

Contents

Part I

Preliminaries 1

1 Introduction 3

- 1.1 Motivation: Why Semantic Web? 4
- 1.2 A Framework for Semantic Web 5
- 1.3 Use Case: Translational Medicine Clinical Vignette 7
- 1.4 Scope and Organization 9

2 Use Case and Functional Requirements 11

- 2.1 Detailed Clinical Use Case 12
- 2.2 Stakeholders and Information Needs 13
- 2.3 Conceptual Architecture 15
- 2.4 Functional Requirements 17
- 2.5 Research Issues 18
- 2.6 Summary 19

Part II

Information Aspects of the Semantic Web 21

3 Semantic Web Content 23

- 3.1 Nature of Web Content 23
- 3.2 Nature of Semantic Web Content 24
- 3.3 Metadata 25
 - 3.3.1 Metadata Usage in Various Applications 26
 - 3.3.2 Metadata: A Tool for Describing and Modeling Information 27
- 3.4 Ontologies: Vocabularies and Reference Terms for Metadata 30
- 3.5 Summary 33

4 Metadata Frameworks 35

- 4.1 Examples of Metadata Frameworks 35
 - 4.1.1 XML-Based Metadata Framework 36
 - 4.1.2 RDF-Based Metadata Framework 36
 - 4.1.3 OWL-Based Metadata Framework 37
 - 4.1.4 WSMO-Based Metadata Framework 37
- 4.2 Two Perspectives: Data Models and Model-Theoretic Semantics 38

4.2.1	Data Models	38
4.2.2	Multiple Syntaxes for RDF: A Short Note	47
4.2.3	Model-Theoretic Semantics	48
4.3	Query Languages	51
4.3.1	Query Languages for XML Data	51
4.3.2	Query Languages for RDF Data	62
4.3.3	Extending Query Languages with Reasoning and Entailment	73
4.4	Clinical Scenario Revisited	74
4.4.1	Semantic Web Specifications: LIMS and EMR Data	74
4.4.2	Linking data from Multiple Data Sources	76
4.4.3	Advantages and Disadvantages of using Semantic Web Specifications	78
4.5	Summary	78
5	Ontologies and Schemas	79
5.1	What is an Ontology?	79
5.2	Ontology Representation Languages	84
5.2.1	XML Schema	84
5.2.2	RDF Schema	92
5.2.3	Web Ontology Language	100
5.2.4	The Web Service Modeling Ontology (WSMO)	112
5.2.5	Comparison of Ontology Representation Languages	118
5.3	Integration of Ontology and Rule Languages	122
5.3.1	Motivation and Requirements	122
5.3.2	Overview of Languages and Approaches	123
5.3.3	Semantic Web Rules Language	124
5.4	Clinical Scenario Revisited	126
5.4.1	A Domain Ontology for Translational Medicine	126
5.4.2	Integration of Ontologies and Rules for Clinical Decision Support	130
5.4.3	Advantages and Disadvantages of using Semantic Web Specifications	135
5.5	Summary	135
6	Ontology Authoring and Management	137
6.1	Ontology Building Tools	137
6.1.1	Ontology Editors: Brief Descriptions	138
6.1.2	Ontology Editors: A Comparative Evaluation	143
6.2	Ontology Bootstrapping Approaches	148
6.3	Ontology Merge and Integration Tools	150
6.3.1	Ontology Merge and Integration Tools: A Brief Description	151
6.3.2	Evaluation of Ontology Merge and Integration Tools	152
6.4	Ontology Engines and Reasoners	154

