

Contents

Foreword	v
Uncertainty Modeling	1
Chapter 1. The Game-Theoretic Framework for Probability	3
1. Introduction	3
2. The Origins of Cournot's Principle	4
3. Ville's Theorem	5
4. The Game-Theoretic Framework	7
5. Extending the Classical Limit Theorems	9
6. The Idea of a Quasi-Universal Test	10
7. Defensive Forecasting	11
Chapter 2. Aggregated Likelihoods: a Comparative Approach	17
1. Introduction	17
2. Coherent Conditional Probabilities	19
3. Comparative Relations	21
Chapter 3. The Moment Problem for Finitely Additive Probabilities	33
1. Introduction	33
2. A Short Introduction to Lower Previsions	34
3. Formulation and Initial Solution of the Problem	35
4. The Natural Extension \underline{E}_m and m -Integrable Gambles	37
5. The Natural Extension of Lower and Upper Distribution Functions	41

5.1. A precise distribution function	41
5.2. Lower and upper distribution functions	42
6. The Information Given by the Lower and the Upper Distribution Functions	42
7. Conclusions	44
Chapter 4. Towards a General Theory of Conditional Decomposable Information Measures	47
1. Introduction	47
2. Kampé de Fériet Information Measures	49
3. Conditional Events	50
4. From Conditional Events to Conditional Information Measures	52
5. Coherent Conditional Information Measures and Their Characterization	56
Chapter 5. Discourse Interpretation as Model Selection — A Probabilistic Approach	61
1. Introduction	61
2. What is an Interpretation?	63
3. Proposing Interpretations	65
4. Probabilistic Formalism	67
4.1. Prior probability of an interpretation	68
4.2. Data Fit Between the Discourse and an Interpretation	69
4.3. Accounting for the Components of an Interpretation	69
5. Conclusion	71
Chapter 6. Elicitation of Expert Opinions for Constructing Belief Functions	75
1. Introduction	75
2. Background	77
2.1. The transferable belief model	77
2.1.1. Credal level	77
2.1.2. Pignistic level	78
2.2. Uncertainty measures	78
2.2.1. Nonspecificity measures	79
2.2.2. Conflict measures	79
2.2.3. Composite measures	79

2.3. Least commitment principle	80
3. Previous Works	80
3.1. Wong and Lingras' method	80
3.2. Bryson <i>et al.</i> ' method	82
4. Constructing Belief Functions from Qualitative Preferences	83
4.1. Main ideas	83
4.2. Mono-objective optimization model	84
4.3. Multiobjective optimization models	85
5. Conclusion	87
Chapter 7. Managing Decomposed Belief Functions	91
1. Introduction	91
2. Decomposition	93
3. Combining Simple Support Functions and Inverse Simple Support Functions	94
3.1. Two SSFs	94
3.2. One SSF and one ISSF	95
3.3. Two ISSFs	98
4. Clustering SSFs and ISSFs	100
5. Conclusions	101
Clustering, Classification and Summarization	105
Chapter 8. Generalized Naive Bayesian Modeling	107
1. The Naive Bayesian Classifier	107
2. t-OWA Operators	108
3. An Extended Bayesian Classifier	109
4. Algorithm for Learning Weights	111
5. An Illustrative Example	112
6. Retaining the Meanness	115
7. Conclusion	115
Chapter 9. Gustafson-Kessel-Like Clustering Algorithm Based on Typicality Degrees	117
1. Introduction	117
2. Fuzzy Clustering	118
3. Typicality Degrees	121

4. Typicality Degrees for Clustering	122
4.1. Justification	122
4.2. Proposed algorithm architecture	123
4.3. Assignment computation	123
4.4. Comparison measure choice	124
4.5. Aggregation operator choice	125
4.6. Overall algorithm	125
5. Numerical Experiments	126
5.1. Considered setup	126
5.2. Obtained results	127
6. Conclusion	129

