Social Semantic Rule Sharing and Querying in Wellness Communities

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Fredericton, NB, Canada

4th Annual Asian Semantic Web Conference, Shanghai, China, Dec. 7-9, 2009

Updated: Jul. 15, 2010

Part 1: WellnessRules Foundation in Profile Knowledge Base Interoperation

- WellnessRules Overview
- Global and Local Knowledge Bases
- Profile Interoperation
  Between Prolog-extending POSL & RDF-extending N3
  - Interoperation Principles for
    Relational (POSL) and **Networked** (N3) Languages
  - POSL ⇔ N3 Transformation
- Taxonomy

Later seen in Part 2:

A use case demo describes an **online-interactive wellness community** through the WellnessRules system in Rule Responder

WellnessRules Overview

- WellnessRules supports a wellness community that is **online-interactive** and **rule-supported**. Each participant of this community has the ability to:
  - **Create profiles about themselves**, containing their preferences for activities and nutrition, their event times, and their fitness levels
  - **Compare and collaborate with others** in the community, to track progress and schedule group events
- Rules about wellness opportunities are
  - **authored** in rule languages such as POSL and N3
  - **interoperated** within the community using RuleML/XML

Global Knowledge Base

- Contains knowledge relevant to everyone in the WellnessRules community

- Knowledge Areas:
  - **Season**
    - Defines timeframe of the seasons
  - **Forecast**
    - Describes the weather forecast within timeframes
  - **Meetup**
    - Contains activity meetup locations for maps

Global Knowledge Base is available in POSL and N3

Local Knowledge Bases

- Contains local knowledge specific to each participant in the WellnessRules community
- Knowledge Areas:
  - **Calendar**
    - Used for event planning. Allows for sharing of calendars between profiles
  - **Map**
    - Links to meetup locations. Allows for sharing of maps between profiles
  - **Fitness**
    - Defines expected fitness level for a specific period of time (scale of 1-10)
  - **Event**
    - Possible/Planned/Performing/Past

  - **MyActivity**
    - Derive participants' individual activity preferences

Local MyActivity Sample Rule (in POSL)
— Centered on Participant p0001as First Argument

```
myActivity(p0001,Running,out,?MinRSVP,?MaxRSVP,?StartTime,?EndTime,?Place,?Duration,?Level)
:-
  calendar(p0001,?Calendar),
  event(?Calendar,?:Running,possible,?StartTime,?EndTime),
  participation(p0001,run,out,?MinRSVP,?MaxRSVP),
 season(?StartTime,summer),
  forecast(?StartTime,sky,?Weather),
  notEqual(?Weather,raining),
  map(p0001,?Map),
  meetup(?Map,run,out,?Place),
  level(p0001,run,out,?Place,?Duration,?Level),
  fitness(p0001,?StartTime,?ExpectedFitness),
 greaterThanOrEqual(?ExpectedFitness,?Level),
 goodDuration(?Duration,?StartTime,?EndTime).
```

Orange designates a profile preference

- Based on this rule the following are p0001's preferences for Running outdoors:
  - The number of participants must be within the minimum and maximum
  - The season must be summer
  - It must not be raining outside
  - p0001's fitness level is greater than or equal to the required fitness level

Profile Interoperation (POSL & N3)

- Support for both ***logic-relational*** (e.g., POSL) and ***graph-networked*** (e.g., N3) knowledge representations

- Users may write their profile in either language

- Support for **OO jDREW** and **Euler** engines to execute queries issued to **POSL** and **N3** knowledge bases, respectively

- *Later seen in Part 2:*
  By using a RuleML subset as the exchange language and Rule Responder as the platform, queries and answers can be exchanged with all supported engines

POSL

- POSL integrates **po**sitional and **sl**otted knowledge (e.g., Prolog's positional and F-logic's slotted knowledge)
- WellnessRules only uses ***po**sitional* *POSL* for ***logic-relational*** knowledge, displayed in a Prolog-like human-readable syntax

- Positional relation descriptions (**f**act and **q**uery examples):
  - **Relation names (f):** `season("2009-06-15T10:15:00",summer).`
    - Each fact and rule head has a **relation name**
  - **Arguments (f):** `season("2009-06-15T10:15:00",summer).`
    - Constant arguments are **strings** or **symbols**, separated by **commas** (“**,**”)
  - **Variables (q):** `season(?StartTime,?)`
    - Variables can be named (“**?**” **prefix**) or anonymous (**stand-alone** “**?**”)

Notation 3 (N3)

- N3 is a compact, rule-extended version of **RDF**'s XML syntax. Writes triples **(subject, property, object)** as **subject** descriptions
- WellnessRules uses ***N3*** for ***graph-networked*** readable knowledge
- Slotted subject descriptions (**f**act and **q**uery examples):
  - **Subject names (f):**
    - Each fact / rule head has a **subject name**

“:” here denotes IRI of this local knowledge base

```
:season_1
   rdf:type     :Season;
   :startTime  "2009-06-15T10:15:00";
   :period      :summer.
```