6.5	Clinical Scenario Revisited	157
6.6	Summary	158
7	Applications of Metadata and Ontologies	161
7.1	Tools and Techniques for Metadata Annotation	161
7.1.1	Requirements for Metadata Annotation	162
7.1.2	Tools and Technologies for Metadata Annotation	163
7.1.3	Comparative Evaluation	168
7.2	Techniques for Schema/Ontology Mapping	173
7.2.1	A Classification of Schema-matching Approaches	173
7.2.2	Schema-matching Techniques: Overview	179
7.3	Ontology Driven Information Integration	183
7.3.1	The Role of Ontologies in Information Integration	183
7.3.2	Ontology Representations Used in Information Integration	187
7.3.3	The Role of Mapping in Information Integration	188
7.3.4	The Role of Ontology Engineering in Information Integration	190
7.4	Summary	192
Part III		
Process Aspects of the Semantic Web		193
8	Communication	195
8.1	Communication Concepts	195
8.1.1	Fundamental Types	196
8.1.2	Formats and Protocols (FAP)	197
8.1.3	Separation of Interface and Logic	198
8.1.4	Communicating Parties	199
8.1.5	Mediation	201
8.1.6	Non-functional Aspects	202
8.2	Communication Paradigms	203
8.2.1	Client/Server (C/S)	204
8.2.2	Queueing	204
8.2.3	Peer-to-Peer (P2P)	205
8.2.4	Blackboard	205
8.2.5	Web Services	206
8.2.6	Representational State Transfer (REST)	207
8.2.7	Agents	207
8.2.8	Tuple Spaces	208
8.2.9	Co-location	208
8.2.10	Summary	209
8.3	Long-Running Communication	209
8.3.1	Business-to-Business (B2B) Protocols	210
8.3.2	Application-to-Application (A2A) Protocols	211

8.4	Web Services	211
8.5	Clinical Use Case	212
8.6	Summary	214
9	State of the Art in Web Services	215
9.1	History	215
9.2	Traditional Web Services	216
9.2.1	WSDL	217
9.2.2	SOAP	218
9.2.3	UDDI	219
9.2.4	Summary	219
9.3	Emerging Web Service Specifications (WS*-Stack)	220
9.3.1	Standards	220
9.3.2	Web Service Standards	221
9.3.3	Semantic-Web-Service-Related Standards	222
9.4	Service-oriented Architecture (SOA)	223
9.4.1	Service Paradigm	223
9.4.2	SOA and Web Services	224
9.4.3	Open Issues and Technical Challenges	224
9.5	Semantics and Web Services	226
9.5.1	Semantics, What Semantics?	227
9.5.2	Data Semantics	228
9.5.3	Process Semantics	229
9.5.4	Selection Semantics	229
9.5.5	Other Types of Semantics	230
9.6	Clinical Use Case	231
9.7	Summary	232
10	Web Service Composition	233
10.1	Composition	233
10.1.1	Motivation	233
10.1.2	Definition of Composition	235
10.1.3	Web Services and Composition	237
10.1.4	Choreography and Orchestration	238
10.2	Dynamic Composition	239
10.3	Business-to-Business Communication	240
10.4	Application-to-Application Communication	241
10.5	Complex Business Logic	242
10.6	Standards and Technologies	243
10.6.1	Web Services Business Process Execution Language (WS-BPEL)	244
10.6.2	Business Process Modeling Notation (BPMN)	245
10.6.3	Web Service Choreography Description Language (WS-CDL)	245
10.6.4	Java Business Integration (JBI)	246

10.7	Clinical Use Case	247
10.8	Summary	247
11	Semantic Web Services	249
11.1	Semantics of Web Services	249
11.1.1	Why Semantic Web Services?	249
11.1.2	Interface vs. Implementation	251
11.1.3	Modeling of State	251
11.2	Alternatives for Capturing Semantics of Web Services	253
11.2.1	Finite State Machines	253
11.2.2	Statechart Diagrams	254
11.2.3	Petri Nets	254
11.2.4	Process Algebras	256
11.3	Semantic Web Service Approaches	259
11.3.1	OWL-S	259
11.3.2	SWSF	261
11.3.3	WSDL-S	266
11.3.4	SAWSDL	268
11.3.5	WSMO, WSML and WSMX	269
11.4	Reasoning with Web Service Semantics	276
11.4.1	Discovery	276
11.4.2	Semantic Web Service Composition	281
11.4.3	Mediation	283
11.5	Clinical Use Case	285
11.6	Summary	286
Part IV		
Standards		287
12	Semantic Web Standards	289
12.1	Relevant Standards Organization	289
12.1.1	International Organization for Standardization (ISO)	289
12.1.2	International Electrotechnical Commission (IEC)	290
12.1.3	Organization for the Advancement of Structured Information Standards (OASIS)	290
12.1.4	World Wide Web Consortium (W3C)	290
12.1.5	International Engineering Task Force (IETF)	291
12.1.6	National Institute of Standards and Technology (NIST)	291
12.1.7	The Object Modeling Group (OMG)	291
12.1.8	Semantic Web Services Initiative (SWSI)	292
12.1.9	United States National Library of Medicine (NLM)	292
12.2	Semantic Web Content Standardization Efforts	293
12.2.1	Standard Generalized Markup Language (SGML)	293
12.2.2	eXtensible Markup Language (XML)	293
12.2.3	eXtensible Stylesheet Transformation Language (XSLT) ...	294