Chapter 10. A Hierarchical Immune-Inspired Approach for Text Clustering **131**

1. Introduction	131
2. Semantic SOM	133
3. Adaptive Radius Immune Algorithm (ARIA)	134
3.1. The hierarchical approach	135
4. Similarity Metric	136
5. Computational Experiments	137
5.1. Sport and cookery	137
5.2. Brazilian newspaper	138
6. Discussion	141

Chapter 11. An Incremental Hierarchical Fuzzy Clustering for Category-Based News Filtering **143**

1. Introduction	143
2. History and Applications of Dissociative Recombination	145
3. The Rationale of the Proposal	147
4. The Hierarchical Fuzzy Clustering Algorithm	148
4.1. Feature selection	148
4.2. Generation of a hierarchy of fuzzy clusters	149
4.3. Determination of the number of clusters	150
4.4. Updating a fuzzy hierarchy	151
5. Evaluation Results	152
6. Conclusions	153

Chapter 12. Soft Mapping Between Hierarchical Classifications	155
1. Introduction	155
2. Instance Matching	157
2.1. Example — news stories	159
3. Hierarchy Matching	160
4. Application to Film Databases	163
4.1. Results on unseen data	165
5. Summary	165
Chapter 13. On Linguistic Summarization of Time Series Using Fuzzy Logic with Linguistic Quantifiers	169
1. Introduction	169
2. Temporal Data and Trend Analysis	172
3. Dynamic Characteristics of Trends	174
4. Linguistic Data Summaries	176
5. Protoforms of Linguistic Trend Summaries	178
6. The use of Zadeh's Calculus of Linguistically Quantified Propositions	179
7. Numerical Experiments	180
8. Concluding Remarks	184
Chapter 14. A Possible Worlds Interpretation of Label Semantics	187
1. Introduction	187
2. The Label Semantics Framework	190
3. The Possible Worlds Model	192
4. Conclusions	198
Decision Making and Information Processing	201
Chapter 15. Definition of an Importance Index for Bi-Capacities in Multi-Criteria Decision Analysis	203
1. Introduction	203
2. Preliminaries	205
2.1. Capacity and Choquet integral	205

2.2. Bi-capacity	206
3. Definition of a Value for Bi-Cooperative Games	206
4. Importance Index	210
4.1. Definition of the importance index in $Q_{S,T}(N)$	211
4.2. Mean importance value	213
5. Interpretation of the Importance Index	214
6. Conclusion	214
Chapter 16. A Fuzzy Constraint-Based Approach to the Analytic Hierarchy Process	217
1. Introduction	218
2. Earlier Work	219
3. An Approach using a Fuzzy-valued Reciprocal Matrix	219
3.1. Fuzzy reciprocal data matrix	219
3.2. Consistency	221
3.3. Unicity of the optimal weight pattern	222
4. An Example	224
5. Evaluating Decisions	225
6. Conclusions	226
Chapter 17. Using Different Transitivity Properties to Deal with Incomplete Fuzzy Preference Relations in Group Decision Making Environments	229
1. Introduction	230
2. Preliminaries	231
2.1. Fuzzy preference relations	231
2.2. Transitivity, consistency and completeness concepts	233
3. Consistency Measures Based on Different Transitivity Properties	234
4. Generalized Procedure to Estimate Missing Values	237
5. Conclusions and Future Works	239
Chapter 18. A Bargaining Agent Models Its Opponent with Entropy-Based Inference	243
1. Introduction	243
2. The Negotiating Agent: <i>NA</i>	245
2.1. Interaction protocol	245
2.2. Agent architecture	246

3. Estimating $\mathbf{P}(OPAcc(.))$	248
3.1. One issue — Without decay	249
3.2. One issue — With decay	250
3.2.1. Maximizing entropy with linear constraints	251
3.3. Two issues — Without decay	252
3.4. Two issues — With decay	253
4. Estimating $\mathbf{P}(NAAcc(.))$	254
5. Negotiation Strategies	255
6. Conclusions	256

Chapter 19. Comparison of Spatiotemporal Difference of Brain Activity Between Correct and Approximation Answer Choices on Addition **259**

