Rule Responder:
A Multi-Agent Web Platform
for Collaborative Virtual Organizations
Based on RuleML and OO jDREW

Benjamin Craig

University Of New Brunswick
APICS 2007
Saturday, October 13, 2007
Outline

- Overview
- Agents
  - Personal
  - Organizational
  - External
- Rule Engines
  - Prova
  - OO jDREW
- Communication Middleware
  - Mule ESB
  - Reaction RuleML messages
- Demo
  - Use Cases
Overview of Rule Responder

- Rule Responder is an intelligent multi-agent system for collaborative teams and virtual communities.
- Supports rule-based collaboration between the different members of the virtual organization.
- Uses RuleML as its Rule Markup Language, based on logic and XML.
  - The member of the RuleML family employed here is Naf Hornlog.
- Implemented as a Web-based service architecture.
Architecture - Overview

Use Case 4

Browser (external Agent)
- Web Browser
  - HTTP Web Form
  - Reaction RuleML Message

Personal Agent 1
- Rule Engine (Prova)
- Knowledge Base (dynamic access to external data sources)
- RDF BibTex
- RDF vCard

Organizational Agent 4
- Rule Engine (Prova)
- Knowledge Base

Personal Agent 2
- Rule Engine (OO jDrew)
  - Knowledge Base
    - (with translated and replicated facts)

Organizational Agent 5
- Rule Engine (Prova)
- Knowledge Base
Personal Agents

- A personal agent represents a single person of an organization
- The personal agent contains a FOAF* profile with FOAF extended rules

*The Friend of a Friend (FOAF) project: http://www.foaf-project.org
Organizational Agents

- Organizational agents are used to represent shared goals and strategies of each person in the collaborative team.
- Organizational agents contain rule sets that describe their organizations’ policies, regulations, opportunities, etc.
External Agents

- External agents communicate with the virtual organization by sending messages that transport queries, answers, or complete rule sets to the public interface of the organizational agents
- HTTP interface to Rule Responder
- Support for multiple unique External Agents (end users) at a single time
- Users can use a web browser to communicate with Rule Responder (current test interface)
Rule Engines

- Prova (Prolog + Java)
- OO jDREW (Object Oriented Java Deductive Reasoning Engine for the Web)
Prova

- Prova is used to implement the organizational agents of Rule Responder
- Prova is also used as some personal agents
OO jDREW

- OO jDREW is used for personal agents in Rule Responder
- Two modes of Rule Execution:
  - Bottom-up (forward reasoning)
  - Top-down (backward reasoning)
- Rule Responder primarily uses top-down
- Supports rules in the following formats:
  - POSL (Positional Slotted Language)
  - RuleML
Communication Middleware

- **Mule** Enterprise Service Bus (ESB)
  - Mule is used to create communication endpoints at each personal and organizational agent of Rule Responder
  - Mule supports various transport protocols (i.e. http, jms, soap)
  - Rule Responder uses http and jms as transport protocols
Reaction RuleML

- Reaction RuleML is a branch of the RuleML family that supports actions and events.
- When two agents need to communicate, each others’ Reaction RuleML messages are sent through the ESB.
Use Cases

- RuleML-2007 Symposium
  - Single Organizational Agent that acts as the single point of entry to the conference
  - Assist with planning, preparing, and running the Symposium
  - Personal Agents represent Chairs of the Symposium
Online Demo

Example Message

```xml
<Message mode="outbound" directive="query">
  <oid />
  <protocol>
    <esb />
  </protocol>
  <sender>
    <user />
  </sender>
  <content>
    <Atom>
      <Rel>sponsor</Rel>
      <Expr>
        <Fun>contact</Fun>
        <Ind>ben</Ind>
        <Ind>nrc</Ind>
      </Expr>
      <Expr type="integer">500</Expr>
      <Fun>results</Fun>
      <Var>Level</Var>
      <Var>Benefits</Var>
      <Var>DeadlineResults</Var>
    </Atom>
  </content>
</Message>
```
Example Message

```xml
<Message mode="outbound" directive="query">
  <oid>RuleML-2007</oid>
  <protocol>esb</protocol>
  <sender>user</sender>
  <content>
    <Atom>
      <Rel>getContact</Rel>
      <Ind>ruleml2007_Challenge</Ind>
      <Ind>update</Ind>
      <Var>Contact</Var>
    </Atom>
  </content>
</Message>
```

Rule Bases

- [http://www.jdrew.org/oojdrew/programChairAgent2.posl](http://www.jdrew.org/oojdrew/programChairAgent2.posl)

- [http://www.jdrew.org/oojdrew/rulesets/publicityChair.posl](http://www.jdrew.org/oojdrew/rulesets/publicityChair.posl)