

Table of Contents

1	Introduction	1
1.1	General Context	1
1.1.1	Problem Description	1
1.1.2	Proposed Solution	2
1.1.3	Outline of the Book	4
1.2	Fuzzy Systems	5
1.2.1	Basic Notions of Fuzzy Sets and Fuzzy Logic	5
1.2.2	Conditional Fuzzy Statements	8
1.2.3	Fuzzy Inference	10
1.2.4	Fuzzy Inference Systems	12
1.3	Evolutionary Computation	18
1.3.1	Genetic Algorithms	21
1.3.2	Genetic Programming	22
1.3.3	Evolution Strategies	23
1.3.4	Evolutionary Programming	24
1.3.5	Classifier Systems	25
2	Evolutionary Fuzzy Modeling	27
2.1	Fuzzy Modeling: The Art of Building Fuzzy Systems	28
2.1.1	The Fuzzy Modeling Problem	28
2.1.2	Approaches and Techniques	29
2.2	Evolutionary Fuzzy Modeling	32
2.2.1	Applying Evolution to Fuzzy Modeling	32
2.2.2	Three Approaches to Behavior and Structure Learning	33
2.3	Interpretability Considerations	34
2.3.1	Semantic Criteria	35
2.3.2	Syntactic Criteria	36
2.3.3	Strategies to Satisfy Semantic and Syntactic Criteria	37
2.4	Example: Medical Diagnosis	39
2.4.1	The Wisconsin Breast Cancer Diagnosis (WBCD) Problem	39
2.4.2	A Genetic-Fuzzy Approach to the WBCD Problem	41
2.4.3	Results	43
2.4.4	Diagnostic Confidence	46
2.4.5	Further Experiments	48

3	Coevolutionary Fuzzy Modeling	51
3.1	Coevolutionary Computation	51
3.2	Cooperative Coevolution	53
3.2.1	Issues Addressed by Cooperative Coevolution	53
3.2.2	Ancestral Work	54
3.2.3	A General Model for Cooperative Coevolution	54
3.3	Fuzzy CoCo	56
3.3.1	The Algorithm	57
3.3.2	Elitism	58
3.3.3	Fitness Evaluation	58
3.3.4	Interpretability Considerations	58
3.3.5	Other Cooperative Coevolutionary Approaches to Fuzzy Modeling	59
3.4	Application Example: The Iris Problem	60
3.4.1	Fisher's Iris Data	60
3.4.2	Application of Fuzzy CoCo to the Iris Problem	62
3.4.3	Results	65
3.5	Summary	69
4	Breast Cancer Diagnosis by Fuzzy CoCo	71
4.1	Breast-Biopsy Analysis: The WBCD Problem	71
4.1.1	The Evolutionary Setup	71
4.1.2	Results	73
4.2	Mammography Interpretation: The COBRA System	76
4.2.1	The Catalonia Mammography Database	76
4.2.2	Proposed Solution: The COBRA System	78
4.2.3	Fuzzy CoCo Setup	78
4.2.4	Results	83
5	Analyzing Fuzzy CoCo	89
5.1	A Stepwise Guide to Applying Fuzzy CoCo	89
5.2	Effects of Some Parameters on Performance	91
5.2.1	Number of Rules	92
5.2.2	Population Size	93
5.2.3	Number of Cooperators	93
5.2.4	Mutation Probability	94
5.2.5	Elitism Rate	95
5.2.6	Qualitative Relationships	96
5.3	Consistency and Quality of Results	96
5.4	Generality of the Designed Fuzzy Systems	98
5.4.1	Generality of Fuzzy Rules	99
5.4.2	Generality of the Systems Designed by Fuzzy CoCo	100
5.5	Summary	102

6	Extensions of the Methodology	103
6.1	Island Fuzzy CoCo	103
6.1.1	The Proposed Algorithm	104
6.1.2	Preliminary Tests of Island Fuzzy CoCo	106
6.2	Incremental Fuzzy CoCo	110
6.2.1	The Proposed Algorithm	111
6.2.2	Testing Incremental Fuzzy CoCo	112
7	Conclusions and Future Work	117
7.1	Summary	117
7.2	Original Contributions	118
7.3	Future Work	119
	Bibliography	123