  - **Variables (q):**
    - Can be named (“**?**” **prefix**), or anonymous (**stand-alone** “**?**”)

```
?season
   rdf:type     :Season;
   :startTime  ?StartTime;
   :period      ?.
```

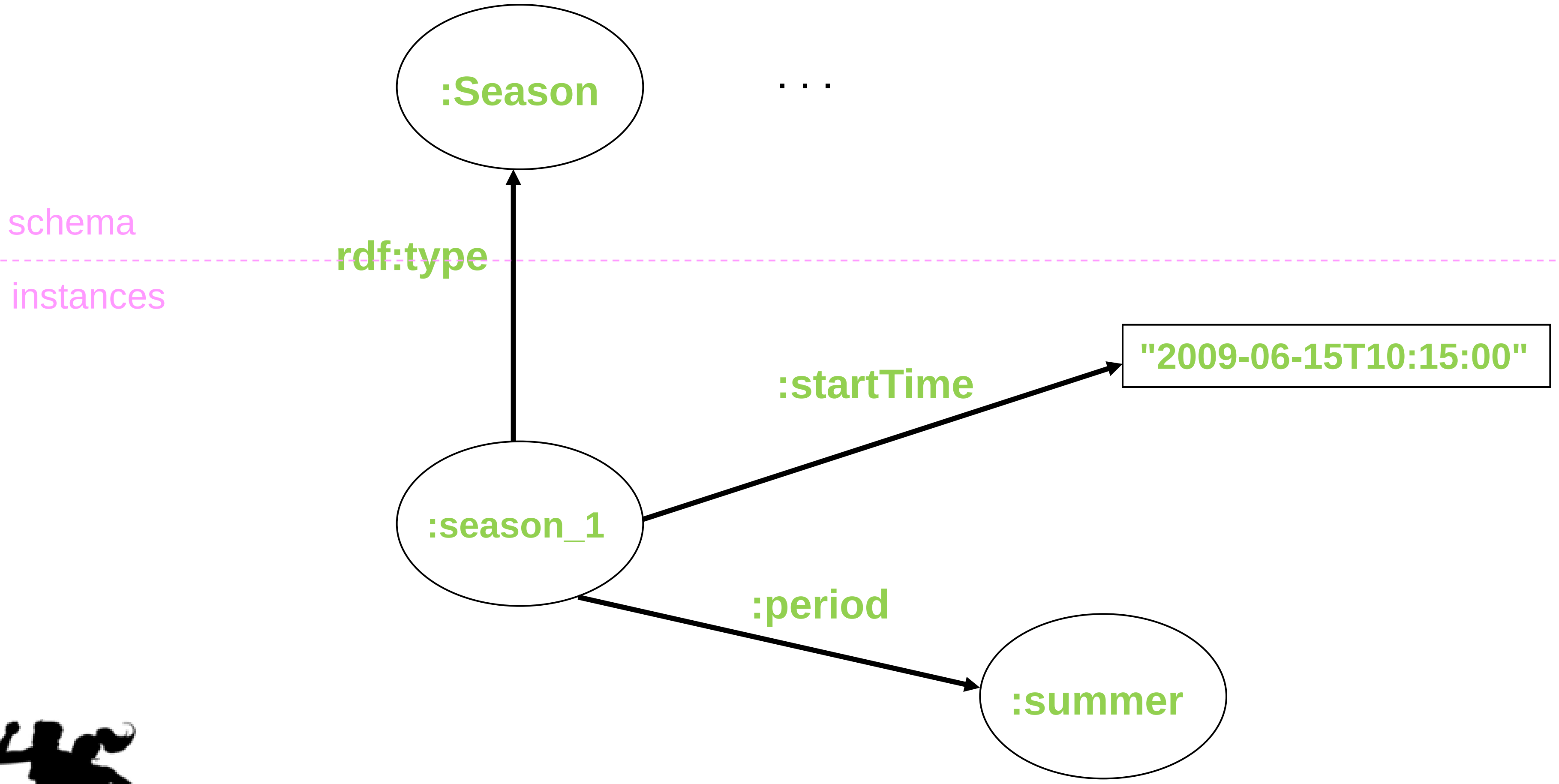
  - **Arguments as property→object slots (f):**
    - Each argument must have a **property** (slot **name**):

```
:season_1
   rdf:type       :Season;
   :startTime   "2009-06-15T10:15:00";
   :period        :summer.
```

    - Each argument must also have an **object** (slot **value**):

```
:season_1
   rdf:type          :Season;
   :startTime      "2009-06-15T10:15:00";
   :period           :summer.
```

Notation 3 (N3): RDF Graph
– Semantic Net / Light-Weight Ontology



:Season

. . .

schema

rdf:type

instances

"2009-06-15T10:15:00"

:startTime

:season_1

:period

:summer

POSL ⇔ N3 Transformation (Atoms)

