
4.3.2 <i>FRANTIC-SRL</i>	86
Rule Construction	86
Heuristic	87
Pheromone Updating	88
Transition Rule	88
Rule Evaluation	89
4.4 Experiments and Analyses	90
4.4.1 Experiment Setup	90
The Datasets	90
Other Induction Algorithms	91
<i>FRANTIC-SRL</i> Parameters	92
4.4.2 Saturday Morning Problem Results	93
4.4.3 Water Treatment Plant Results	93
4.5 Conclusions and Future Work	95
References	97

5 Ant Colony Clustering and Feature Extraction for Anomaly Intrusion Detection

<i>Chi-Ho Tsang, Sam Kwong</i>	101
5.1 Introduction	101
5.2 Related Works	103
5.3 Ant Colony Clustering Model	104
5.3.1 Basics and Problems of Ant-based Clustering Approach	104
5.3.2 Measure of Local Regional Entropy	106
5.3.3 Pheromone Infrastructure	107
5.3.4 Modified Short-term Memory and α -adaptation	109
5.3.5 Selection Scheme, Parameter Settings and Cluster Retrieval	110
5.4 Experiments and Results	111
5.4.1 Dataset Description and Preprocessing	111
5.4.2 Metrics of Cluster Validity and Classification Performance	112
5.4.3 Cluster Analysis on Benchmark Datasets	114
5.4.4 ACCM with Feature Extraction for Intrusion Detection	116
5.5 Conclusions	120
5.6 Future Works	121
References	121

6 Particle Swarm Optimization for Pattern Recognition and Image Processing	
<i>Mahamed G.H. Omran, Andries P. Engelbrecht, Ayed Salman</i>	125
6.1 Introduction	125
6.2 Background	126
6.2.1 The clustering problem	126
The <i>K</i> -means Algorithm	128
The Fuzzy C-means Algorithm	129
Swarm Intelligence Approaches	130
6.2.2 Color Image Quantization	130
6.2.3 Spectral Unmixing	132
Linear Pixel Unmixing (or Linear Mixture Modeling)	132
Selection of the End-Members	133
6.3 Particle Swarm Optimization	134
6.4 A PSO-based Clustering Algorithm with Application to Unsupervised Image Classification	135
6.4.1 Experimental Results	137
6.5 A PSO-based Color Image Quantization (PSO-CIQ) Algorithm	138
6.5.1 Experimental Results	140
6.6 The PSO-based End-Member Selection (PSO-EMS) Algorithm	141
6.6.1 The Generation of Abundance Images	143
6.6.2 Experimental results	143
6.7 Conclusion	148
References	148
7 Data and text mining with hierarchical clustering ants	
<i>Hanene Azzag, Christiane Guinot, Gilles Venturini</i>	153
7.1 Introduction	153
7.2 Biological and computer models	154
7.2.1 Ants based algorithms for clustering	154
7.2.2 Self-assembly in real ants	155
7.2.3 A computer model of ants self-assembly for hierarchical clustering	155
7.2.4 Self-assembly and robotics	157
7.3 Two stochastic and deterministic algorithms	158
7.3.1 Common principles	158
7.3.2 Stochastic algorithm: <i>AntTreeSTOCH</i>	158
7.3.3 Deterministic algorithm with no thresholds and no parameters :	
<i>AntTree_{NO-THRESHOLDS}</i>	161
7.3.4 Properties	162
7.4 Experimental results with numeric, symbolic and textual databases	164
7.4.1 Testing methodology	164
7.4.2 Parameters study	166
7.4.3 Tested algorithms	166
7.4.4 Results with numeric databases	168
7.4.5 Results with symbolic databases	168

7.4.6 Processing times	169
7.4.7 Comparison with biomimetic methods	170
7.4.8 Comparative study on textual databases	172
7.5 Real world applications	175
7.5.1 Human skin analysis	175
7.5.2 Web usage mining	177
7.5.3 Generation and interactive exploration of a portal site	179
7.6 Incremental clustering of a large data set	182
7.6.1 Principles of AntTree _{INC}	182
7.6.2 Results with incremental and large data sets	184
7.7 Conclusions	186
References	186

8 Swarm Clustering Based on Flowers Pollination by Artificial Bees

<i>Majid Kazemian, Yoosef Ramezani, Caro Lucas, Behzad Moshiri</i>	191
8.1 Introduction	191
8.2 Clustering	192
8.2.1 What is clustering?	192
8.2.2 Why swarm intelligence?	193
8.2.3 Swarm clustering	193
8.2.4 Some artificial models	194
8.3 FPAB	195
8.3.1 FPAB underlying algorithms	196
Picking up pollen	197
Pollinating	198
Natural selection	198
Merge algorithm	199
8.4 Experimental results	199
8.5 Conclusion and future works	200
References	201

9 Computer study of the evolution of ‘news foragers’ on the Internet

<i>Zsolt Palotai, Sándor Mandusitz, András Lőrincz</i>	203
9.1 Introduction	203
9.2 Related work	204
9.3 Forager architecture	205
9.3.1 Algorithms	206
9.3.2 Reinforcing agent	208
9.3.3 Foragers	209
9.4 Experimental results	210
9.4.1 Environment	210
9.4.2 Time lag and multiplication	210
9.4.3 Compartmentalization	211
9.5 Discussion	214
9.6 Conclusions	217

References	217
10 Data Swarm Clustering	
<i>Christian Veenhuis, Mario Köppen</i>	221
10.1 Introduction	221
10.2 Data Clustering	223
10.3 Flock Algorithms	223
10.4 Particle Swarm Optimization	225
10.5 Data Swarm Clustering	226
10.5.1 Initialization	227
10.5.2 Iteration	228
10.5.3 Cluster Retrieval	234
10.6 Experimental Setup	234
10.6.1 Synthetic Datasets	234
10.6.2 Real Life Datasets	236
10.6.3 Parameters	236
10.7 Results	237
10.8 Conclusion	240
References	241
11 Clustering Ensemble Using ANT and ART	
<i>Yan Yang, Mohamed Kamel, Fan Jin</i>	243
11.1 Introduction	243
11.2 Ant Colony Clustering Algorithm with Validity Index (ACC-VI)	245
11.2.1 Ant Colony Clustering Algorithm	245
11.2.2 Clustering Validity Index	247
11.2.3 ACC-VI Algorithm	248
11.3 ART Algorithm	249
11.4 Clustering Ensemble Model	253
11.4.1 Consensus Functions	253
11.4.2 ART Ensemble Aggregation Model	253
11.5 Experimental Analysis	255
11.5.1 Artificial Data Set (2D3C)	256
11.5.2 Real Data Set (Iris)	256
11.5.3 Reuter-21578 Document Collection	258
11.6 Conclusions	262
Acknowledgements	262
References	262
Index	265