W3C Rules Interchange Format (Basic Logic Dialect)

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Rules, rules, rules…

RIF Background

- Semantic web approach
  - interoperability requires a formal semantics
- The OWL WG approach
  - Start with something (DAML+OIL, OWL1.1)
- Literally *hundreds* of rule system implementations
  - JSR-94, JESS, ISO-Prolog, CLIPS, OPS…
  - http://www.w3.org/2005/rules/wg/wiki/List_of_Rule_Systems
  - Already several "SW" rule languages
    - SWRL, RuleML, WRL, SWSL, KAON2, TRIPLE, JenaRules…
  - Everyone wants "their" system/technique/theory to be the SW rule standard
- Workshop April '05
  - http://www.w3.org/2004/12/rules-ws/
  - Outcome: **Nash Equilibrium…**

Enter the Vendors

- "Rule systems Vendors"
  - $1B/year existing market
  - iLog (IBM), Fair Isaac, Haley, …
- Database vendors
  - Oracle, IBM
- OMG PRR effort
  - Simple production rules
  - Event-condition-action
  - Vendors understand the value of standardization
  - Interchange already a priority
  - …a common *semantics?*

Credits

- Editors
  - Michael Kifer (U. Stonybrook), Harold Boley (NRCC) , Jos de Bruijn (U. Bolzano), Axel Polleres (DERI Galway), Christian de Sainte-Marie (Ilog/IBM), Gary Hallmark (Oracle), Dave Reynolds (HP)
- Active WG members
  - Adrian Paschke (REWERSE), Hassan Aït-Kaci (ILOG), John Hall (OMG), Jos de Bruijn (FUB), Leora Morgenstern (NYU), Mike Dean (SRI), Changhai Ke(Ilog/IBM), and Stella Mitchell (IBM)
- WG Team
  - Chris Welty (IBM), Christian de Sainte Marie (ILOG), and Sandro Hawke (W3C/MIT)

What is a Rule?

- IF <condition> THEN <conclusion>
  - <condition> aka rule body, antecedant
  - <conclusion> aka rule head, consequent
- In RIF BLD (Basic Logic Dialect)
  - Condition and conclusion are *monotonic*
  - IF (child-of(y,x) AND brother-of(z,x)) THEN (uncle-of(z,y))
  - You cannot *change* the *value* of any predicate, all statements are either true or false (as in OWL or RDF)
- In RIF PRD (Production Rule Dialect)
  - Condition and conclusion are non-monotonic
  - IF (customer.level = “gold”) THEN (customer.discount = 10%)
  - This will *change* the *value* of customer.discount if it was e.g. 5% before the rule (as in a programming language)

RIF Design

RIF BLD

- Equality in conclusions
- membership in conclusions
- External Functions
- Frame subclass
- Open Lists
- “logic” functions

RIF PRD

- Conclusion “actions”
- Negation
- frames-as-objects
- Retraction
- subclass
- membership in conclusion

RIF CORE

- Horn (monotonic)
- Datatypes & builtins
- external functions
- frames, class membership (in conditions)
- equality (in conditions)
- ground lists
- existential quantification (in conditions)

RIF Documents

- RIF Core, BLD, PRD
- DTB – datatypes and builtins
  - Defines all the required datatypes and pre-defined predicates and functions on them
- SWC – RDF & OWL Compatibility
  - Defines syntax and semantics for combining RIF rules with RDF graphs and OWL-2
- FLD – Framework for Logic Dialects
  - Defines how new dialects that extend BLD can be described

Negation

"One must understand, [rule systems] include a version of negation that is operationally well-defined. The problem is to make sense of it."

Fitting, 1999

"…and agree on it. Thus RIF logic dialects (CORE and BLD) do not have negation."

Welty, just now

Objects and Frames

id [slot -> value]

```
a1 [  status -> “active”
      discount -> .1 ]
ForAll ?x ( ?x [ discount -> .2 ] :-
            ?x [ status -> “active” ] )
```

Object (PRD, Java)

- a1 [status -> “active”
  discount -> .2]

Change is non-montonic

Frame (Core, BLD)

- a1 [status -> “active”
  discount -> .1
  discount -> .2]

Change is montonic. All changes result in the KB getting larger.

BLD Overview

- Definite Horn rules
  - Disjunction of atoms with exactly one positive literal

    `A :- B and C and D …`
- Equality, functions, lists, and a standard *first-order* semantics
- Syntactic features
  - 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 imports

Symbols & Datatypes

- 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#type"^^<rif:iri>
  - "Person1"^^rif:local
- Datatype literals have *lexical space* and *value space*
  - Taken from XML Schema Datatypes (xsd)
  - Lexical space defines the syntax of the constant
  - Value space defines the domain
  - Values, value spaces are disjoint
    - "Chris"^^<xsd:string> != "Christopher"^^<xsd:string>
    - "1"^^<xsd:float> != "1"^^<xsd:int>
    - "1"^^<xsd:float> == "1.0"^^<xsd:float>

Denotes the same entity across documents, rule sets, the web, …

May denote a different entity in different RIF documents

Frames

- In Core & BLD frame syntax is available

```
id [ slot -> value]
```

- …but frames are NOT objects, they are RDF triples

  <id> <slot> <value>.

