FOL RuleML: Release, Use, and Outlook

Harold Boley, Presenter
NRC IIT e-Business

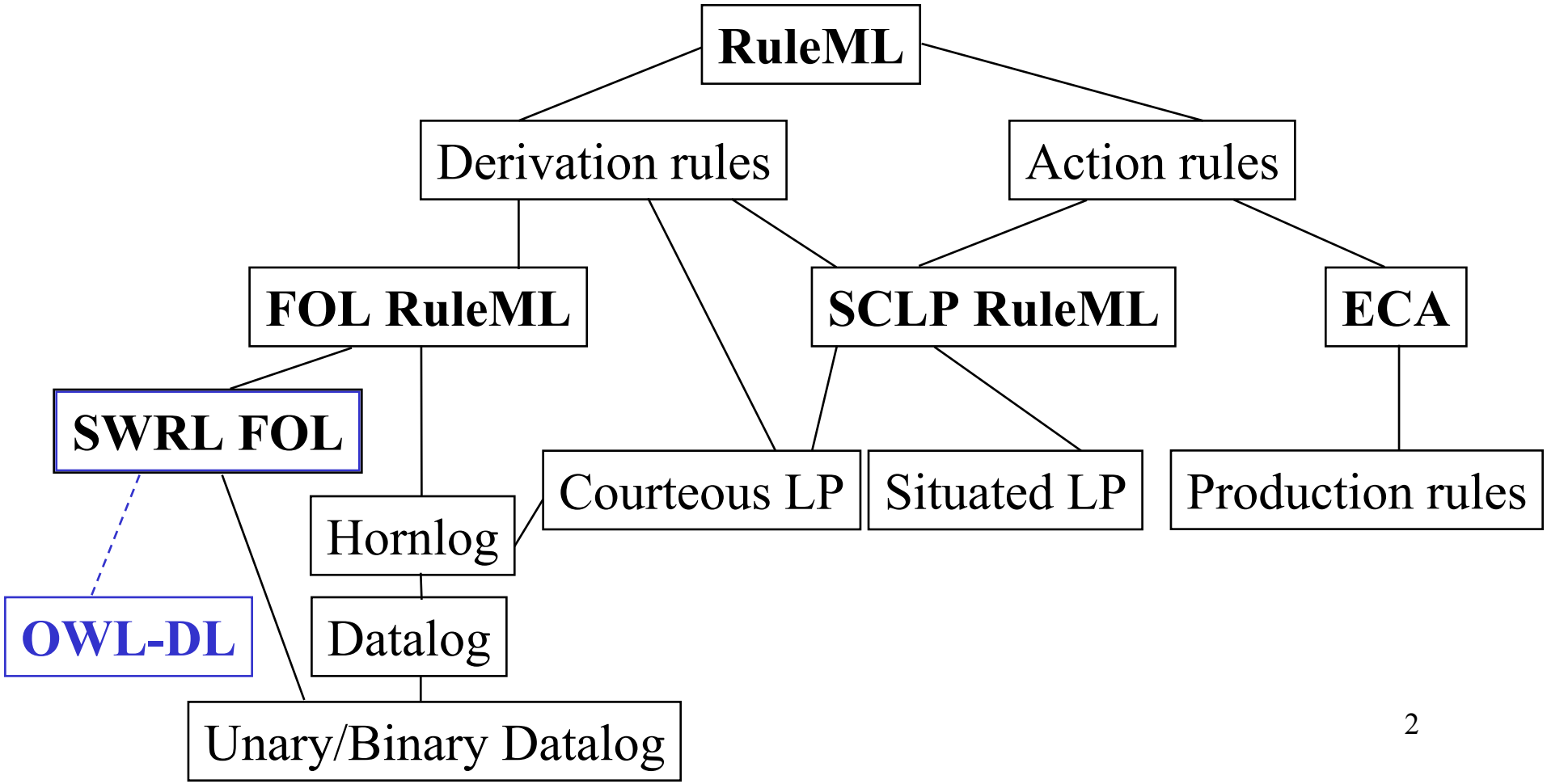
Joint Work with
Benjamin Grosof and Said Tabet
as part of the
RuleML Initiative and Joint Committee

DAML PI Meeting, San Antonio, TX
Nov 30 – Dec 02, 2004

Outline

- RuleML V0.87
  - Slots generalized for F-Logic
- FOL RuleML V0.9
  - Release; Synergy with SWRL FOL
- DTD and Example
- Applications at NRC; OMG and RuleML
- Plan for full RuleML V0.9
  - Tighter SWRL convergence
  - Include-a-KB (refine SweetRules design)
  - Action/reaction rules

SWRL FOL and (FOL/SCLP) RuleML



RuleML 0.87

- Groundwork for FOL (First-Order-Logic) RuleML
  - Markup economy as in RuleML Lite: stripe skipping
- Access to SWRL properties as "foreign" atoms
- UML for language lattice, MOF for abstract syntax
- Strong negation (Neg) & Negation-as-failure (Naf)
  - More support for Courteous LP (prev.: rule labels)
- Slotted syntax permits (generalized) attribute sets
  - In addition to positional syntax
  - Facilitates N3 / RDF / OWL / SWRL style
  - (Variable, Complex) terms as slot names: for F-Logic

FOL RuleML 0.9

- FOL RuleML 0.9 announced: 2004-11-14
- Co-developed as platform for Web rules by RuleML Initiative and Joint Committee
- Roles of FOL RuleML:
  - the FOL ***sublanguage*** of **RuleML**
  - extends rule ***component*** of **SWRL FOL**
  - an FOL ***content language*** for **SWSI**

(FOL) RuleML Has N-ary Relations & Functions, Extending SWRL (FOL)

- N-ary relations (predicate symbols)
  - Extends SWRL, which is unary/binary
- N-ary constructors (function symbols)
  - Extends SWRL, which uses individuals as 0-ary constructors (function-free)

FOL RuleML: Syntax and Semantics

- Modular combination of syntactically characterized sublanguages with:
  - Explicit quantifiers (also: LP convention)
  - Head disjunctions
  - Equivalence and Negation
- Semantics is FOL model theory
- (Pragmatics via performatives)

Example

English:

"If
a person buys *an* object *from a* merchant
and
the person keeps *the* object
then
the person owns *the* object."