- □ Transformations are bi-directional; harder left-right reading focused here
- □ N3 uses subjects to provide named instances/relationships.
  The **subject name** is the “:”-prefixed relation “:*name*” extended by “_*i*”, where “*i*” is an instance counter
- □ A *POSL* **relation name** becomes defined in an N3 rule head via an **rdf:type** property using the “:”-prefixed, uppercased version of the “:*Name*”

POSL

```
season(?StartTime,?Season).
```

⇔

```
:season_1
   rdf:type     :Season;
   :startTime   ?StartTime;
   :period      ?Season.
```

N3

- □ Starting with ***positional*** *POSL*, **slot names** (properties) can be generated and stored in signatures for reuse; **variables** and **constants** as **slot values** (objects) employ the **same names** as in POSL

POSL

```
season(?StartTime,?Season).
```

⇔

```
:season_1
   rdf:type     :Season;
   :startTime   ?StartTime;
   :period      ?Season.
```

N3

POSL ⇔ N3 Transformation (Rules)

- **Rule** transformation builds on atom transformation
- OO jDREW (using POSL) typically does **top-down** (:-) reasoning; Euler (using N3) always does **bottom-up** (=>) reasoning: ‘conclude … **from** ---’ becomes ‘if --- **then** …’
  :- =>

POSL

```
myActivity(p0001,Running,out,?MinRSVP,?MaxRSVP,
             ?StartTime,?EndTime,?Place,?Duration,?Level)
:-
   ...
  forecast(?StartTime,sky,?Weather),
  notEqual(?Weather,raining),
   ...
 .
```

⇔

N3

```
{
...
?forecast
    rdf:type                        :Forecast;
    :startTime                      ?StartTime;
    :aspect                         :sky;
    :value                          ?Weather.

 ?Weather log:notEqualTo :raining.
...
}
=>
{
 _:myActivity
    rdf:type                        :MyActivity;
    :profileID                      :p0001;
    :activity                       :Running;
    :inOut                          :out;
    :minRSVP                        ?MinRSVP;
    :maxRSVP                        ?MaxRSVP;
    :startTime                      ?StartTime;
    :endTime                        ?EndTime;
    :location                       ?Place;
    :duration                       ?Duration;
    :fitnessLevel                   ?FitnessLevel.
}.
```

POSL ⇔ N3 Transformation (naf and built-ins)

- The POSL handling of **negation as failure** (**naf**) is via a primitive:

```
naf( event(?Calendar, ?:Running, past, ?StartTimePast, ?EndTimePast))
```

POSL

Euler's N3 doesn't recommend the naf primitive.

Instead, naf is encoded by an **e:findall** expecting an **empty solution list** ()

```
?NAF e:findall
    (?event
        {?event
            rdf:type          :Event;
            :calendarID      ?CalendarID;
            :aspect          :Running;
            :tense           :past;
            :startTime       ?StartTimePast;
            :endTime         ?EndTimePast.}
                                        () )
```

N3

- **POSL** has **built-in** math operations.

N3 uses **package-prefixed** math operations

POSL

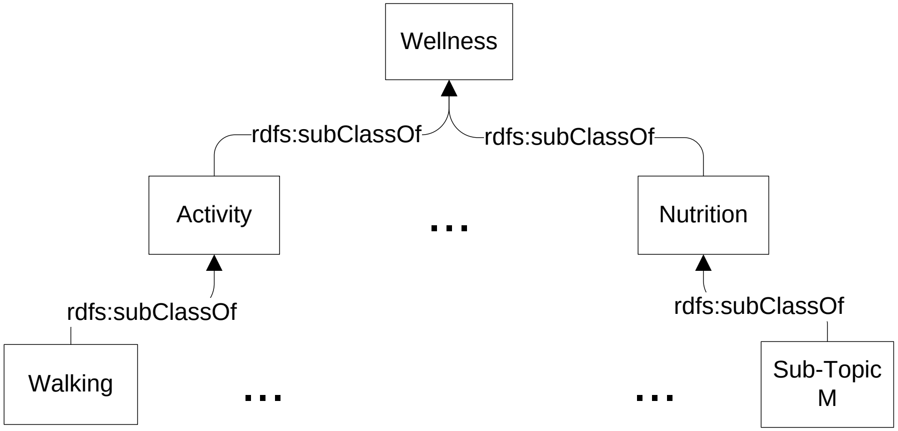
```
greaterThanOrEqual(?ExpectedFitness,?Level)
```

⇔

N3

```
?ExpectedFitness math:notLessThan ?FitnessLevel.
```

Taxonomy



- □ The WellnessRules taxonomy is broken into two topics: Activity and Nutrition
- □ Each of these contains multiple subtopics (e.g., Walking and Running)
- □ Both representations use **rdf:type**, **rdfs:Class** and **rdfs:subClassOf**
- □ Taxonomy *classes* act as user-defined *types* to restrict rule variables

RDF (used by POSL)

