

Contents

1	Decision Making in Complex Systems	1
1.1	Introduction	1
1.2	Modeling of Natural and Complex Phenomena	2
1.3	Complex Systems: Definition and Principal Characteristics	2
1.4	Decision Making and Decision Support Systems	5
1.4.1	Decision Making	5
1.4.2	The Evolution of Decision Support Systems	6
1.4.3	Decision Making in Complex Systems	9
1.5	Composite Decisions	11
1.6	Motivation	13
1.6.1	Frameworks for the Design of Decision Support Systems	13
1.6.2	The Need for an Interdisciplinary Approach	14
1.6.3	Multi-agent Paradigm for Complex Systems Modeling	15
2	A Review on Frameworks for Decision Support Systems	19
2.1	Introduction	19
2.2	Decision Support Systems in Academy and Research	20
2.3	Agent-Based Frameworks for Decision Support Systems	28
2.3.1	Frameworks for Multi-agent Systems Planning	28
2.3.2	Software Tools for Multi-agent Systems Design and Implementation	36
2.3.3	Comparison of Agent-Based Frameworks	43
3	Design and Implementation of the DeciMaS Framework	47
3.1	Introduction	47
3.2	The DeciMaS Framework	48
3.3	Approach towards Ontology Creation	48
3.4	The General Structure of the System	50

3.5	Description of the Ontological Basis of the Multi-agent Architecture	54
3.5.1	The Domain of Interest Ontology	55
3.5.2	The MAS Architecture Ontology	55
3.5.3	The Tasks Ontology	57
3.5.4	The Agent Ontology	57
3.5.5	The Interactions Ontology	58
3.5.6	The Distributed Meta-Ontology	59
3.6	Data Mining Methods in the DeciMaS Framework	60
3.6.1	Methods for Information Fusion and Preprocessing	63
3.6.2	Methods for Knowledge Discovery	68
3.6.3	Methods for Decision Generation	86
4	A Case Study for the DeciMaS Framework	89
4.1	Introduction	89
4.2	Human Health Environmental Impact Assessment	90
4.2.1	Environment and Human Health	90
4.2.2	Environmental Impact Assessment	92
4.3	Design of the Agent-Based Decision Support System	92
4.3.1	Meta-ontology of the System	92
4.3.2	Logical Levels of the ADSS	98
4.3.3	The Principal Abstractions of the System	100
4.4	Implementation in Jack	121
4.4.1	Program Architecture	121
4.4.2	Defining Agents in JACK	122
5	Data and Results	139
5.1	Introduction	139
5.2	Data for Experiment	140
5.2.1	Data Retrieval and Fusion	142
5.3	Information Fusion and Preprocessing	144
5.3.1	Detection and Elimination of Artifacts	144
5.3.2	Filling of Missing Values	145
5.3.3	Smoothing Results	146
5.3.4	Normalization Results	147
5.3.5	Results of the Correlation Analysis	147
5.3.6	Decomposition Results	148
5.4	Knowledge Discovery Results	150
5.4.1	Regression Models	150
5.4.2	Neural Network Models	152
5.4.3	Models Obtained with the Group Method of Data Handling	155
5.4.4	Committee Machines	157
5.4.5	Environmental Impact Assessment Results	159

5.5	Decision Making	161
5.6	Discussion of the Experiment	165
6	Conclusions	169
6.1	Conclusions	169
6.2	Future Work	171
	References	173