

Semantic Web Technologies

Review of Course Material

Jos de Bruijn
debruijn@inf.unibz.it

KRDB Research Group
Free University of Bolzano, Italy

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Outline

Ontologies

RDF(S)

SPARQL

OWL

F-Logic

FOAF, GRDDL, and Information Integration

Semantic Web Services

Semantic Web in Life Sciences – HCLSIG

Main Aspects

- ▶ Two ways of defining ontologies
 - ▶ Conceptual: a formal specification of a shared conceptualization
 - ▶ Elements of an ontology: concepts, relations, axioms, instances

Key Material

- ▶ **Slides!** lecture 1
- ▶ Ontology Development 101: http://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.html
- ▶ Recommended: Jos de Bruijn: Using Ontologies. DERI-TR-2003-10-29, 2003. <http://www.deri.org/publications/techpapers/documents/DERI-TR-2003-10-29.pdf>

Main Aspects

- ▶ RDF as a graph vs. RDF as a logical theory
- ▶ RDF, RDFS vocabularies
 - ▶ RDF Containers
 - ▶ RDFS meta-data properties
- ▶ RDFS as lightweight ontology language
- ▶ Semantic notions: subgraph, instance, entailment
- ▶ RDF simple entailment
 - ▶ If S' is an instance and S'' is a subgraph of S , then
$$S' \models_{\text{simple}} S''$$
 - ▶ Intuitively, subgraph matching with bNodes as existential variables
- ▶ RDFS entailment
 - ▶ Axiomatic triples
 - ▶ RDFS Entailment rules (not necessary to know by hart)
- ▶ Syntaxes
 - ▶ write **Turtle**
 - ▶ read RDF/XML

Key Material

- ▶ **Slides!** lectures 1,2,9
- ▶ RDF Primer: <http://www.w3.org/TR/rdf-primer/>
- ▶ RDF Semantics, Chapter 7:
<http://www.w3.org/TR/rdf-mt/>

Main Aspects

- ▶ Kinds of sparql queries
 - ▶ select, construct, ask
- ▶ Syntax of a select query
 - ▶ Basic, optional graph patterns, filters
- ▶ Query answers
- ▶ E-entailment regimes
- ▶ Basic Graph Pattern Matching

Key Material

- ▶ **Slides!** lecture 3,4
- ▶ Consult spec if slides unclear!
<http://www.w3.org/TR/rdf-sparql-query/>

Main Aspects

- ▶ OWL as more expressive ontology language
- ▶ Features of OWL
- ▶ Species of OWL: Lite, DL, Full
- ▶ OWL Lite/DL as Description Logic
- ▶ Layering issues with RDF(S)
- ▶ Layering of OWL species
- ▶ Description Logic Programs
 - ▶ Checking whether an OWL ontology is in this fragment
 - ▶ Considerations on expressiveness

Key Material

- ▶ **Slides!** lecture 5,6,9
- ▶ OWL Guide: <http://www.w3.org/TR/owl-guide/>
- ▶ Jos de Bruijn. Logics for the semantic web. In *Semantic Web Services: Theory, Tools and Applications*. IDEA Publishing, 2007. Sections 2 and 3.
- ▶ Ian Horrocks, Peter F. Patel-Schneider, and Frank van Harmelen. From SHIQ and RDF to OWL: The making of a web ontology language. **Journal of Web Semantics**, 1(1):7, 2003.

Main Aspects

- ▶ F-Logic (Programming) as Ontology and Rules language
- ▶ F-Logic syntax as explained on slides
- ▶ Quantification over class, attribute names
- ▶ F-Logic Semantics, key aspects
 - ▶ Indirection in interpreting classes, individuals
 - ▶ Relating individuals in domain with subsets (classes), functions (attributes)
- ▶ Encoding RDF in F-Logic
 - ▶ Possible issue with bNodes if skolemized
- ▶ Differences with OWL (DL)
 - ▶ Differences DL, LP
 - ▶ $::$ vs. \sqsubseteq

Key Material

- ▶ **Slides!** lecture 7,8,9
- ▶ Michael Kifer: Rules and Ontologies in F-Logic. Reasoning Web 2005: 22-34
- ▶ Jos de Bruijn. Logics for the semantic web. In Semantic Web Services: Theory, Tools and Applications. IDEA Publishing, 2007. Sections 4 and 5.

Main Aspects

- ▶ FOAF as RDF vocabulary for specifying social networks
- ▶ Extracting RDF from HTML/XML
 - ▶ Including RDF as comments
 - ▶ Linking to external file
 - ▶ Using GRDDL: Associating transformations with
 - ▶ Types of documents
 - ▶ Individual documents
- ▶ Basic information integration scenario (global-as-view)
 - ▶ Databases, connected to
 - ▶ single global ontology, with
 - ▶ additional constraints

Key Material

- ▶ **Slides!** lecture 10
- ▶ E. Dumbill: XML Watch: Finding friends with XML and RDF, 2002.
<http://www-128.ibm.com/developerworks/xml/library/x-foaf.html>
- ▶ GRDDL:
<http://www.idealliance.org/proceedings/xtech05/papers/03-06-01/>
- ▶ H-P. Schnurr, J. Angele: Automotive Industry Experience with Semantic Guides. ISWC 2005: 1029-1040

Main Aspects

- ▶ Problems with current Web Services technologies
 - ▶ advertising, discovery, selection, composition, ...
- ▶ Semantic Description of Service
 - ▶ Functional Description
 - ▶ **coarse-grained**, DL-style categorization
 - ▶ **fine-grained**, precondition/effect(postcondition)
 - ▶ Non-functional properties
- ▶ Notions of matching for DL-based discovery
 - ▶ exact, plugin, subsume, intersection, disjoint
- ▶ Web Service Modeling Ontology
 - ▶ Ontologies, Goals, Web services, Mediators
 - ▶ usage process

Key Material

- ▶ **Slides!** lecture 11
- ▶ J. de Bruijn, D. Fensel, U. Keller, and R. Lara. Using the web service modelling ontology to enable Semantic eBusiness. Communications of the ACM, special issue on the semantic e-business vision, 48(12):43-47, December 2005.
- ▶ (S. McIlraith, T.C. Son, H. Zeng: Semantic Web Services, in IEEE Intelligent Systems, Special Issue on the Semantic Web, 16(2): 46-53, March/April 2001.)
- ▶ (L. Li, I. Horrocks: A Software Framework For Matchmaking Based on Semantic Web Technology, in WWW2003.)

Main Aspects

- ▶ (potential) Benefits of Semantic Web technologies in LS
 - ▶ data integration
 - ▶ integrating data from scientific publications
 - ▶ URI as unique identifiers
 - ▶ RDFS and OWL as standard languages, abstracting from vendor-specific formats
 - ▶ reuse of existing ontologies
 - ▶ flexible combination and extension of vocabularies
 - ▶ clinical guidelines (decision support)
 - ▶ reasoning (e.g. consistency checking for improving quality)
- ▶ Limitations of Semantic Web technologies in LS
 - ▶ limited amount of the RDF data available
 - ▶ performance limitations in the RDF and OWL
 - ▶ problems in representing information about knowledge sources
 - ▶ lack of standardized rules language

Key Material

- ▶ **Slides!** lecture 12
- ▶ Ruttenberg, A. et al. Advancing translational research with the Semantic Web. BMC Bioinformatics, 2007, 8(Suppl 3):S2.