N3

```
<rdf:RDF
 xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">

   <rdf:Description rdf:ID="Wellness">
     <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
   </rdf:Description>

   <rdf:Description rdf:ID="Activity">
     <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
     <rdfs:subClassOf rdf:resource="#Wellness"/>
   </rdf:Description>

   <rdf:Description rdf:ID="Walking">
     <rdf:type rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
     <rdfs:subClassOf rdf:resource="#Activity"/>
   </rdf:Description>

    …
```

⇔

```
@prefix : <wellnessRules#>.
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>.

:Wellness      rdf:type            rdfs:Class.
:Activity      rdf:type            rdfs:Class;
               rdfs:subClassOf     :Wellness.
:Walking       rdf:type            rdfs:Class;
               rdfs:subClassOf     :Activity.
 …
```

Part 2: WellnessRules for an Online-Interactive Wellness Community via Rule Responder

□ WellnessRules as a Rule Responder

□ WellnessRules Architecture

□ WellnessRules Agent Implementation and Role Assignment Matrix

□ Activity Scenario: Example Queries with Live Demo

Previously seen in Part 1:

Foundation of WellnessRules in **profile knowledge base interoperation,** which is assisted through **transformation techniques**

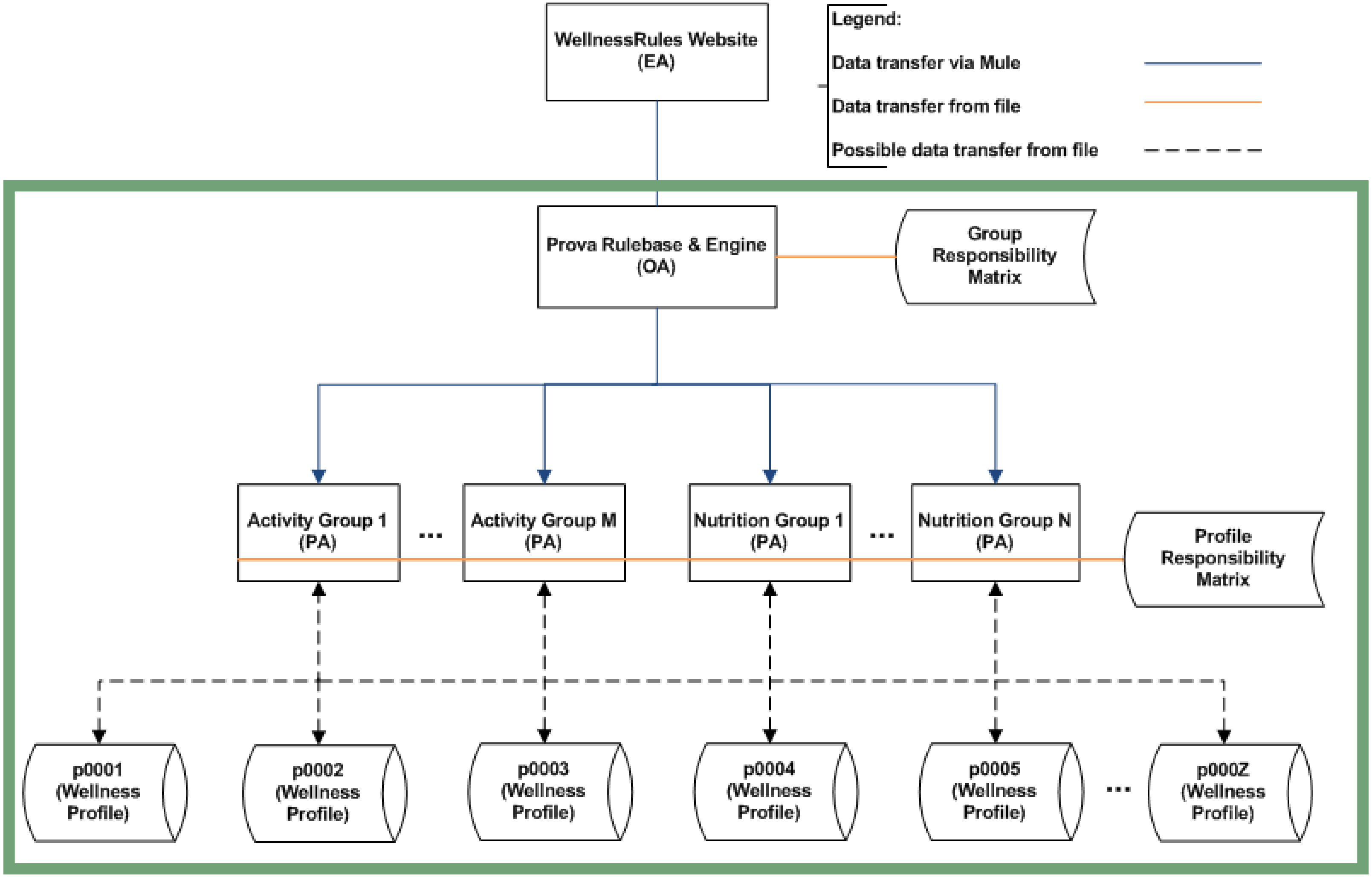
WellnessRules as a Rule Responder

- Rule Responder is an intelligent multi-agent infrastructure for **collaborative** teams and **virtual communities**

