RuleML Technology for Rules and Reasoning

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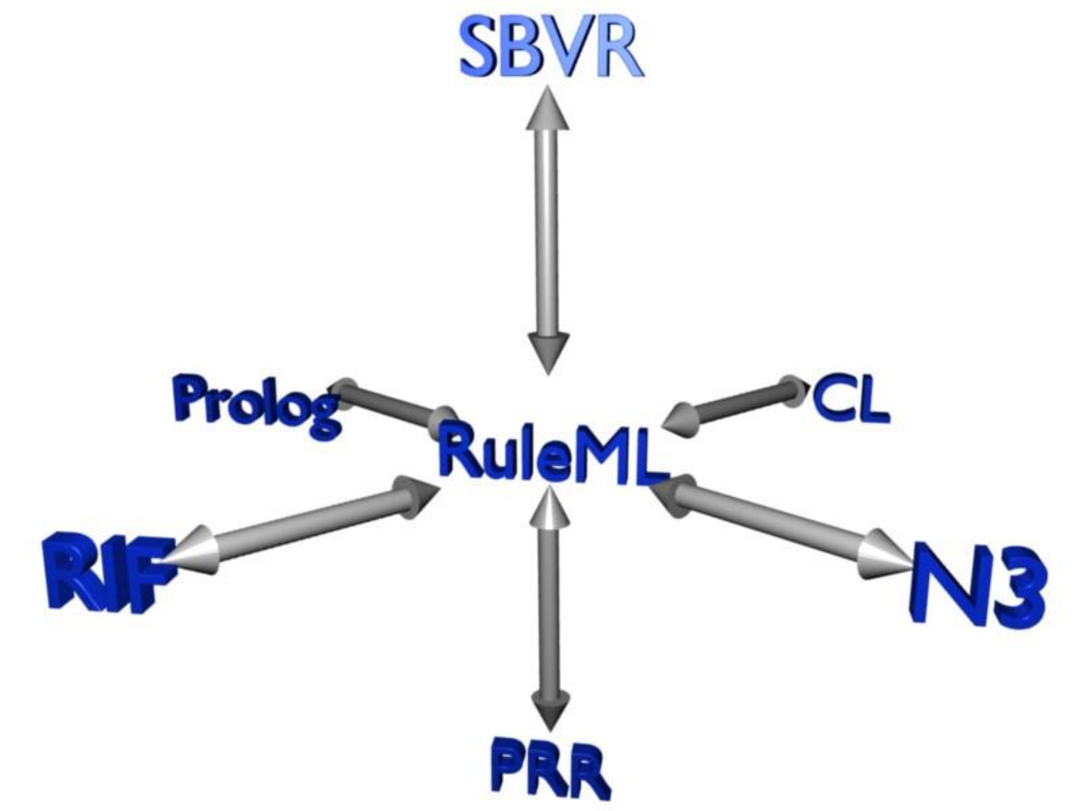
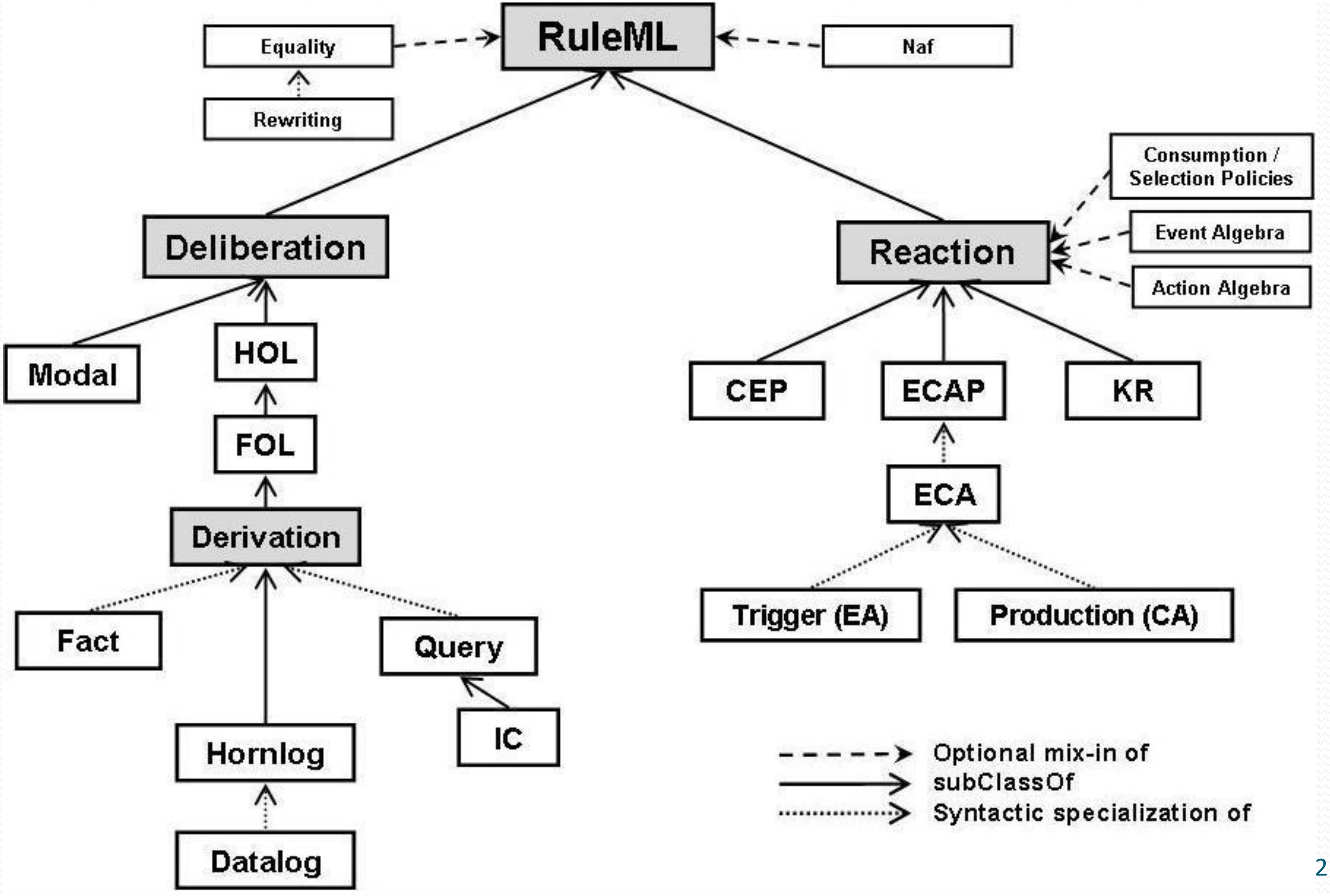
Ontology, Rules, and Logic Programming
for Reasoning and Applications (RulesReasoningLP)
Ontolog Mini-Series Planning Session, July 25, 2013

