

# ISWC-2006 Tutorial Proposal: Semantic Web Rules with Ontologies, and their E-Services Applications

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## 1 Overview

**Goals:** Rules are a main emerging area of the Semantic Web. There has been significant progress in just the last three years in several aspects of Semantic Web rules. This includes exciting developments in the underlying knowledge representation formalisms as well as advances in integration of rules with ontologies; translations between heterogeneous commercial rule engines; development of open-source tools for inferencing and interoperability; standards proposals and efforts (including RuleML, SWRL, Semantic Web Service Framework, and recently W3C Rule Interchange Format); proposals for rule-based semantic Web services; and pilot applications in the emerging area of e-services.

This tutorial will provide an introduction to these developments and will explore techniques, applications, and challenges. We will also touch upon the issues of business value, adoption, investment, and strategy considerations.

**Potential Audience:** Most of the ISWC audience, especially those interested in rules and their applications in Semantic Web and semantic Web services in particular. This includes researchers interested in core technologies and developers interested in applications.

**Background Knowledge Required:** Helpful but not required are: the basics of logical knowledge representation (relational DBMS, logic programs, and/or first order logic); and the basics of XML, RDF, and OWL. (Much of the ISWC audience actually has this background.)

## 2 Detailed Outline

### A. Core - KR Languages & Standards (with examples throughout)

1. Intro
  - a. Overview and get acquainted
  - b. Uses of rules in current commercial systems and current semantic web
  - c. Current commercial rule systems:
    - Prolog, SQL databases, production rules (including Jess),  
event-condition-action rules, others
  - d. Current semantic web rule languages, systems, tools, and applications
  - e. Desired/envisioned uses of rules in semantic web, including services
  - f. High-level requirements for semantic web rules
  - g. Advantages and value of rules in IT systems/applications specification,  
development, maintenance, integration
2. Overview of Logical Knowledge Representations and Standards
  - a. First Order Logic (FOL), Logic Programs (LP), Description Logic (DL),  
Higher Order Logic (HOL)
  - b. Rule Markup/Modeling Language (RuleML), Semantic Web Rules Language (SWRL),  
Common Logic (formerly KIF), OWL, RDF
3. Horn Logic / Horn LP
  - KR theory, algorithms, computational complexity
4. Nonmonotonic LP
  - a. Negation As Failure: Ordinary LP (& pure Prolog)
  - b. Priorities: Courteous LP; Defeasible Logic; Inheritance
5. Procedural Attachments:
6. Production Rules
7. Frame Logic (F-Logic, F-Logic Programs)
8. Hilog and quasi higher-order expressiveness
9. Lloyd-Topor enriched connectives and quantifiers
10. Datatypes
11. RuleML and SWSL; WSML
12. Combining Rules with Ontologies
  - a. Overview of relationships:
    - Rules on top of ontologies, rules to represent ontologies,  
rules to map between ontologies.
  - b. Description Logic Programs and DLP-Fusion: overlap of LP and DL
  - c. SWRL Approach: OWL plus Horn expressiveness
  - d. Default Inheritance
  - e. Integrity Constraints
  - f. Hypermonotonic Reasoning
13. Other approaches and issues in current rule languages and systems
  - Existentials, equality, reification; SPARQL RDF query
14. W3C Rule Interchange Format standards effort
15. OMG Production Rule Representation standards effort

### B. Tools – SweetRules, Jena, cwm, and More

(organized as historical progression of tools:)

1. commercially important pre-SW rule systems

- system families; open source; rule management
- 2. Overview of SW Rule Generations:
- 3. 1st generation: Rudimentary Interoperability and XML/RDF Support
  - CommonRules, SweetRules V1, OWLJessKB
- 4. 2nd Generation: Rule Systems within RDF/OWL Toolkits
  - a. cwm and N3; builtins, incl. WS calls
  - b. Jena-2 (in detail)
  - c. list of other SW rules tools:
    - OO JDrew, Flora, hoolet, Triple, ...
- 5. 3rd Generation: SW Rule Integration and Life Cycle
  - SweetRules V2 (in detail)
    - integration capabilities and architecture,
      - standard rule+ontology repn's, more rule lifecycle support

### C. Applications in Services, including Policies, Contracts, Mediation & Integration

1. Applications in Semantic Web Services
  - high level concept, business motivations, application scenarios
  - SWSI's SWS Framework (SWSF), service descriptions
  - policies cluster of tasks in contracting, discovery, monitoring, etc.
  - process model cluster of tasks in composition etc.
  - WSMO, WSML, WSMX
2. Applications in Service Mediation:
  - Ontology/Context Translation and Info Integration
  - a. matching; expansion, enhanced expressiveness in ontology specification
  - b. Financial services, XBRL business reporting standard, accounting, ECOIN system, equational ontologies, context integration
3. Applications in End-to-End E-Contracting Services and Business Process Automation
  - a. pricing, ordering: in B2B/supply chain, B2C
  - b. SweetDeal Approach: rule-based contract modules; exception handling, negotiation, supply chains, auctions
  - c. Workflow, customer relationship management, more about monitoring
  - d. process ontologies/descriptions, Process Handbook
4. Applications in Authorization and Trust Services using Policies
  - a. Authorization, Security, Trust, Access Control, Privacy
    - examples: credit, health records; XACML, P3P, RBAC, Rei
  - b. Justifications and Proofs on semantic web; InferenceWeb
5. Prospective early adopter areas for semantic web rules in e-business, strategic considerations, market evolution, entrepreneurial opportunities
6. Windup and Discussion

### 3 Why of Interest; Justification

(To begin, see "Goals" in section 1.) Along with ontologies and RDF query/access, rules is the most important frontier area today for the Semantic Web's core technology and standards. There are a number of exciting research issues, most

semantic web researchers (and developers) are not yet up to speed in this area, yet this half-day tutorial to help them get there is quite doable.