- Rule Responder uses three kinds of agents:
  - **Organizational Agent (OA)**
  - **Personal Agents (PAs)**
    - **PAs extended to select relevant profiles of participants**
  - **External Agents (EAs)**

- The WellnessRules instantiation of Rule Responder employs the **OA, PAs,** and **EAs** for **communication** and **query delegation** to support an **online-interactive wellness community**
  - Similar to SymposiumPlanner

WellnessRules Architecture



Rule Responder Agents (OA, PAs, EAs)

- External Agent (EA):
  - The WellnessRules website (shown later)

- Organizational Agent (OA):
  - Contains a Prova knowledge base which is used for incoming queries: **directs** them to **appropriate PAs** via the **Group Responsibility Matrix**

- Personal Agent with Profiles (PA):
  - Consists of a Java servlet and – using the two embedded engines, **OO jDREW** and **Euler** – forwards the query to **POSL** and **N3** profile knowledge bases, respectively
  - It only has **access** to **profiles** which contain **relevant information** for its responsible activity by using the **Profile Responsibility Matrix**

Group and Profile Responsibility Matrix

- Role assignment on two levels: **Group Responsibility Matrix** (GRM) and **Profile Responsibility Matrix** (PRM)

- The **GRM** contains information about PA **wellness responsibility**, written as an OWL light ontology. It defines which PA is best suited for different kinds of queries

- The **PRM** contains information about PA **profile responsibility** and the **format** of each profile knowledge base:

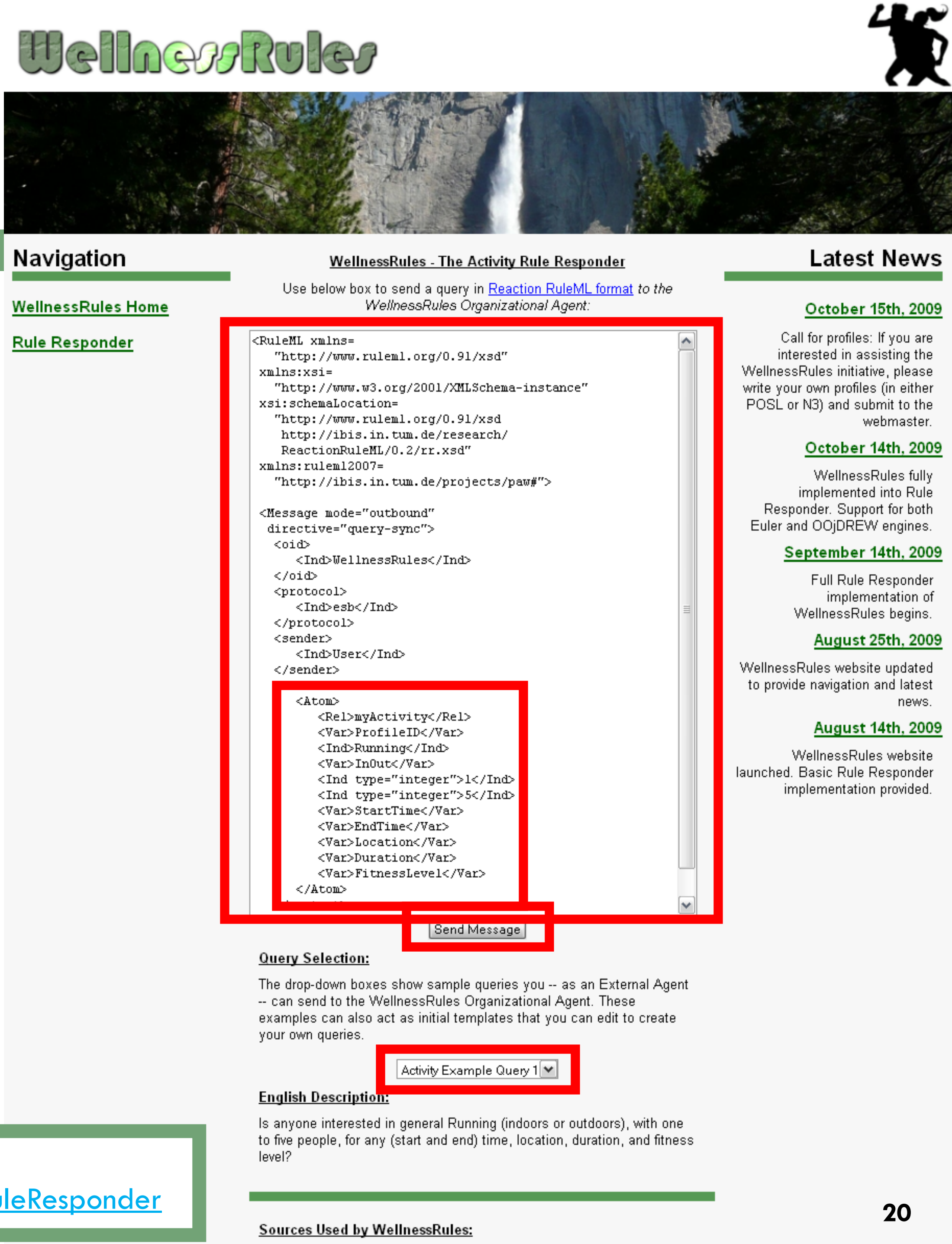
$PA_{Walking}$:

```
<Activity>
     <Walking>
        <ResponsibleProfile name="p0001" format=”posl"/>
        <ResponsibleProfile name="p0002" format=”n3"/>
        <ResponsibleProfile name="p0003" format="posl"/>
     </Walking>
     . . .
</Activity>
```