RuleML Interoperation

XML-based interchange between (sublanguages of) RIF, CL, SBVR, PRR, N3, Prolog, as well as Rulelog etc.



RuleML Family of Sublanguages (1)



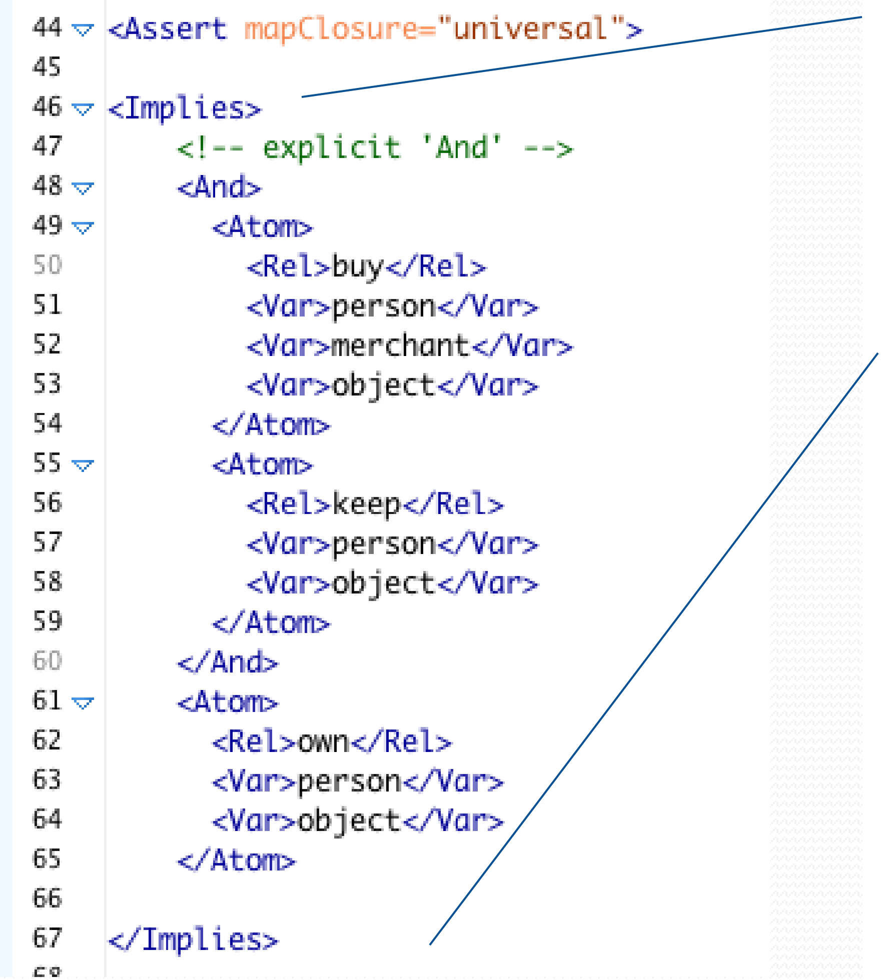
RuleML Family of Sublanguages (2)

- RuleML family covers a wide rule spectrum, from Deliberation rules to Reaction rules
  - Rule condition part reused across the spectrum
  - Syntactic uniformity enables further reuse
- Family constitutes a deep sublanguage lattice
  - E.g. for logical sublanguage backbone: Deliberation→HOL→**FOL**→Derivation→**Hornlog**→Datalog→…
- Naf mix-in customization of Hornlog RuleML (Naf Hornlog RuleML) leads to Logic Programs

Foundational RuleML Technology

- User syntaxes (for knowledge acquisition and querying)
  - Presentation (symbolic): Positional-Slotted Language (POSL), Prova, …
  - Visualization (graphical): Graph inscribed logic (Grailog), …
- Serialization syntax (for knowledge exchange): Valid w.r.t. XML schemas
  - In Relax NG (RNG)
    - MYNG Web GUI generates RNG for fine-grained schema customization
  - In XML Schema Definition Language (XSD)
  - *RuleML 1.0*: RNG and XSD separate. *Planned*: generate XSD from RNG
- Transformations
  - XSLT normalizers (to the most explicit or most concise RuleML/XML)
  - JAXB unmarshalling of RuleML/XML into Java objects
- Model-theoretic semantics
  - For (Naf-free, OID/slot-free) FOL, Hornlog, Datalog RuleML: Classical
  - For Positional-Slotted Object-Applicative (PSOA) RuleML: RIF-style
- Engines (OO jDREW, Prova, DR-DEVICE, VampirePrime, …)

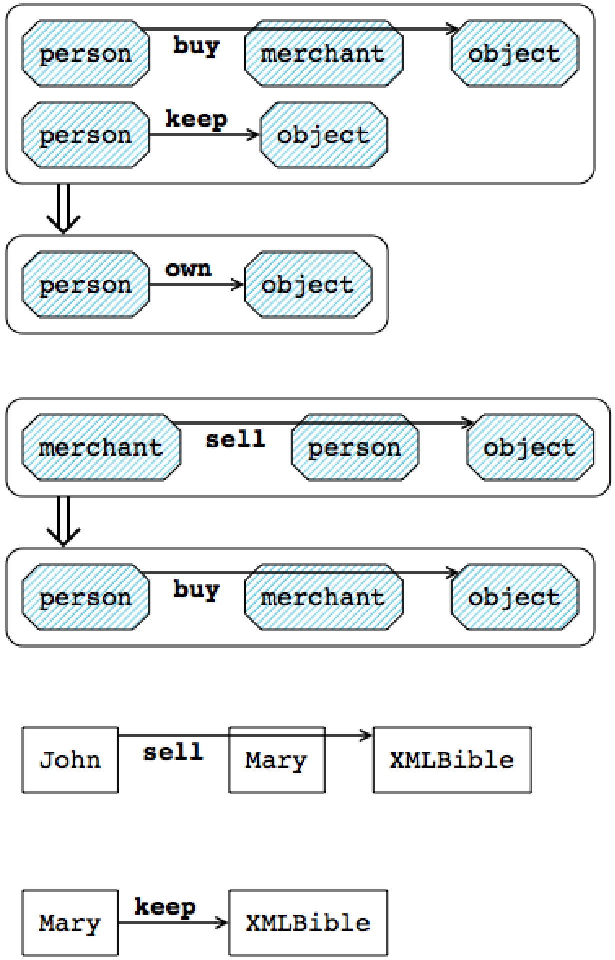
Sub…Sublanguage Datalog RuleML
from XML Serialization to Grailog Visualization



