W3C rule interchange format
Rule interchange

Application A

Rule system 1

Data

Rule interchange

<XML doc>

Data model (OWL, RDF-S, XML-S, XMI, ...)

de-serial.

Rules

Application B

Rule system 2

Data

<XML doc>

Rules

de-serial.
Rules interchange

Policy setting organisation (regulator)

specifies rules (CIM level)

Compliance organisation

• Specifies operational interpretation of rules (PIM level)
• Merges rules from relevant sources

Policy compliant organisation (regulated)

Implements rules (PSM level)

Implements rules
Negotiating eCommerce Transactions Through Disclosure of Buyer and Seller Policies and Preferences

• In order to grant access a buyer must provide valid credit card information together with delivery information (address, postal code, city, and country)

Forall ?buyer
  Forall ?card ?address
    such that (?buyer[ex:creditCard->?card
       ex:deliveryAddress->?address])
    if ex:validAddress(?address) and ex:validCreditCard(?card)
    then Execute(ex:grantAccess(?buyer))

ex:validAddress(?address) :-
   Exists ?x ?y ?z …
       ex:isValidZip(?x ?y ?z)
       ...

• Disclose Alice's credit card information only to online shops belonging to the Better Business Bureau
• For anonymity reasons, never provide both her birth date and postal code.
Interchanging Rule Extensions to OWL

• “A rule is used to express the dependency between the ontology properties isMAEConnectedTo and isMAEBoundedBy, in particular (a simplified form of) the knowledge that two Material Anatomical Entities having a shared boundary are connected”

\[
\text{Forall } ?x \ ?y \ ?z \\
(?x[\text{isMAEConnectedTo}]->?y :- \\
\text{And}(?x[\text{isMAEBoundedBy}]->?z] \\
\text{?y[isMAEBoundedBy}]->?z]))
\]
Publishing Rules for Interlinked Metadata

- Every science fiction movie is a movie
  \[\text{?Movie}\#\text{ex:Movie} :- ?Movie\#\text{ex:ScienceFictionMovie}\]
- Every movie produced before 1930 is black and white
  \[\text{?Movie}\#\text{ex:BlackWhiteMovie} :-
  \quad ?\text{Movie}\#\text{ex:Movie}[\text{ex:date} -> ?\text{Date}], ?\text{Date} < "1930"^{\text{xs:dateTime}}\]
- All movies listed at http://altmd.example.org but not listed at http://imd.example.org are independent movies
  \[\text{?Movie}\#\text{ex:IndependentMovie} :-
  \quad \text{listed(?Movie\#\text{ex:Movie},http://altmd.example.org)}
  \quad \text{not(listed(?Movie\#\text{ex:Movie},<http://imd.example.org>))}\]
- All movies with budgets below 5 million USD are low-budget movies.
  \[\text{?Movie}\#\text{ex:LowBudgetMovie} :-
  \quad ?\text{Movie}\#\text{ex:Movie}[\text{date} -> ?\text{Date}, \text{budget} -> ?\text{Budget}]
  \quad ?\text{Budget} < 5000000^{\text{xs:long}}\]
- All of these can be expressed with OWL, but not all of them belongs in an ontology
Publishing Rules for Interlinked Metadata

• FOAF user Charlie might choose to complement his normal FOAF profile with his preferences about which of his phone numbers should be used depending on his iCalendar schedule:
  – If Charlie is currently in a meeting according to http://charlie.example.org/calender.ical and the importance is high then call his cell number
  – If Charlie is currently attending a public talk according to http://charlie.example.org/calender.ical then leave him a voicemail message
  – If Charlie currently has no appointments according to http://charlie.example.org/calender.ical then call his office number
Access control policies

• PRIME
  \(<subject>\) with \([<subject\_expression>]\) can \(<actions>\) on \(<object>\)
  with \([<object\_expression>]\) for \(<purposes>\) if \([<conditions>]\)

• RIF-BLD
  \(\text{Forall } ?\text{subject } ?\text{object}\)
  \(\text{prime:allowed(prime:action } ?\text{object prime:purpose) :-}\)
  \(\text{And}(subject\_expression \text{ object\_expression conditions})\)

• RIF-PRD
  \(\text{Forall } ?\text{subject such that (subject\_expression)}\)
  \(\text{Forall } ?\text{object such that (object\_expression)}\)
  \(\text{If conditions then Execute(prime:action(?object prime:purpose))}\)
What is the Rule Interchange Format?