Website (EA)

- □ EA used to **issue queries** to the WellnessRules **OA**
- □ Query is placed in the text box, in **RuleML** format
- □ The Send Message will issue the query to the OA
- □ A new screen containing a list of **answers** in **RuleML** will be presented
- □ **Query examples** are provided with their subsequent English descriptions. Can be modified to suit your query

Online Demo:
http://www.ruleml.org/WellnessRules/RuleResponder



WellnessRules

Navigation

WellnessRules Home

Rule Responder

WellnessRules - The Activity Rule Responder

Use below box to send a query in Reaction RuleML format *to the WellnessRules Organizational Agent:*

```
<RuleML xmlns=
   "http://www.ruleml.org/0.91/xsd"
 xmlns:xsi=
   "http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=
   "http://www.ruleml.org/0.91/xsd
    http://ibis.in.tum.de/research/
    ReactionRuleML/0.2/rr.xsd"
 xmlns:ruleml2007=
   "http://ibis.in.tum.de/projects/paw#">

 <Message mode="outbound"
  directive="query-sync">
   <oid>
      <Ind>WellnessRules</Ind>
   </oid>
   <protocol>
      <Ind>esb</Ind>
   </protocol>
   <sender>
      <Ind>User</Ind>
   </sender>

      <Atom>
         <Rel>myActivity</Rel>
         <Var>ProfileID</Var>
         <Ind>Running</Ind>
         <Var>InOut</Var>
         <Ind type="integer">1</Ind>
         <Ind type="integer">5</Ind>
         <Var>StartTime</Var>
         <Var>EndTime</Var>
         <Var>Location</Var>
         <Var>Duration</Var>
         <Var>FitnessLevel</Var>
      </Atom>
```

Query Selection:

The drop-down boxes show sample queries you -- as an External Agent -- can send to the WellnessRules Organizational Agent. These examples can also act as initial templates that you can edit to create your own queries.

Activity Example Query 1

English Description:

Is anyone interested in general Running (indoors or outdoors), with one to five people, for any (start and end) time, location, duration, and fitness level?

Sources Used by WellnessRules:

Latest News

October 15th, 2009

Call for profiles: If you are interested in assisting the WellnessRules initiative, please write your own profiles (in either POSL or N3) and submit to the webmaster.

October 14th, 2009

WellnessRules fully implemented into Rule Responder. Support for both Euler and OOjDREW engines.

September 14th, 2009

Full Rule Responder implementation of WellnessRules begins.

August 25th, 2009

WellnessRules website updated to provide navigation and latest news.

August 14th, 2009

WellnessRules website launched. Basic Rule Responder implementation provided.

Activity Scenario: Structured English

Introduction:

- In this scenario a participant of WellnessRules (Peter) uses the system to find one or more partners for Running some time in the near future

Query 1:

- Peter first asks the community if anyone at all is interested in running with 2 to 6 people. Assessing the answer to this, he finds that there are far too many candidates on the list, and decides to narrow down his question

Query 2:

- He feels that he will continue to have a fitness level of 5 for Running, and so asks a refined question wanting only Level-5 activities. In the answer list he notices p0001 (John), who is someone he has previously performed cycling with. (He finds John's fitness level of 5 for running surprising, as he did not realize he was also a good Runner)

Query 3:

- Now he wishes to run with John (perhaps in a race?) and so targets p0001, and that he prefers Joe's Gym as the location. Peter now receives a single, final answer on the list, from which he takes the type of running, time, and duration, to contact John for scheduling this event

Example Query 1

Peter would like to go for a run at some point in time.
He poses the following question:

Green designates a relation name

RuleML

```
...
      <Atom>
          <Rel>myActivity</Rel>
          <Var>ProfileID</Var>
          <Ind>Running</Ind>
          <Var>InOut</Var>
          <Ind type="integer">2</Ind>
          <Ind type="integer">6</Ind>
          <Var>StartTime</Var>
          <Var>EndTime</Var>
          <Var>Location</Var>
          <Var>Duration</Var>
          <Var>FitnessLevel</Var>
       </Atom>
...
```