1. Introduction	260
2. Experiments	261
2.1. Experimental apparatus and method	261
2.2. Stimulus conditions and presentations	261
3. Experimental Results	263
4. Discussion	269

Chapter 20. Overabundant Answers to Flexible Queries — A Proximity-Based Intensification Approach **273**

1. Introduction	273
2. Background	276
2.1. Absolute proximity relation	276
2.2. Dilation and erosion operations	276
2.2.1. Dilation operation	277
2.2.2. Erosion operation	277
3. Overabundant Answers	279
3.1. Problem definition	279
3.2. Intensifying atomic queries	280
3.3. Basic features of the approach	282
4. Comparison with Other Modifier-Based Approaches	283
5. Case of Conjunctive Flexible Queries	284
6. Conclusion	286

Systems Modeling and Applications	289
Chapter 21. Words or Numbers, Mamdani or Sugeno Fuzzy Systems: A Comparative Study	291
1. Introduction	291
2. Sugeno-Like Fuzzy Systems	293
2.1. Computation mechanism	293
2.2. Computing with fuzzy numbers	294
2.3. Computing with words	295
2.3.1. Notations	295
2.3.2. Mapping between words and numbers	296
2.3.3. Linguistic operations	297
3. Mamdani-Like Fuzzy Systems	298
3.1. Reasoning with fuzzy numbers	298
3.2. Reasoning with words	299
4. Illustration	300
5. Conclusion	304
Chapter 22. A New Method to Compare Dynamical Systems Modeled Using Temporal Fuzzy Models	307
1. Introduction	307
2. Introduction to TFMs	308
3. The Proposed Method of DSs Comparison	310
3.1. Obtaining the set of tendencies	311
3.2. Obtaining the sections of a tendency	311
3.3. Comparing sections	316
4. A Real Example	317
5. Conclusions	319
Chapter 23. Improvement of Approximation Properties of a First-Order Takagi-Sugeno Fuzzy System	321
1. Introduction	322
2. Review of ATS Model	322
3. Analysis of Shape-Failures of ATS Models	324
4. Fuzzy Partition Transformations Portfolio	325
5. Linear-Multilinear ATS Model	326
6. Linear-Multiquadratic ATS Model	327

7. Local Linear-Quadratic B-Spline Partitions	328
8. Example of a SISO ATS Model	330
9. Conclusions	331
Chapter 24. Knowledge and Time: A Framework for Soft Computing Applications in PHM	333
1. Introduction	333
2. PHM Functional Architecture	334
3. Decisions and Time Horizons	335
4. A Linguistics Metaphor	337
5. Knowledge and Time: A Framework	340
6. Decision Support for Maintenance and Logistics	341
6.1. Problem formulation and SC solution	341
6.2. Results	342
7. Conclusions	343
Chapter 25. A Multi-Granular Model for Direct E-Commerce Services	345
1. Introduction	345
2. Architecture Overview	346
3. Modeling View	348
4. Data Representation	351
5. The Clustering	353
6. Agents and the Data Mining Step	355
7. Conclusions	356
Chapter 26. Using the Fuzzy Spatial Relation “Between” to Segment the Heart in Computerized Tomography Images	359
1. Introduction	360
2. The Spatial Relation “Between”	362
3. Using “Between” to Segment the Heart	365
3.1. Definition of the region of interest	365
3.2. Segmentation using a deformable model	367
4. Results and Discussion	369
5. Conclusion and Future Work	370