• Format for interchanging rules, so they can be used across diverse systems
  – allowing rules written for one application to be published, shared, and re-used in other applications and other rule engines.
  – In a semantic preserving way (between languages with compatible semantics)
  – Encouraging interoperability
  – XML syntax
  – Compatible with relevant standards (PRR, RDF, OWL, …)

• A rule is (just another) data item
  – RIF provides a standard means to feed rules into an application (at run time)
  – Semantics to prescribe (intended) application’s behaviour
RIF Background: standards

• The early days of rule interchange
  – 1998: KIF – Knowledge Interchange Format
  – 2000: RuleML
  – 2001: SRML – Simple Rule Markup Language (Colleen and Changhai)
  – ...

• 2001-2004: JSR 94 – Java rule engine API
  – Prescribes a set of fundamental rule engine operations (i.e. loading rulesets, parsing rules, adding objects to an engine, firing rules, and getting resultant objects from the engine)
  – Engine semantics are not defined, so the API and specification are very high level (JDBC API ... without SQL)
  – No underlying rule language, hence no API to introspect rules, create rulesets, provide pluggable parsers etc.

• 2003-2008: OMG PRR – Production Rule Representation
  – “A metamodel for a language that can be used with UML models for explicitly representing production rules as visible, separate and primary model elements in UML models”
    • A MOF/UML meta-model and an UML profile
    • Addresses the PIM level of MDA
  – Engine semantics are defined (forward chaining + sequential)
  – No underlying rule language: PRR Core + non-normative PRR OCL

• April 2005: W3C workshop on rule languages for interoperability
• November 2005: W3C Rule Interchange Format working group chartered
• OMG SBVR, ISO Common Logic, …
RIF Background: semantic Web

• Semantic web approach
  – interoperability requires a formal semantics

• The OWL WG approach
  – Start with something (DAML+OIL)

• Literally *hundreds* of rule system implementations
  – ISO-Prolog, CLIPS, OPS…
  – Already several “SW” rule languages
    • SWRL, RuleML, WRL, SWSL, KAON2, TRIPLE, JenaRules…
  – Everyone wants “their” system/technique/theory to be the SW rule standard
Wherefore the RIFt(s)?

- **OWL DL < OWL < FOL**
  - Original idea to add full first-order at the logic level
  - Semantic web very “open world”
- **Most back-end DBs support closed queries**
- **Many rule systems have non-FO features**
  - CWA/NAF
  - Procedural Attachment
  - Rule ordering
  - Non-monotonicity
  ... can’t be layered on OWL
- **Not a strict SW layering already**
  - OWL restricted dialects (DL) not layered on (all of) RDF/S semantics
  - RDF & RDFS not layered at all
RIF Background: Business rules

- “Business Rule systems” Vendors
  - $1B/year existing market
  - 1,000’s end users
  - 1,000,000’s rules in use
  - ILOG, Fair Isaac, Haley, ...

- Database vendors
  - Oracle, IBM

- OMG PRR effort
  - Simple production rules
  - Event-condition-action
  - Vendors understand the value of standardization (see also JSR 94)
  - Interchange already a priority
  - ...a common semantics?
W3C RIF working group

• W3C working group
  – Chartered Nov. 05 (for 2 years)
    • Phase 1: extensible XML rule interchange format, Horn expressiveness, semantic Web compatibility
  – Kick-off Dec. 05
    • March 06: FPWD UCR
    • March 07: FPWD Core
    • Oct. 07: FPWD BLD
  – Extended Nov. 07 (for 6 months)
    • BLD to Last Call
  – Extended May 08 (for 1 year)
    • BLD, SWC to REC
    • FLD, DTB, PRD, extensibility