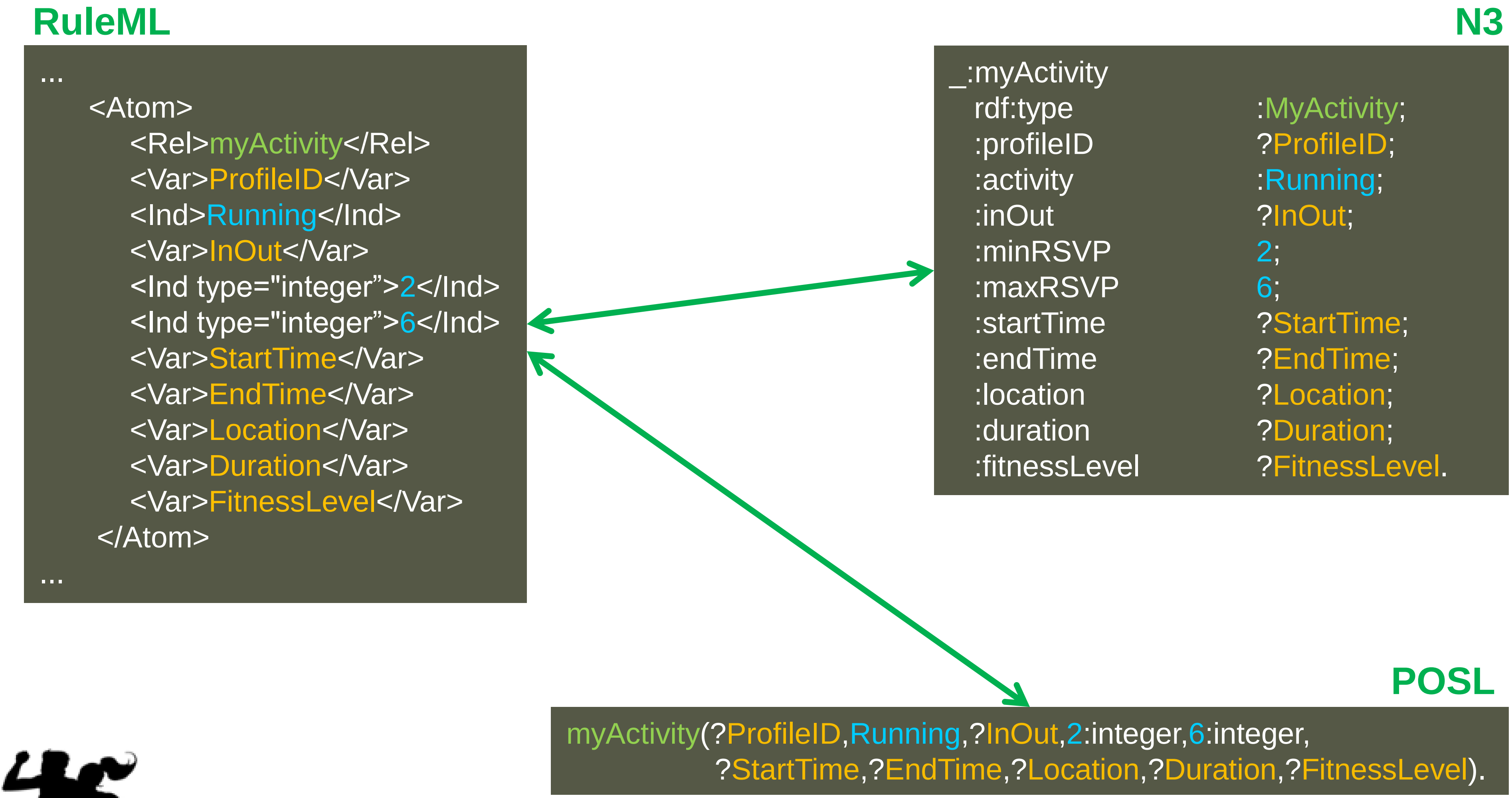
- □ English Description:

Is anyone interested in
general Running
(indoors or outdoors),
with 2
to 6 people,
for any (start
and end) time,
location,
duration,
and fitness level?