- Like RDF, you cannot *change* a triple, you can only *add a new one*
  - This is what *monotonic* means
- RIF frames also give you membership (type) and subclass (BLD only)

```
id # class ## superclass [ slot -> value]
```

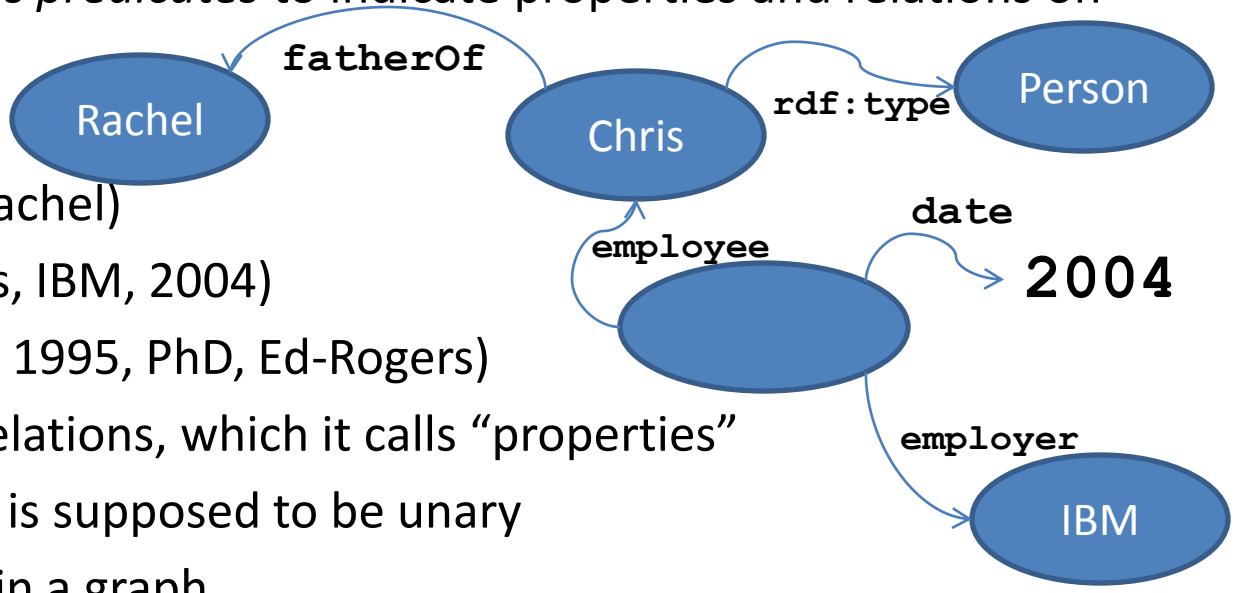
<id> <slot> <value>.

<id> <rdf:type> <class>.

<class> <rdfs:subclassOf> <superclass>.

Frames and Predicates

- Traditionally, logic uses *predicates* to indicate properties and relations on entities
  - Person(Chris)
  - Father-of(Chris, Rachel)
  - Employee-of(Chris, IBM, 2004)
  - Degree(Chris, RPI, 1995, PhD, Ed-Rogers)



- RDF only has *binary* relations, which it calls "properties"
  - *sigh* A property is supposed to be unary
  - Nodes and edges in a graph
  - Unary relations (nee properties) represented using a special binary relation, rdf:type
  - Frames represent unary and binary relations with special syntax, basically the same as RDF
- The difference between frames and predicates is simply a matter of taste, they can be used to encode the same information

RIF BLD

- BLD rule:
  - (**Forall** var* <conclusion> **:-** <condition>)
  - Conclusions may contain conjunction (aka AND)
  - Conditions may contain conjunction, disjunction (OR), and existential quantification
- Restrictions on conclusion
  - No existential, disjunction, external functions
- Existentials

```
Exists ?y ( P ( ?x ?y ) )
```

  - "There exists a value for ?y such that P(?x ?y) is true"

```
Parent(?x) :- Exists ?y ( HasChild(?x ?y))
```

  - In Core & BLD, exists can only appear in conditions

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)))
  Group((Forall ?y _R(?y) :- <ex:op>(?y))))
```

Simple Example
Database mapping

