SweetJess: Translating DamlRuleML To Jess

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**Overall Problem Addressed, Previous Work**

- Rules as widely deployed KR $\rightarrow$ SW Knowledge Integration for Business
- Challenge: **inter-operability** of heterogeneous intelligent applications ("agents") that use rules (incl. relational DB’s).
  - E.g., rules represent e-business policies and workflows.
  - Heterogeneous rule systems: **four important families:**
    - Prolog, SQL; production (OPS5), ECA
- **History:**
  - Core requirements & design ‘99 (while at IBM Research)
    - Declarative Logic Programs in XML; + *extensions*:
      - **Courteous** LP: prioritized conflict handling; modularity; tractably
      - **Situated** LP: procedural attachments for actions, queries: cleanly
  - IBM CommonRules V1 ‘99 (V3 currently)
    - large-scale pilot (EECOMS $29$Million, supply chain) ‘99–’00
  - Co-Lead RuleML: V0.7 ‘01 (V0.8 currently)
**Problem and Previous Work continued**

- **SweetRules V1 ‘01**: bi-directional translation with equivalent semantics via RuleML, between:
  - XSB Prolog: backward Ordinary Logic Programs (OLP)
  - Smodels: forward OLP
  - IBM CommonRules: forward Situated Courteous LP (SCLP)
  - Knowledge Interchange Format (KIF): First Order Logic interlingua
  - *Design in principle for*: SQL
    - well-understood in theory literature: as OLP
  - *Design in principle for*: production (OPS5), ECA
    - Based on Situated extension of LP, piloted in IBM Agent Building Environment ‘96 for info-workflow applications. Also piloted in EECOMS.
    - BUT: not much other literature/theory to support
    - HENCE motivation for this work: “bring them to the party”
  - **Jess**: production (OPS5), close to ECA
    - popular, open-source, Java: it’s useful in particular
Projects Context at MIT Sloan since ‘01

1. Rules KR Technology, esp. for Semantic Web Services
   - fundamental theory, technology, support of standards
   - SweetRules prototype (Semantic WEb Enabling Technology)
     - translation, inferencing, merging
     - current work: + ontologies cf. OWL, database systems

2. Business Implications of the Semantic Web
   - applications & strategy
   - SweetDeal prototype for rule-based e-contracting
     - modular, reusable contract fragments: as SCLP RuleML rulesets
Outline

1. Intro: Why Care
   - “bring to the party” of SW e-business, RuleML, and SweetRules: production/OPS5 & ECA rules; inter-operate Jess via RuleML translator

2. Some Details of the Translation
   - Ordinary Logic Programs: facts, rules
   - Situated extension to LP: procedural attachments
     - effectors (actions); sensors (tests/queries)
   - Courteous extension to LP: prioritized conflict handling; mutex’s, classical neg.
     - via tractable Courteous Compiler → OLP

3. Other Contributions related to the Translation
   - Inferencing in SCLP RuleML via: translate to Jess, run rules in Jess, go back
   - DamlRuleML: DAML+OIL ontology for RuleML’s syntax
     - E.g., Rule, Atom, Predicate as classes. Nice, but not necessary, for translating.

4. Conclusions and Future Work
   - comparative insights: Jess limitations, e.g., all-bound-sensors
   - in progress: prototype; deeper theory
Translating a Fact from (Daml)RuleML to Jess

```xml
<damlRuleML:fact>
  <damlRuleML:_rlab>fact8962</damlRuleML:_rlab>
  <damlRuleML:_head>
    <damlRuleML:atom>
      <damlRuleML:_opr>
        <damlRuleML:rel>shopper</damlRuleML:rel>
      </damlRuleML:_opr>
      <damlRuleML:ind>Debbie</damlRuleML:ind>
    </damlRuleML:atom>
  </damlRuleML:_head>
</damlRuleML:fact>

equivalent in JESS:
  (assert (shopper Debbie) )
```
Translating a Rule from (Daml)RuleML to Jess

<ruleML:imp>
  <ruleML:_rlab>
    <ruleML:ind>steadySpender</ruleML:ind>
  </ruleML:_rlab>
  <ruleML:_body>
    <ruleML:andb>
      <ruleML:atom>
        <ruleML:_opr>
          <ruleML:rel>shopper</ruleML:rel>
        </ruleML:_opr>
        <ruleML:var>Cust</ruleML:var>
      </ruleML:atom>
      <ruleML:atom>
        <ruleML:_opr>
          <ruleML:rel>spendingHistory</ruleML:rel>
        </ruleML:_opr>
        <ruleML:tup>
          <ruleML:var>Cust</ruleML:var>
          <ruleML:ind>loyal</ruleML:ind>
        </ruleML:tup>
      </ruleML:atom>
    </ruleML:andb>
  </ruleML:_body>
Continued: Translating a Rule from (Daml)RuleML to Jess

Equivalent in JESS:
(defrule steadySpender
  (shopper ?Cust)
  (spendingHistory ?Cust loyal)
  =>
  (assert (giveDiscount percent5 ?Cust) ) )
Translating an **Effector Statement**

`<damlRuleML:effe>`
`<damlRuleML:_opr>`
`<damlRuleML:rel>giveDiscount</damlRuleML:rel>`
`</damlRuleML:_opr>`
`<damlRuleML:_aproc>`
`<damlRuleML:jproc>`
`<damlRuleML:meth>setCustomerDiscount</damlRuleML:meth>`
`<damlRuleML:clas>orderMgmt.dynamicPricing</damlRuleML:clas>`
`<damlRuleML:path>com.widgetsRUs.orderMgmt</damlRuleML:path>`
`</damlRuleML:jproc>`
`</damlRuleML:_aproc>`
`</damlRuleML:effe>`