• 74 participants from 35 organisations
  – IBM, HP, Oracle, ILOG, JBoss, Fair Isaac, Corticon, Tibco, MITRE…
  – NIST, OMG (esp. SBVR and PRR), RuleML…
  – Research organisations, universities…
  – And 4 invited experts
  – Chairs: Chris Welty (IBM), Christian de Sainte Marie (ILOG)

• Working in the public eye
  – Under the W3C patent policy
W3C RIF: Design issues

• Very large number of rule users/use cases and types to satisfy!!!
  – Descriptive {OMG MDA level = CIM} VS executable rules {OMG MDA level = PIM & PSM}
  – Logical (side-effect free) VS active (side-effect full) rules
  – Data-oriented (SQL triggers, PR, …) VS proof-oriented (FOL…)
    • All kinds of different data sources (DB, WM, OO, OWL…)
  – Semantic Web VS non-SW usage

• Simplicity VS coverage
• Extensibility VS compliance VS interoperability
• Executable (AST) VS human-readable syntax
• …
Superset approach
Super-set approach

• Define a super-language so expressive that any language can be translated to/from it
  – The CL and IKL approach
  @deprecated: infeasible for this group, as major differences appeared irreconcilable (e.g. non-mon vs. mon)
A common core...
...and standard dialects
Core + standard dialects

• Define a *core* language that accounts for the intersection of all rule language capabilities
  – E.g. Horn, datalog, …

@postponed: The production rule, logic programming, and FO core is not clear
Separate families + Core

IRL

JBoss

RIF PRD

RIF BLD

RLj

RLn
Separate families + Core
Separate families + Core

• Define a logic-based core and a separate production-rule core
• If there is an intersection, define the common core (which may possibly be just a syntax)

@version 0.1: BLD LC (July 08)
@version 0.0.1: PRD FPWD (July 08)
Approach 3a

• Define a framework in the form of a menu of syntactic and semantic features that can be combined into dialects
  – @version 0.0.9: FLD
Design principles

• Translation paradigm
  – No intrusion in covered rule languages and rule sets

• Same semantics ⇔ same syntax
  – Share constructs across dialects wherever they agree on the semantics
  – Different constructs where semantics do not agree

• Fully striped XML (type-tagged, object-oriented, …)
  – alternating Class and role tags
  – Metadata can be attached to any class element

• Only XML schema is normative
  – Presentation syntax added for specification’s readability (examples, semantics etc)

• Principles are there so you can rest on them…until they break
BLD Overview

• Definite Horn rules
  – Disjunction of atoms with exactly one positive literal
• Equality, functions, and a standard *first-order* semantics
• Syntactic features
  – objects and frames
  – internationalized resource identifiers (IRIs) as identifiers
  – XML Schema data types and builtins
• XML (1.0) syntax with normative XMLS definition
• Non-normative presentation syntax
• Metadata and (RDF+OWL) imports
Symbols

• Used to identify constants, variables, functions, predicates

• "literal"^^<symspace-identifier>
  – Notable symbol spaces: xsd:string, rif:local, rif:iri
  – “Chris”^^<xsd:string>
  – “
    
    http://www.w3.org/1999/02/22-rdf-syntax-ns#ty
    rif:iri>
  – “Person1”^^rif:local
Rules

• IF <condition> THEN <conclusion>
  – <condition> aka rule body, antecedent
  – <conclusion> aka rule head, consequent

• BLD rule:
  – (Forall var* <conclusion> :- <condition>)
  – Conclusions may contain conjunction
  – Conditions may contain conjunction, disjunction, and existential

• Restrictions on conclusion
  – No existential, disjunction, external functions
Horn Extensions

• Functions and external calls (DTB)
• Equality (in conclusion and condition)
• Frames
  – Objects with slots and (multiple) values
    • Used to map to RDF and OWL (SWC)
  – Special syntactic treatment of class membership and subclass
• Named argument functions and predicates
  – However all arguments must be provided
Structure

• Rules occur in Groups
  
  Group( Forall ?x _Q(?x) :- _P(?x) )
  (Forall ?x _Q(?x) :- _R(?x))