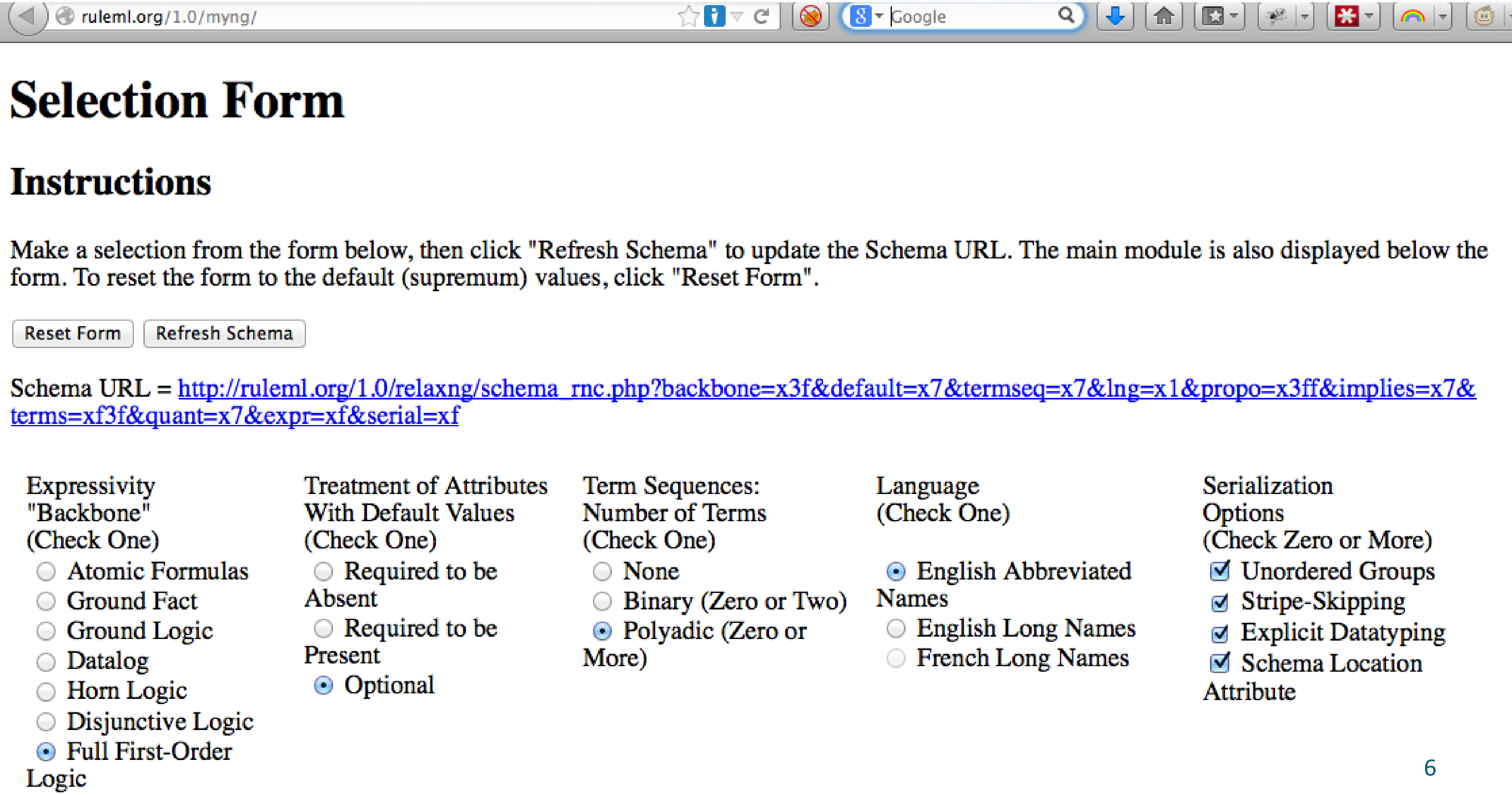
```
<Assert mapClosure="universal">

<Implies>
    <!-- explicit 'And' -->
    <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>
```