12.2.4	XPath	294
12.2.5	XQuery	294
12.2.6	XML Schema	294
12.2.7	Resource Description Framework (RDF)	295
12.2.8	SPARQL	295
12.2.9	RDF Schema	295
12.2.10	Web Ontology Language (OWL)	296
12.2.11	Rule-ML	296
12.2.12	Semantic Web Rules Language (SWRL)	296
12.2.13	Ontology Definition Metamodel (ODM)	296
12.2.14	Unified Modeling Language (UML)	297
12.2.15	Knowledge Interchange Format (KIF)	297
12.2.16	Open Knowledge Base Connectivity Protocol (OKBC)	297
12.2.17	DIG Description Logics Interface	297
12.2.18	OWL API	298
12.2.19	Standardized Vocabularies and Ontologies	298
12.3	Semantic Web Services Standardization Efforts	300
12.3.1	ISO-18629 Process Specification Language (PSL)	301
12.3.2	W3C Semantic Annotations for the Web Services Description Language (SAWSDL)	302
12.3.3	OWL-S	303
12.3.4	Web Services Modeling Ontology (WSMO)	303
12.3.5	Semantic Web Services Framework (SWSF)	304
12.3.6	WSDL-S	304
12.3.7	OASIS Semantic Execution Environment (SEE)	304
12.3.8	OASIS Service-Oriented Architecture Reference Model (SOA RM)	305
12.3.9	Semantic Web Services Architecture (SWSA)	306
12.3.10	Semantic Web Services Interest Group (SWS-IG)	307
12.4	Summary	307

Part V

Putting it All Together and Perspective 309

13 A Solution Approach to the Clinical Use Case 311

13.1	Service Discovery, Composition and Choreography	312
13.1.1	Specification of Clinical Workflow using WSMO	313
13.1.2	Data Structures in Data Flow	316
13.1.3	Data Mediation	319
13.1.4	Goal Definition	328
13.1.5	Discovery	331
13.1.6	Orchestration/Service Composition	333
13.1.7	Process and Protocol Mediation	339
13.2	Data and Knowledge Integration	342

13.2.1	Data Integration Services: WSMO/WSML Specification	343
13.2.2	Semantic Data Integration Architecture	344
13.2.3	A Domain Ontology for Translational Medicine	346
13.2.4	Use of RDF to represent Genomic and Clinical Data	351
13.2.5	The Integration Process	353
13.3	Decision Support	356
13.3.1	Decision Support Services: WSMO/WSML Specification ..	357
13.3.2	Architecture	358
13.3.3	Business Object Model Design	359
13.3.4	Rule Base Design	360
13.3.5	Definitions vs. Actions: Ontology Design	360
13.4	Knowledge Maintenance and Provenance	365
14	Outlook: The Good, the Bad and the Ugly?	369
14.1	The Good - Progress and Impact	369
14.2	The Bad - Major Obstacles to Overcome	371
14.3	The Ugly - Possible Prohibitors	372
Part VI		
References and Index		375
References		377
Index		405

The Semantic Web

Semantics for Data and Services on the Web

Kashyap, V.; Bussler, C.; Moran, M.

2008, XV, 414 p., Hardcover

ISBN: 978-3-540-76451-9