The tutorial identifies and explains synergies between three major different areas of Semantic Web – rules, ontologies, and services – that are all foci of ISWC. It connects not only to the Research track of ISWC but also the Industrial track, in that it includes examples of real world deployments in tools and applications, and discusses a variety of business and standards aspects.

**Comment:** Groszof & Dean presented a similar Semantic Web Rules tutorial at ISWC-2005. It was quite successful, with about 60 participants staying for the entire session. It also got very good informal feedback from the participants to the speakers. The tutorial session itself was quite lively. Interestingly, the attendees were NOT the "usual suspects" already known to the presenters or active in Rules research - they were mainly new faces, and mainly not the people who attended the RuleML-2005 conference colocated with ISWC-2005.

## 4 Short CV of the Presenters

Benjamin Groszof is Assistant Professor in Information Technology (IT) at MIT Sloan School of Management. He focuses especially on the technologies, business applications, and strategies for Semantic Web Services (SWS), the convergence of Web Services and Semantic Web. The pioneer of inter-operable XML business rules, he co-founded the RuleML emerging industry standards design effort. He has led several fundamental contributions to knowledge representation theory and technologies in semantic web rules, including the development of Situated Courteous Logic Programs, their interoperability with production rules, and the SweetRules open source tool platform. His research also includes several application areas for rule-based SWS in business process automation: e-contracting, which he has pioneered; financial information and reporting; and business policies, e.g, for trust and security. He was Principal Investigator and Rules co-lead in the DARPA Agent Markup Language (DAML) program, and has had several leadership roles in the Semantic Web Services Initiative. He is an Invited Expert participant in the W3C Rule Interchange Format standards effort. Previous to joining MIT Sloan in 2000, he was a senior research scientist, in software, at IBM T.J. Watson Research Center (12 years there). He holds a PhD in Computer Science from Stanford University, and a BA in Applied Mathematics from Harvard University.

Prof. Groszof has given numerous research talks on the Semantic Web, and has developed and taught several course units on semantic web (focusing largely on rules and services) ranging in length from 1.5-hour to half-semester. He has presented conference tutorials at IJCAI-2001, EC-04, ISWC-2004, and ISWC-2005; has had senior conference organizing roles in WWW-2001, EC-03, and RuleML-2005; and was on the Senior PC of ISWC-2004.

Mike Dean is a Principal Engineer at BBN Technologies and was Principal Investigator for the DAML Integration and Transition effort within the DARPA Agent Markup Language (DAML) program. He chairs the Joint US/EU ad hoc

Markup Language Committee responsible for the DAML+OIL and SWRL languages, edited the OWL Web Ontology Language Reference, was a member of the W3C RDF Core and Web Ontology Working Groups, and is a member of the RuleML Steering Committee and the Architecture Committee of the Semantic Web Services Initiative. Dean is the developer of a number of Semantic Web tools and reference data sets and has been actively using SWRL in a variety of Semantic Web applications. He holds a B.S. in Computer Engineering from Stanford University.

Mr. Dean has given numerous talks on the Semantic Web, including an early tutorial "DAML+OIL for Application Developers". He gave, with Benjamin Grosz, a half-day ISWC-2005 Tutorial on "Semantic Web Rules with Ontologies, and their E-Services Applications" ( 60 attendees).

## 5 Support Material to be Given to the Attendees

A list of papers and resources available on the web will be provided to the attendees, in addition to the usual tutorial slideset of course.

The following papers, available on the web, cover the majority of the tutorial's content (additional ones are not listed here due to space constraints):

- "Representing E-Commerce Rules Via Situated Courteous Logic Programs in RuleML", by B. Grosz, Electronic Commerce Research and Applications (ECRA) 3(1):2-20, Spring 2004.
- "Semantic Web Services Framework" (SWSF), V1.0, by Battle, S., Bernstein, A., Boley, H., Grosz, B., Gruninger, M., Hull, R., Kifer, M., Martin, D., McIlraith, S., McGuinness, D., Su, J., and Tabet, S. (alphabetic), May 2005. Technical Report (~200 pages).
- "SweetDeal: Representing Agent Contracts with Exceptions using Semantic Web Rules, Ontologies, and Process Descriptions", by B. Grosz and T. Poon, International Journal of Electronic Commerce (IJEC) 8(4):61-98, Summer 2004.
- "Description Logic Programs: Combining Logic Programs with Description Logic", by B. Grosz, I. Horrocks, R. Volz, and S. Decker, Proc. 12th Intl. Conf. on the World Wide Web (WWW-2003), 2003.
- "SWRL: A Semantic Web Rules Language Combining OWL and RuleML", V0.7, by I. Horrocks, P. Patel-Schneider, H. Boley, S. Tabet, B. Grosz, and M. Dean, Nov. 2004. Technical Report and W3C Member Submission.
- RuleML website, especially design documents and list of tools. Ed. by H. Boley, B. Grosz, and S. Tabet, 2001-present.

## 6 Audio-Visual, Technical, and Room Requirements

None beyond the basics: an LCD projector. Some sort of a whiteboard or blackboard would be nice too, if that's possible.