FOL RuleML:

```
<Forall>
 <Var>person</Var>
 <Var>merchant</Var>
 <Var>object</Var>
 <Implies>
  <And>
   <Atom>
    <Rel>buy</Rel><Var>person</Var><Var>merchant</Var><Var>object</Var>
   </Atom>
   <Atom>
    <Rel>keep</Rel><Var>person</Var><Var>object</Var>
   </Atom>
  </And>
  <Atom>
   <Rel>own</Rel><Var>person</Var><Var>object</Var>
  </Atom>
 </Implies>
</Forall>
```

FOL (binary/ternary, function-free):

$$(\forall\ person, merchant, object)\ buy(person, merchant, object) \wedge keep(person, object) \rightarrow own(person, object)$$

DTD for Recursive FO Formulas

```
<!ENTITY % foformula
        "(Atom | And | Or | Neg | Implies | Equivalent | Forall | Exists)">
<!ELEMENT Atom (Rel, (Ind | Var | Cterm)*)>
<!ELEMENT Cterm (Ctor, (Ind | Var | Cterm)*)>
<!ELEMENT And ((%foformula;)*)>
<!ELEMENT Or ((%foformula;)*)>
<!ELEMENT Neg (%foformula;)>
<!ELEMENT Implies (%foformula;, %foformula;)>
<!ELEMENT Equivalent (%foformula;, %foformula;)>
<!ELEMENT Forall (Var+, %foformula;)>
<!ELEMENT Exists (Var+, %foformula;)>
<!ELEMENT Ind (#PCDATA)>
<!ELEMENT Var (#PCDATA)>
<!ELEMENT Rel (#PCDATA)>
<!ELEMENT Ctor (#PCDATA)>
```

☞ *Translated to XML Schema for SWRL FOL spec*

Slotted FOL RuleML Extension

- N-ary relations and constructors can contain set of slots ("name→filler" pairs)
  - Enables Object Oriented modeling
    - RDF URI descriptions (rather than triples)
    - RDFS and OWL class descriptions
  - Positional logic ☞ Frame logic (F-logic)
- Markup for F-logic in OO RuleML

Example (Original)

Positional FOL RuleML:

```
<Forall>
 <Var>person</Var>
 <Var>merchant</Var>
 <Var>object</Var>
 <Implies>
  <And>
   <Atom>
    <Rel>buy</Rel><Var>person</Var><Var>merchant</Var><Var>object</Var>
   </Atom>
   <Atom>
    <Rel>keep</Rel><Var>person</Var><Var>object</Var>
   </Atom>
  </And>
  <Atom>
   <Rel>own</Rel><Var>person</Var><Var>object</Var>
  </Atom>
 </Implies>
</Forall>
```

Positions

arg 1 *arg 2* *arg 3*

Example (Extended)

Slotted FOL RuleML:

```
<Forall>
 <Var>person</Var>
 <Var>merchant</Var>
 <Var>object</Var>
 <Implies>
  <And>
   <Atom>
    <Rel>buy</Rel><Var>person</Var><Var>merchant</Var><Var>object</Var>
   </Atom>
   <Atom>
    <Rel>keep</Rel><Var>person</Var><Var>object</Var><Slot><Ind>Δt</Ind><Ind>'04</Ind></Slot>
   </Atom>
  </And>
  <Atom>
   <Rel>own</Rel><Var>person</Var><Var>object</Var><Slot><Ind>Δt</Ind><Ind>'04</Ind></Slot>
  </Atom>
 </Implies>
</Forall>
```

Slot

name → *filler*

Exemplary RuleML Apps: NRC

- RACSA, RALOCA, RACOFI: Rule Applying Agents for Comparison Shopping, Learning Object Comparison, and COllaborative FIltering (commercial: inDiscover.net)
- NBBizKB: New Brunswick Business Knowledge Base uses OO RuleML for data validation and integration
- AgentMatcher: e-Learning metadata interchanged in Weighted OO RuleML
- Teclantic: Profiles of startup companies for Atlantic technology transfer in Weighted OO RuleML

OMG and RuleML

- OMG has Production & Business Rule RFPs
  - Focus: meta-model of OMG
  - Considering RuleML for markup and KR semantics
- RuleML developed UML, MOF & MDA specs
  - UML for language lattice (OCL planned)
  - MOF for abstract syntax
  - MDA: platform-independent business logic

Plan '05 for RuleML 0.9: Toplevel

- Transfer the FOL RuleML 0.9 innovations to all sublanguages, esp. LP
- Tighten SWRL convergence (e.g., 1-, 2-, n-ary)
- Finalize RuleML/SWRL datatypes and built-ins
- Update equality (active: rewrite/transformation)
- Permit (FOL) integrity constraints: Mutex, OCL
- Develop webized, KB-converting 'Includes'
- Extend RuleML towards action/reaction rules
  - Production rules / Situated Courteous LP