

CONTENTS

FOREWORD	xiii
PREFACE	xvii
ABOUT THE AUTHORS	xxi
1 INTRODUCTION	1
1.1 Background / 1	
1.2 Components and Features of Case-Based Reasoning / 2	
1.2.1 CBR System versus Rule-Based System / 4	
1.2.2 CBR versus Human Reasoning / 5	
1.2.3 CBR Life Cycle / 6	
1.3 Guidelines for the Use of Case-Based Reasoning / 9	
1.4 Advantages of Using Case-Based Reasoning / 9	
1.5 Case Representation and Indexing / 11	
1.5.1 Case Representation / 12	
1.5.2 Case Indexing / 15	
1.6 Case Retrieval / 15	
1.7 Case Adaptation / 18	
1.8 Case Learning and Case-Base Maintenance / 19	
1.8.1 Learning in CBR Systems / 19	
1.8.2 Case-Base Maintenance / 20	
1.9 Example of Building a Case-Based Reasoning System / 21	

- 1.9.1 Case Representation / 23
- 1.9.2 Case Indexing / 23
- 1.9.3 Case Retrieval / 24
- 1.9.4 Case Adaptation / 25
- 1.9.5 Case-Base Maintenance / 26
- 1.10 Case-Based Reasoning: Methodology or Technology? / 26
- 1.11 Soft Case-Based Reasoning / 27
 - 1.11.1 Fuzzy Logic / 29
 - 1.11.2 Neural Networks / 30
 - 1.11.3 Genetic Algorithms / 30
 - 1.11.4 Some CBR Tasks for Soft Computing Applications / 30
- 1.12 Summary / 31
- References / 32

2 CASE REPRESENTATION AND INDEXING 34

- 2.1 Introduction / 34
- 2.2 Traditional Methods of Case Representation / 37
 - 2.2.1 Relational Representation / 38
 - 2.2.2 Object-Oriented Representation / 40
 - 2.2.3 Predicate Representation / 41
 - 2.2.4 Comparison of Case Representations / 42
- 2.3 Soft Computing Techniques for Case Representation / 43
 - 2.3.1 Case Knowledge Representation Based on Fuzzy Sets / 43
 - 2.3.2 Rough Sets and Determining Reducts / 46
 - 2.3.3 Prototypical Case Generation Using Reducts with Fuzzy Representation / 52
- 2.4 Case Indexing / 63
 - 2.4.1 Traditional Indexing Method / 63
 - 2.4.2 Case Indexing Using a Bayesian Model / 64
 - 2.4.3 Case Indexing Using a Prototype-Based Neural Network / 69
 - 2.4.4 Case Indexing Using a Three-Layered Back Propagation Neural Network / 71
- 2.5 Summary / 72
- References / 73

3 CASE SELECTION AND RETRIEVAL 75

- 3.1 Introduction / 75
- 3.2 Similarity Concept / 76

- 3.2.1 Weighted Euclidean Distance / 76
- 3.2.2 Hamming and Levenshtein Distances / 78
- 3.2.3 Cosine Coefficient for Text-Based Cases / 78
- 3.2.4 Other Similarity Measures / 79
- 3.2.5 k -Nearest Neighbor Principle / 80
- 3.3 Concept of Fuzzy Sets in Measuring Similarity / 80
 - 3.3.1 Relevance of Fuzzy Similarity in Case Matching / 81
 - 3.3.2 Computing Fuzzy Similarity Between Cases / 85
- 3.4 Fuzzy Classification and Clustering of Cases / 90
 - 3.4.1 Weighted Intracluster and Intercluster Similarity / 91
 - 3.4.2 Fuzzy ID3 Algorithm for Classification / 92
 - 3.4.3 Fuzzy c -Means Algorithm for Clustering / 96
- 3.5 Case Feature Weighting / 98
 - 3.5.1 Using Gradient-Descent Technique and Neural Networks / 99
 - 3.5.2 Using Genetic Algorithms / 102
- 3.6 Case Selection and Retrieval Using Neural Networks / 105
 - 3.6.1 Methodology / 106
 - 3.6.2 Glass Identification / 108
- 3.7 Case Selection Using a Neuro-Fuzzy Model / 109
 - 3.7.1 Selection of Cases and Class Representation / 110
 - 3.7.2 Formulation of the Network / 111
- 3.8 Case Selection Using Rough-Self Organizing Map / 120
 - 3.8.1 Pattern Indiscernibility and Fuzzy Discretization of Feature Space / 120
 - 3.8.2 Methodology for Generation of Reducts / 121
 - 3.8.3 Rough SOM / 122
 - 3.8.4 Experimental Results / 124
- 3.9 Summary / 130
- References / 131