RuleML Sublanguages Customized by MYNG as Relax NG Schemas (1)



Selection Form

Instructions

Make a selection from the form below, then click "Refresh Schema" to update the Schema URL. The main module is also displayed below the form. To reset the form to the default (supremum) values, click "Reset Form".

Reset Form | Refresh Schema

Schema URL = http://ruleml.org/1.0/relaxng/schema_rnc.php?backbone=x3f&default=x7&termseq=x7&lng=x1&propo=x3ff&implies=x7&terms=xf3f&quant=x7&expr=xf&serial=xf

Expressivity "Backbone" (Check One)

- ○ Atomic Formulas
- ○ Ground Fact
- ○ Ground Logic
- ○ Datalog
- ○ Horn Logic
- ○ Disjunctive Logic
- ● Full First-Order Logic

Treatment of Attributes With Default Values (Check One)

- ○ Required to be Absent
- ○ Required to be Present
- ● Optional

Term Sequences: Number of Terms (Check One)

- ○ None
- ○ Binary (Zero or Two)
- ● Polyadic (Zero or More)

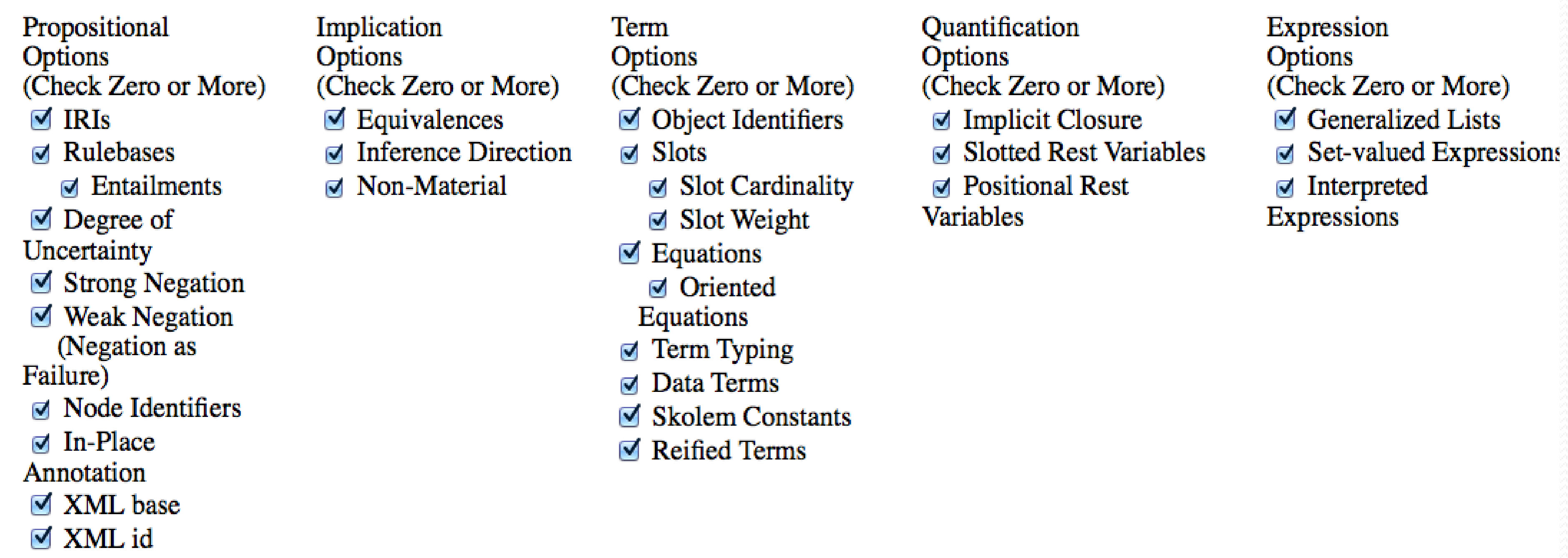
Language (Check One)