Blue designates a constant. More will get blue as we progress

Orange designates a variable

Example Query 1 – POSL & N3



RuleML

```
...
     <Atom>
          <Rel>myActivity</Rel>
          <Var>ProfileID</Var>
          <Ind>Running</Ind>
          <Var>InOut</Var>
          <Ind type="integer”>2</Ind>
          <Ind type="integer”>6</Ind>
          <Var>StartTime</Var>
          <Var>EndTime</Var>
          <Var>Location</Var>
          <Var>Duration</Var>
          <Var>FitnessLevel</Var>
      </Atom>
...
```

N3

```
_:myActivity
   rdf:type                    :MyActivity;
   :profileID                  ?ProfileID;
   :activity                   :Running;
   :inOut                      ?InOut;
   :minRSVP                    2;
   :maxRSVP                    6;
   :startTime                  ?StartTime;
   :endTime                    ?EndTime;
   :location                   ?Location;
   :duration                   ?Duration;
   :fitnessLevel               ?FitnessLevel.
```

POSL

```
myActivity(?ProfileID,Running,?InOut,2:integer,6:integer,
                 ?StartTime,?EndTime,?Location,?Duration,?FitnessLevel).
```

Example Query 2

Peter feels that he will continue to have a fitness level of 5 for Running. He poses the following question:

RuleML

```
...
      <Atom>
           <Rel>myActivity</Rel>
           <Var>ProfileID</Var>
           <Ind>Running</Ind>
           <Var>InOut</Var>
           <Ind type="integer">2</Ind>
           <Ind type="integer">6</Ind>
           <Var>StartTime</Var>
           <Var>EndTime</Var>
           <Var>Location</Var>
           <Var>Duration</Var>
           <Ind type="integer">5</Ind>
       </Atom>
...
```

- English Description:

Is anyone interested in
general Running
(indoors or outdoors),
with 2
to 6 people,
for any (start
and end) time,
location,
and duration,
at a fitness level of 5?

Example Query 3

Now he wishes to run with John, and so addresses p0001, and that he prefers Joe's Gym as the location. He poses the following question:

RuleML

```
...
      <Atom>
           <Rel>myActivity</Rel>
           <Ind>p0001</Ind>
           <Ind>Running</Ind>
           <Var>InOut</Var>
           <Ind type="integer">2</Ind>
           <Ind type="integer">6</Ind>
           <Var>StartTime</Var>
           <Var>EndTime</Var>
           <Ind>joesGym</Var>
           <Var>Duration</Var>
           <Ind type="integer">5</Ind>
       </Atom>
...
```

□ English Description:

Is p0001 interested in
general Running
(indoors or outdoors),
with 2
to 6 people,
for any (start
and end) time,
at Joe’s Gym,
for any duration,
at a fitness level of 5?

Answer to Query 3

WellnessRules will return the answer seen below. This gives Peter all of the information he needs to contact John about scheduling this event.

RuleML

```
...
     <Atom>
         <Rel>myActivity</Rel>
         <Ind>p0001</Ind>
         <Ind>Running</Ind>
         <Ind>in</Ind>
         <Ind type="integer">2</Ind>
         <Ind type="integer">6</Ind>
         <Ind>2009-06-15T10:15:00</Ind>
         <Ind>2009-06-15T11:15:00</Ind>
         <Ind>joesGym</Ind>
         <Ind>P60M</Ind>
         <Ind type="integer">5</Ind>
      </Atom>
...
```

- English Description:

p0001 is interested
in Running
Indoors,
with 2
to 6 people,
between 10:15AM and
11:15AM
on June 15th, 2009,
at Joe's Gym,
for 60 minutes,
at a fitness level of 5.

Conclusion

- The WellnessRules case study:
  - Uses a global as well as distributed local **knowledge bases** to support profile interoperation and querying
  - Demonstrates **profile interoperation** between ***logic-relational*** (e.g., POSL) and ***graph-networked*** (e.g., N3) knowledge representations
  - Introduces an **extended** Rule Responder **architecture,** adding the **profile level** underneath the PAs
  - Supports **online-interactive wellness communities** through the demoed WellnessRules ActivityPlanner in Rule Responder
  - This system, described here, was recently complemented by a WellnessRules NutritionPlanner and by PatientSupporter
  - More Rule Responder instantiations are being planned

Example of Interoperation

- □ According to the PRM, p0001’s profile has a format of POSL:

```
<WellnessRules>
  <Activity>
    <Walking>
      <ResponsibleProfile name="p0001" format=”posl"/>
      <ResponsibleProfile name="p0002" format=”n3"/>
      <ResponsibleProfile name="p0003" format="posl"/>
    </Walking>

    <Running>
      <ResponsibleProfile name="p0001" format=”posl"/>
      <ResponsibleProfile name="p0002" format=”n3"/>
      <ResponsibleProfile name="p0003" format="posl"/>
    </Running>
  . . .
  </Activity>
</WellnessRules>
```

- □ Since p0001’s profile is transformable to N3, the format can be, too:

```
<WellnessRules>
  <Activity>
    <Walking>
      <ResponsibleProfile name="p0001" format=”n3"/>
      <ResponsibleProfile name="p0002" format=”n3"/>
      <ResponsibleProfile name="p0003" format="posl"/>
    </Walking>

    <Running>
      <ResponsibleProfile name="p0001" format=”n3"/>
      <ResponsibleProfile name="p0002" format=”n3"/>
      <ResponsibleProfile name="p0003" format="posl"/>
    </Running>
  . . .
  </Activity>
</WellnessRules>
```