4 CASE ADAPTATION

136

- 4.1 Introduction / 136
- 4.2 Traditional Case Adaptation Strategies / 137
 - 4.2.1 Reinstantiation / 138
 - 4.2.2 Substitution / 139
 - 4.2.3 Transformation / 142
 - 4.2.4 Example of Adaptation Knowledge in Pseudocode / 143
- 4.3 Some Case Adaptation Methods / 143

x CONTENTS

- 4.3.1 Learning Adaptation Cases / 148
- 4.3.2 Integrating Rule- and Case-Based Adaptation Approaches / 149
- 4.3.3 Using an Adaptation Matrix / 149
- 4.3.4 Using Configuration Techniques / 150
- 4.4 Case Adaptation Through Machine Learning / 150
 - 4.4.1 Fuzzy Decision Tree / 151
 - 4.4.2 Back-Propagation Neural Network / 152
 - 4.4.3 Bayesian Model / 153
 - 4.4.4 Support Vector Machine / 154
 - 4.4.5 Genetic Algorithms / 158
- 4.5 Summary / 159
- References / 159

5 CASE-BASE MAINTENANCE 161

- 5.1 Introduction / 161
- 5.2 Background / 162
- 5.3 Types of Case-Base Maintenance / 163
 - 5.3.1 Qualitative Maintenance / 163
 - 5.3.2 Quantitative Maintenance / 165
- 5.4 Case-Base Maintenance Using a Rough-Fuzzy Approach / 166
 - 5.4.1 Maintaining the Client Case Base / 167
 - 5.4.2 Experimental Results / 182
 - 5.4.3 Complexity Issues / 186
- 5.5 Case-Base Maintenance Using a Fuzzy Integral Approach / 187
 - 5.5.1 Fuzzy Measures and Fuzzy Integrals / 188
 - 5.5.2 Case-Base Competence / 190
 - 5.5.3 Fuzzy Integral-Based Competence Model / 192
 - 5.5.4 Experiment Results / 195
- 5.6 Summary / 196
- References / 196

6 APPLICATIONS 201

- 6.1 Introduction / 201
- 6.2 Web Mining / 202
 - 6.2.1 Case Representation Using Fuzzy Sets / 202
 - 6.2.2 Mining Fuzzy Association Rules / 203
- 6.3 Medical Diagnosis / 205
 - 6.3.1 System Architecture / 205

6.3.2	Case Retrieval Using a Fuzzy Neural Network /	206
6.3.3	Case Evaluation and Adaptation Using Induction /	207
6.4	Weather Prediction /	209
6.4.1	Structure of the Hybrid CBR System /	209
6.4.2	Case Adaptation Using ANN /	209
6.5	Legal Inference /	213
6.5.1	Fuzzy Logic in Case Representation /	213
6.5.2	Fuzzy Similarity in Case Retrieval and Inference /	215
6.6	Property Valuation /	216
6.6.1	PROFIT System /	216
6.6.2	Fuzzy Preference in Case Retrieval /	217
6.7	Corporate Bond Rating /	219
6.7.1	Structure of a Hybrid CBR System Using GAs /	219
6.7.2	GA in Case Indexing and Retrieval /	220
6.8	Color Matching /	221
6.8.1	Structure of the Color-Matching Process /	221
6.8.2	Fuzzy Case Retrieval /	222
6.9	Shoe Design /	223
6.9.1	Feature Representation /	224
6.9.2	Neural Networks in Retrieval /	225
6.10	Other Applications /	226
6.11	Summary /	226
	References /	227

APPENDIXES 229

A FUZZY LOGIC 231

A.1	Fuzzy Subsets /	232
A.2	Membership Functions /	234
A.3	Operations on Fuzzy Subsets /	236
A.4	Measure of Fuzziness /	236
A.5	Fuzzy Rules /	237
A.5.1	Definition /	238
A.5.2	Fuzzy Rules for Classification /	238
	References /	240

B ARTIFICIAL NEURAL NETWORKS 242

B.1	Architecture of Artificial Neural Networks /	243
B.2	Training of Artificial Neural Networks /	244

xii CONTENTS

- B.3 ANN Models / 246
 - B.3.1 Single-Layered Perceptron / 246
 - B.3.2 Multilayered Perceptron Using a Back-Propagation Algorithm / 247
 - B.3.3 Radial Basis Function Network / 249
 - B.3.4 Kohonen Neural Network / 251
- References / 252

C GENETIC ALGORITHMS **253**

- C.1 Basic Principles / 253
- C.2 Standard Genetic Algorithm / 254
- C.3 Examples / 256
 - C.3.1 Function Maximization / 256
 - C.3.2 Traveling Salesman Problem / 259
- References / 260

D ROUGH SETS **262**

- D.1 Information Systems / 262
- D.2 Indiscernibility Relation / 264
- D.3 Set Approximations / 265
- D.4 Rough Membership / 266
- D.5 Dependency of Attributes / 267
- References / 268

INDEX **271**