**Equivalent in JESS:** key portion is:

```
(defrule effect_giveDiscount_1
  (giveDiscount ?percentage ?customer)
  =>
  (effector setCustomerDiscount orderMgmt.dynamicPricing
   (create$ ?percentage ?customer))
)```

**Associates with predicate P:** an attached procedure A that is side-effectful.
- Drawing a conclusion about P triggers an action performed by A.

**jproc = Java attached procedure.**

**meth, clas, path =** its methodname, classname, pathname.
Translating a Sensor Statement

Associates with predicate P: an attached procedure Q that is side-effect-free.

- Testing a rule condition about P results in a query to Q.

Simplistic view of Equivalent in JESS is:
(defrule sense_steadySpender_1
  (shopper ?Cust)
  (test (shopper_SF getSpendingLevel transaction.customer.queries
    (create$ ?Cust loyal) ) )
=> (assert (giveDiscount percent5 ?Cust) )

modli = the proc.'s binding pattern: a list of, for each argument, a ...

bmode = binding mode (bound vs. free)
Translating a Sensor Statement
continued

• Equivalent in JESS: More precisely, the presence of a sensor statement modifies the translation of every rule whose body mentions that sensor predicate:

• `(defrule steadySpender
  (shopper ?Cust)
  (or (spendingHistory ?Cust ?loyal)
  (test (sensor getSpendingLevel transaction.customer.queries
  (create$ ?Cust loyal) ) ) )
  => (assert (giveDiscount percent5 ?Cust) ) )`
Also in the Jess equivalent:

```jess
(deffunction effector /* generic effector */
  (?methodName ?className $?arglist)
  (bind ?classInstance (new ?className))
  /*create new instance of class */
  (return (call ?classInstance ?methodName $?arglist) ) )

(deffunction sensor /* generic sensor */
  (?methodName ?className $?arglist)
  (bind ?classInstance (new ?className))
  /*create new instance of class */
  (return (call ?classInstance ?methodName $?arglist) ) )

[& set the CLASSPATH, appropriately]

[similar for RMI, using hostname instead of classpath]
```
SweetRules & SweetJess: Translating Courteous features of SCLP RuleML

**Courteous compiler**

- courteous representation (Sit.) Courteous LP.
- mutex* priorities

≡ equivalent semantically

ordinary ("vanilla") (Sit.)OLP representation

* classical negation too

**Translation for Situated OLP**

- Tractable:
  - $O(n^3)$, often linear
- Preserves ontology.
  - Plus extra predicates for
    - phases of prioritized argumentation
    - classical negations

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Discussion, Conclusions, and Future Work

• Nature of contribution:
  – design for translation, and its use in inferencing

• In progress: implementation → testing/refinement of the design

• In progress: deeper theory → proof of correctness, hard limits of expressiveness that can handle

• Tricky/subtle: Jess "Functions”
  – used for procedures, logical functions, and system commands

• Expressive restrictions imposed on the translation (currently):
  – “All-bound-sensors”: sensor arguments must all be bound (i.e., instantiated) before call.
  – “Datalog” (= no ctor’s), stratified, misc. about naming
continued: Conclusions and Future Work

• Comparative insights:
  – Courteous more powerful & clean than control-sequencing
  – Situated more powerful and clean than Jess “functions”

• Implications → Future Work:
  – Can do translation and RuleML-based inter-operability for more systems in production/reactive/ECA category
    • Current Work: more closely represent Events cf. ECA
      – Enables merging, knowledge sharing/integration
      – Helps achieve business intelligence on the Semantic Web
  – Broad Future Direction:
    – Represent and reason over RDF and DAML+OIL content
• For More Info:
  – http://www.mit.edu/~bgrosof/

• Download Site:
  – http://daml.umbc.edu/sweetjess
“RuleML: Semantic Web Rules!”
**Functionality:** SWEETRules Prototype

*(Semantic WEB Enabling Technology)*

**RuleML-SCLP**

**Inferencing:** forward, backward

Courteous compiler

- **courteous** representation
  - (Sit.) Courteous LP.
  - mutex* priorities

equivalent semantically

ordinary ("vanilla")
  - (Sit.)OLP representation

Translation

between RuleML-SCLP,

rule system languages

- Y Rule family
- X Rule family

Logic Program family

common cores

depth shared semantics

in common representation:

situating courteous LP’s

* classical negation too

**RuleML,**

KIF,

Prolog, other string formats

Heterogeneous rule systems

IBM CommonRules

XSB

Smodels

app 1

rule sys 1

app 2

rule sys 2

app N

rule sys N
Dec.-2001 Architecture: SWEETRules Prototype
(Semantic WEb Enabling Technology)

RuleML Translators

RuleML representation
Log. Prog.

≡ equivalent semantically

BRML, other formats

IBM CommonRules

Courteous Compiler

Translation

Speaks BRML
(Business Rules Markup Language)

Drivers: translation, inferencing

RuleML
Directly to more rule systems

KIF, Prolog, other string formats

Heterogeneous rule systems

app 1
rule sys 1

app 2
rule sys 2

objects ⋮

app N
rule sys N

IBM CommonRules

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Criteria for Contract Rule Representation

1. **High-level**: Agents reach common understanding; contract is easily modifiable, communicatable, executable.

2. Inter-operate: heterogeneous commercially important rule systems.

3. Expressive power, convenience, natural-ness.

   - ... but: computational tractability.

   - Modularity and locality in revision.

   - Declarative semantics.

   - Logical non-monotonicity: default rules, negation-as-failure.
     - essential feature in commercially important rule systems.

   - Prioritized conflict handling.

   - Ease of parsing.

   - Integration into Web-world software engineering.

   - Procedural attachments.

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