Chapter 27. Neurofuzzy Network with On-Line Learning in Fault Detection of Dynamic Systems	375
1. Introduction	375
2. Fault Detection and Diagnosis	376
3. Driving System and Fault Modeling	378
4. Neurofuzzy Network	379
5. Identification of DC Driver System	381
6. Fault Detection and Diagnosis	382
7. Conclusion	385
Chapter 28. A New Hybrid Fusion Method for Diagnostic Systems	389
1. Introduction	389
2. Diagnostic System	391
2.1. The internal knowledge base	391
2.2. The external knowledge base	393
3. Fusion Method	394
3.1. Definition of the new external knowledge base which is deduced from the p source coupling	396
3.2. Selecting the referent linguistic term	397
3.3. Operator of the conflict measure	397
3.4. Confidence measure	398
4. Evaluation	399
5. Conclusion	400
Logic and Mathematical Structures	403
Chapter 29. Fuzzy Description Logic Programs	405
1. Introduction	405
2. Preliminaries	406
3. Fuzzy DLPs	412
4. Conclusions	414
Chapter 30. Imperfect Information Representation Through Extended Logic Programs in Bilattices	419
1. Introduction	419
2. Preliminaries	422

2.1. Bilattices	422
2.2. Extended programs	424
3. Extended Well-Founded Semantics of Extended Programs	425
3.1. Interpretations	425
3.2. Semantics of extended programs	426
3.3. Computing the extended well-founded semantics	429
4. Related Work and Concluding Remarks	430

Chapter 31. On n -Contractive Fuzzy Logics:

First Results 433

1. Introduction	434
2. Axiomatic Extensions of MTL and their Algebraization	435
3. The n -Contraction	440
4. New Results	441
4.1. n -contractive chains	441
4.2. Combining weakly cancellative and n -contractive fuzzy logics	442
4.3. Some properties of n -contractive fuzzy logics	443

Chapter 32. Geometric Representations of

Weak Orders 447

1. Introduction	447
2. The Hasse Diagram	448
3. Geometric Models of WO	451

Chapter 33. Lexicographic Composition of

Similarity-Based Fuzzy Orderings 457

1. Introduction	457
2. Preliminaries	458
3. Starting the Easy Way: One Crisp and One Fuzzy Ordering	460
4. Lexicographic Composition of Two Nontrivial Fuzzy Orderings	461
5. Conclusion	467

Chapter 34. Efficiently Updating and Tracking the Dominant Normalized Kernel

Principal Components 471

1. Introduction	471
2. The Laplacian Kernel Matrix	473

3. Updating the Eigenspace	474
4. DOWndating the Eigenspace	478
5. Tracking the Eigenspace	481
6. Performance Assessment	482
7. Numerical Stability and Further Benchmarking	483
8. Conclusions	483

Chapter 35. Topological Relations on Fuzzy Regions — An Extended Application of Intersection Matrices **487**

1. Introduction	487
2. Regions with Undetermined Boundaries	488
2.1. Related work	488
2.2. Fuzzy regions	488
2.2.1. Fuzzy set theory	488
2.2.2. Definition of a fuzzy region	489
2.2.3. Practical feasibility of fuzzy regions	489
3. Topological Relations	490
3.1. Nine-intersection model (crisp)	490
3.2. Intersection model for regions with undetermined boudaries	491
3.3. Fuzzy region intersection model	491
4. Defining the Fuzzy Region Topology	492
4.1. Defining the extended concepts	492
4.1.1. Intersection-operator for regions	494
4.2. Nine-intersection model for fuzzy regions	494
4.3. Interpretation	494
4.3.1. Crisp regions	494
4.3.2. Fuzzy regions	495
4.3.3. Example	497
5. Conclusion	498

Chapter 36. Quantifier Elimination Versus Generalized Interval Evaluation — A Comparison on a Specific Class of Quantified Constraints **501**

1. Introduction	501
2. Problem Statement	503
3. A Specific Quantifier Elimination	504

3.1.	Decomposition of the quantified distance constraint	504
3.1.1.	The constraint $c'_{a,r}(x)$	505
3.1.2.	The constraint $c''_{a,r}(x)$	505
3.2.	Interval arithmetic	506
4.	Generalized Interval Evaluation	506
4.1.	Generalized intervals and quantifiers	507
4.2.	The Kaucher arithmetic	508
4.3.	Generalized evaluation of an expression	509
5.	Comparison of the Two Methods	510
6.	Conclusion	512