• Groups occur in Documents
  
  Document( Group((Forall ?x _Q(?x) :- _P(?x))
    (Forall ?x _Q(?x) :- _R(?x))))

Warning

• While representative of the RIF syntax, the following diagrams and examples are not completely up-to-date at the time of the presentation
If the Prop is a slot of a named argument UNITERM, the key is a Name, not a TERM.
PRD Overview

• Production rules
  – FOR <variables> WITH <binding patterns>, IF <condition> THEN <actions>
  – FORALL Var* (IF patterns AND condition THEN action
  – With an operational semantics a labelled transition system

• Patterns and condition
  – BLD condition language minus logic functions plus negation
  – With a model-theoretic semantics (compatible with BLD)

• Assert, Retract, New
  – Assign, Remove, Execute
  – Defining a transition relation

• Syntactic features
  – objects and frames
  – internationalized resource identifiers (IRIs) as identifiers
  – XML Schema data types and builtins

• Metadata
<Const type="xsd:anyURI" [xml:lang="xsd:language"]? />

Any Unicode string
</Const>

<Var> any Unicode string </Var>

<External><content><Expr><op> Const </op>
  <args rif:ordered="yes"> TERM* </args>?
</Expr> </content> </External>
ATOMIC

• jim:owns(?c ?p)
  <Atom>
    <op>
      <Const type="rif:iri">http://rif.examples.com/2008/jim#owns</Const>
    </op>
    <args rif:ordered="yes">
      <Var> ?c </Var>
      <Var> ?p </Var>
    </args>
  </Atom>

• ?c.age = ?a
  <Frame>
    <object> <Var> ?c </Var> </object>
    <slot rif:ordered="yes">
      <Const type="rif:iri">ttp://rif.examples.com/2008/jim#Chicken/age</Const>
      <Var> ?a </Var>
    </slot>
  </Frame>
• Exists Chicken(age>8)
  <Exists>
   <declare> <Var> ?c </Var> </declare>
   <declare> <Var> ?a </Var> </declare>
   <formula>
    <And>
     <Member> ?c jim:Chicken </Member>
     <Frame> ?c.age=?a </Frame>
     <External>
      <content>
       <Atom>
        <op> <Const type="rif:iri"> op:numeric-greater-than</Const> </op>
        <args rif:ordered="yes"> <Var> ?a </Var> <Const type="xsd:decimal"> 8 </Const> </args> 
       </Atom>
      </content>
      </External>
    </And>
  </formula>
 </Exists>
RULE etc
RULE

• When
  ?c Chicken(age==8)
evaluate(today()="Monday")
Then …
  <Forall>
    <declare> <Var> ?c </Var> </declare>
    <pattern>
      <And>
        <Member> ?c jim:Chicken </Member>
        <Frame> ?c.age=8 </Frame>
      </And>
    </pattern>
    <formula>
      <Implies>
        <if> <External> today()="Monday" </External>
        <then> … </then>
      </Implies>
    </formula>
  </Forall>
<CLASSELT>
  <id> Const </id>?
  <meta>
    [ Frame
     | <And>
       <formula> Frame </formula>*
     ]
  </meta>?
  other CLASSELT content
</CLASSELT>
RIF Documents

- BLD: RIF basic logic dialect
  - LC July 2008
  - REC by May 2009?
- FLD: RIF framework for logic dialects
  - 2nd public WD July 2008
  - LC November 2008?
- PRD: RIF production rule dialect
  - FPWD July 2008
  - LC May 2009?
- DTB: RIF data types and builtins
  - FPWD July 2008
  - LC November 2008?
- SWC: RIF RDF and OWL compatibility
  - LC July 2008
  - REC by May 2008?
- UCR: RIF use cases and requirements
  - 4th public WD July 2008
- Test Cases: FPWD November 2008

Credits

- BLD and FLD Editors
  - Michael Kifer (U. Stonybrook), Harold Boley (NRCC)
- PRD Editors
  - Christian de Sainte Marie (ILOG), Adrian Paschke (FUBerlin), Gary Hallmark (ORACLE)
- SWC Editor
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Thank you!

Questions?