- ● English Abbreviated Names
- ○ English Long Names
- ○ French Long Names

Serialization Options (Check Zero or More)

- ☑ Unordered Groups
- ☑ Stripe-Skipping
- ☑ Explicit Datatyping
- ☑ Schema Location Attribute

RuleML Sublanguages Customized by MYNG as Relax NG Schemas (2)



Propositional Options (Check Zero or More)

☑ IRIs
☑ Rulebases
  ☑ Entailments
☑ Degree of Uncertainty
☑ Strong Negation
☑ Weak Negation (Negation as Failure)
☑ Node Identifiers
☑ In-Place Annotation
☑ XML base
☑ XML id

Implication Options (Check Zero or More)

☑ Equivalences
☑ Inference Direction
☑ Non-Material

Term Options (Check Zero or More)

☑ Object Identifiers
☑ Slots
  ☑ Slot Cardinality
  ☑ Slot Weight
☑ Equations
  ☑ Oriented Equations
☑ Term Typing
☑ Data Terms
☑ Skolem Constants
☑ Reified Terms

Quantification Options (Check Zero or More)

☑ Implicit Closure
☑ Slotted Rest Variables
☑ Positional Rest Variables

Expression Options (Check Zero or More)

☑ Generalized Lists
☑ Set-valued Expressions
☑ Interpreted Expressions

Extended RuleML Technology

- Translators (interchange/interoperation tools)
  - RuleML ↔ POSL
  - PSOA → TPTP
  - Attempto Controlled English (ACE) → RuleML
  - Translators between RuleML and Prolog, Jess, N3, …
- APIs (Rulestore API, API4KB)
- Multi-agent frameworks (Rule Responder, EMERALD)
- More tools (http://wiki.ruleml.org/index.php/RuleML_Implementations)

RuleML as Basis for other Languages

- Semantic Web Rule Language (SWRL)
  - Uses RuleML Version 0.89
- Semantic Web Services Language (SWSL)
  - Uses RuleML Version 0.89
- LegalRuleML
  - Uses RuleML Version 1.0

RuleML Uses

- Specific use cases (http://ruleml.org/usecases)
    - ChemXelem (Chemical XML Elements)
    - WineOnto (Wine Ontology)
    - NBBizKB (New Brunswick Business Knowledge Base)
    - FindXpRT (Find an eXpert via Rules and Taxonomies)
    - eTourPlan (eTourism Route and Activity Planner)
    - …
- Rule Responder instantiations (http://responder.ruleml.org)
    - SymposiumPlanner (formalizing RuleML 20xy in RuleML)
    - WellnessRules, PatientSupporter
- Uses as basis for other languages (see above)

Further Reading

- RuleML wiki page corresponding to this talk (http://wiki.ruleml.org/index.php/Introducing_RuleML)
- RuleML 1.0: The Overarching Specification of Web Rules
  - Talk (http://cs.unb.ca/~boley/talks/RuleML-Overarching-Talk.pdf)
  - Paper (http://link.springer.com/chapter/10.1007%2F978-3-642-16289-3_15)
- Reaction RuleML 1.0: Standardized Semantic Reaction Rules
  - Talk (http://www.slideshare.net/swadpasc/reaction-ruleml-ruleml2012paschketutorial)
  - Paper (http://link.springer.com/chapter/10.1007%2F978-3-642-32689-9_9)
- Grailog 1.0: Graph-Logic Visualization of Ontologies and Rules
  - Talk (http://cs.unb.ca/~boley/talks/RuleMLGrailog.pdf)
  - Paper (http://link.springer.com/content/pdf/10.1007%2F978-3-642-39617-5_9)