
Contents

Part I Information sharing and ontologies

1	Semantic integration	3
1.1	Syntactic standards	4
1.1.1	HTML: visualizing information	4
1.1.2	XML: exchanging information	5
1.1.3	RDF: a data model for meta-information	6
1.1.4	The roles of XML and RDF	8
1.2	The Problem of Heterogeneity	10
1.2.1	Structural Conflicts	10
1.2.2	Semantic Conflicts	12
1.3	Handling information semantics	14
1.3.1	Semantics from structure	15
1.3.2	Semantics from text	16
1.3.3	The need for explicit semantics	17
1.4	Representing and comparing semantics	19
1.4.1	Names and labels	20
1.4.2	Term networks	20
1.4.3	Concept lattices	21
1.4.4	Features and constraints	22
1.5	Conclusion	23
2	Ontology-based information sharing	25
2.1	Ontologies	25
2.1.1	Shared vocabularies and conceptualizations	26
2.1.2	Specification of context knowledge	27
2.1.3	Beneficial applications	29
2.2	Ontologies in information integration	31
2.2.1	Content explication	31
2.2.2	Additional roles of ontologies	34
2.3	A framework for information sharing	36

2.4	A translation approach to ontology alignment	39
2.4.1	The translation process	39
2.4.2	Required infrastructure	40
2.5	Conclusions	42
3	Ontology languages for the Semantic Web	45
3.1	An abstract view	45
3.2	Two Semantic Web ontology languages	47
3.2.1	RDF Schema	49
3.2.2	OWL Lite	50
3.2.3	OWL DL	52
3.2.4	OWL Full	53
3.2.5	Computational Complexity	54
3.2.6	Simple relations between ontologies	54
3.3	Other Web-based ontology languages	58
3.3.1	Languages for expressing ontology mappings	60
3.4	Conclusions	61

Part II Creating ontologies and metadata

4	Ontology creation	65
4.1	Ontological engineering	66
4.2	Building an ontology infrastructure for Information sharing ..	68
4.3	Applying the approach	70
4.3.1	The task to be solved	71
4.3.2	The Information Sources	72
4.3.3	Sources of knowledge	73
4.4	An example walkthrough	76
4.5	Conclusions	82
5	Metadata generation	85
5.1	The role of metadata	86
5.1.1	Use of metadata	87
5.1.2	Problems with metadata management	88
5.2	The WebMaster approach	90
5.2.1	BUISY: A Web based environmental information system	90
5.2.2	The WebMaster Workbench	91
5.2.3	Applying WebMaster to the BUISY system	93
5.3	Learning classification rules	97
5.3.1	Inductive logic programming	98
5.3.2	Applying inductive logic programming	100
5.3.3	Learning experiments	102
5.3.4	Extracted classification rules	106
5.4	Ontology deployment	110

5.4.1	Generating ontology-based metadata	111
5.4.2	Using ontology-based metadata	112
5.5	Conclusions	114
<hr/>		
Part III Retrieval, integration and querying		
<hr/>		
6	Retrieval and Integration	119
6.1	Semantic integration	120
6.1.1	Ontology heterogeneity	120
6.1.2	Multiple systems and translatability	122
6.1.3	Approximate re-classification	123
6.2	Concept-based filtering	125
6.2.1	The idea of query-rewriting	126
6.2.2	Boolean concept expressions	127
6.2.3	Query re-writing	129
6.3	Processing complex queries	131
6.3.1	Queries as concepts	132
6.3.2	Query relaxation	134
6.4	Examples from a case study	137
6.4.1	Concept approximations	137
6.4.2	Query relaxation	138
6.5	Conclusions	140
7	Sharing statistical information	143
7.1	The nature of statistical information	144
7.1.1	Statistical metadata	145
7.1.2	A basic ontology of statistics	146
7.2	Modelling Statistics	150
7.2.1	Statistics as views	150
7.2.2	Connection with the domain	151
7.3	Translation to Semantic Web languages	155
7.3.1	Ontologies	155
7.3.2	Description of information	159
7.4	Retrieving statistical information	162
7.5	Conclusions	164
8	Spatially-related information	167
8.1	Spatial representation and reasoning	168
8.1.1	Levels of spatial abstraction	168
8.1.2	Reasoning about spatial relations	169
8.2	Ontologies and spatial relevance	170
8.2.1	Defining Spatial Relevance	171
8.2.2	Combined spatial and terminological matching	172
8.2.3	Limitations	174

XVIII Contents

8.3	Graph-based reasoning about spatial relevance	175
8.3.1	Partonomies	176
8.3.2	Topology	178
8.3.3	Directions	179
8.3.4	Distances.....	180
8.4	Conclusions	182
9	Integration and retrieval systems	185
9.1	OntoBroker	186
9.1.1	F-Logic and its relation to OWL	187
9.1.2	Ontologies, sources and queries.....	189
9.1.3	Context transformation	191
9.2	OBSERVER	192
9.2.1	Query Processing in OBSERVER.....	193
9.2.2	Vocabulary integration	195
9.2.3	Query plan generation and selection	197
9.3	The BUSTER system	198
9.3.1	The use of shared vocabularies	200
9.3.2	Retrieving accommodation information.....	201
9.3.3	Spatial and temporal information.....	203
9.4	Conclusions	207

Part IV Distributed ontologies

10	Modularization	211
10.1	Motivation	212
10.1.1	Requirements	213
10.1.2	Our approach	213
10.1.3	Related work	214
10.2	Modular ontologies	216
10.2.1	Syntax and architecture	216
10.2.2	Semantics and logical consequence	217
10.3	Comparison with OWL.....	220
10.3.1	Simulating OWL import	220
10.3.2	Beyond OWL	223
10.4	Reasoning in modular ontologies	225
10.4.1	Atomic concepts and relations	225
10.4.2	Preservation of Boolean operators	225
10.4.3	Compilation and integrity	227
10.5	Conclusions	228

11 Evolution management	231
11.1 Change detection and classification	232
11.1.1 Determining harmless changes	232
11.1.2 Characterizing changes	233
11.1.3 Update management	235
11.2 Application in a case study	236
11.2.1 The WonderWeb case study	236
11.2.2 Modularization in the case study	238
11.2.3 Updating the models	239
11.3 Conclusions	240
<hr/>	
Part V Conclusions	
<hr/>	
12 Conclusions	245
12.1 Lessons learned	245
12.2 Assumptions and Limitations	248
12.2.1 Shared Vocabularies	248
12.2.2 On demand translation	249
12.2.3 Modular Ontologies	250
12.3 Where are we now?	251
12.4 Is that all there is?	252
A Proofs of theorems	255
A.1 Theorem 6.6	255
A.2 Theorem 6.11	255
A.3 Theorem 6.14	256
A.4 Theorem 10.9	256
A.5 Theorem 10.11	256
A.6 Lemma 11.1	259
A.7 Theorem 11.2	259
References	261
Index	275