```
Document( Prefix(dbp http://dbpedia.org/property/)
   Prefix(my http://mydata.org/resource#)
   Prefix(rdfs http://www.w3.org/2000/01/rdf-schema#)
   Group ( Forall ?mname ?aname ?movie ?actor
       my:actorIn(?aname ?mname) :-
       And( dbp:starring(?movie ?actor)
            rdfs:label(?movie ?mname)
            rdfs:label(?actor ?aname))))
```

Simple Example w/ Frames
Database mapping

```
Document( Prefix(dbp http://dbpedia.org/property/)
   Prefix(my http://mydata.org/resource#)
   Prefix(rdfs http://www.w3.org/2000/01/rdf-schema#)
   Group ( Forall ?mname ?aname ?movie ?actor
       my:actorIn(?aname ?mname) :-
         And(?movie[dbp:starring -> ?actor
                    rdfs:label -> ?mname]
             ?actor[rdfs:label ?aname])))
```

Builtins and Negative Guards

Entailing disjunction

```
Document( Prefix(ex http://example.com/example#)
          Prefix(pred http:…/rif-builtin-predicate#)
 Group( ex:p(ex:a)
        Forall ?x
          (1=2 :-
               And (ex:p(?x)
                   External(pred:isNotInteger(?x))
                   External(pred:isNotString(?x)))) ) )
```

Entails:

```
Or ( External(pred:isInteger(ex:a))
     External(pred:isString(ex:a)) )
```

Compatibility With RDF

Frames, membership, subclass

```
<http://ex.org/ex#i> rdf:type <http://ex.org/ex#A>.
```

```
Document( Prefix(ex http://example.com/example#)
          Import(<http://example.org/mygraph>
      <http://www.w3.org/2007/rif-import-profile#Simple>)
  Group ( ex:A ## ex:B    ex:k # ex:A ) )
```

Entails:

```
And ( ex:i # ex:A ex:k[rdf:type->ex:A]
      ex:A[rdfs:subClassOf->ex:B]
      ex:i # ex:B
      ex:i[rdf:type->ex:B] )
```

XML Syntax

```
And (Exists ?Buyer (cpt:purchase(?Buyer ?Seller
                                 cpt:book(?Author bks:LeRif)
                                 curr:USD(49)))
     ?Seller=?Author )
```

```
<And><formula><Exists><declare><Var>Buyer</Var></declare>
        <formula><Atom><op><Const type="&rif;iri">&cpt;purchase</Const></op>
                       <args ordered="yes"><Var>Buyer</Var> <Var>Seller</Var>
                           <Expr><op><Const type="&rif;iri">&cpt;book</Const></op>
                                 <args ordered="yes">
                                   <Var>Author</Var>
                                   <Const type="&rif;iri">&bks;LeRif</Const></args>
                           </Expr>
                           <Expr><op><Const type="&rif;iri">&curr;USD</Const></op>
                                 <args ordered="yes">
                                 <Const type="&xsd;integer">49</Const></args>
                           </Expr>
                       </args>
        </Atom></formula>
    </Exists></formula>
    <formula><Equal>
        <side><Var>Seller</Var></side>
        <side><Var>Author</Var></side>
    </Equal></formula>
</And>
```

Metadata

- Can hang off any “class element”

```
<And>
<meta> <Frame>
 <object><Const type="rif:local">pd</Const></object>
 <slot ordered="yes">
   <Const type="&rif;iri">&dc;publisher</Const>
   <Const type="&rif;iri">&w3;W3C</Const>
 </slot> </Frame> </meta>
<formula>...</formula>
</And>
```

Metadata

- Can hang off any “class element”

```
<Group>
<meta> <Frame>
 <object><Const type="rif:local">pd</Const></object>
 <slot ordered="yes">
   <Const type="&rif;iri">&dc;publisher</Const>
   <Const type="&rif;iri">&w3;W3C</Const>
 </slot> </Frame> </meta>

...
</Group>
```

Metadata

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<Document>
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 <object><Const type="rif:local">pd</Const></object>
 <slot ordered="yes">
   <Const type="&rif;iri">&dc;publisher</Const>
   <Const type="&rif;iri">&w3;W3C</Const>
 </slot> </Frame> </meta>

...
</Document>
```

Logic Functions (BLD)

```
Document(
   Prefix(pred <http://www.w3.org/2007/rif-builtin-predicate#>)
   Prefix(func <http://www.w3.org/2007/rif-builtin-function#>)
   Prefix(ex <http://example.org/example#>)

   Group (
    ex:factorial(0) = 1

    Forall ?N (
      ex:factorial(?N) =
        External(func:numeric-multiply(
           ?N
           ex:factorial(
             External(
               func:numeric-subtract(?N 1) ) ) ) )
     :- External(pred:numeric-greater-than(?N 0) ) ) ) )
```

Status

- RIF BLD, RDF&OWL in Last Call
  - Last call indicates “final version for external review”
  - Expected “call for implementation” (Candidate Recommendation) any day now
  - Roughly 10 implementation committments
- See http://w3.org/2005/rules