A Conformance Test Suite for the OWL 2 RL/RDF Rules Language and the OWL 2 RDF-Based Semantics

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Introduction

"The Web Ontology Language (OWL)
is a family of knowledge representation languages
for authoring ontologies"

-- Wikipedia: Web_Ontology_Language, 2009-10-23

But **knowledge representation** is *not* the only possible use of OWL!

Introduction

OWL can also be used for **semantically enriching** existing RDF data on the Web!

Example Data for ISWC 2009 (real):

<http://iswc2009.semanticweb.org>
<http://data.semanticweb.org/conference/iswc/2009/chair/general>
<http://data.semanticweb.org/person/enrico-motta> .

Example semantic enrichment (possible):

<http://data.semanticweb.org/conference/iswc/2009/chair/general>
rdf:type owl:FunctionalProperty .
<http://data.semanticweb.org/person/enrico-motta>
rdf:type foaf:Person ;
owl:sameAs *[Enrico's private FOAF entry]* .

„Semantic Enrichment Tags“ may be part of provided data itself, or be added by a different party

Introduction

Claims: Technically still an OWL ontology, but

- large parts of data will typically not be covered
- will often not meet OWL DL's syntactic constraints on RDF

Claims: Reasoners for this scenario

- must cope with ***arbitrary RDF***
  because zero tolerance for „Syntax Error!“ on the Web
- should be good for ***materilization*** and ***query answering*** tasks
  to get more / improved results from browsing and querying the data
- strict completeness not a primary requirement, rather:
  „as many as possible correct inferences in a given time slot“

Introduction

Logicians may say:

> *„It'll be a huge mess – so let's ignore it!“*

... but this mess might become *too* huge to ignore it.
... and too lucrative :-)

The new ***OWL 2 RL / RDF Rules*** language *might* turn out to be useful!

OWL 2 RL / RDF Rules: OWL 2 RL Specification

OWL 2 RL is part of OWL 2 (becoming W3C Recommendation soon)
<http://www.w3.org/TR/owl2-profiles/>

Two „flavors“:

- OWL 2 RL syntactic fragment of OWL 2 DL

```
subClassExpression :=
    Class other than owl:Thing |
    subObjectIntersectionOf | subObjectUnionOf | ObjectOneOf |
    subObjectSomeValuesFrom | ObjectHasValue |
```

  typically interpreted by Direct Semantics (OWL 2 DL sub-language)

- OWL 2 RL / RDF rules

prp-fp	T(?p, rdf:type, owl:FunctionalProperty) T(?x, ?p, ?y_1) T(?x, ?p, ?y_2)	T(?y_1, owl:sameAs, ?y_2)

  „partial axiomatization of OWL 2 RDF-Based Semantics“

OWL 2 RL / RDF Rules: Inferences

prp-fp	T(?p, rdf:type, owl:FunctionalProperty) T(?x, ?p, ?y_1) T(?x, ?p, ?y_2)	T(?y_1, owl:sameAs, ?y_2)

Obvious example:

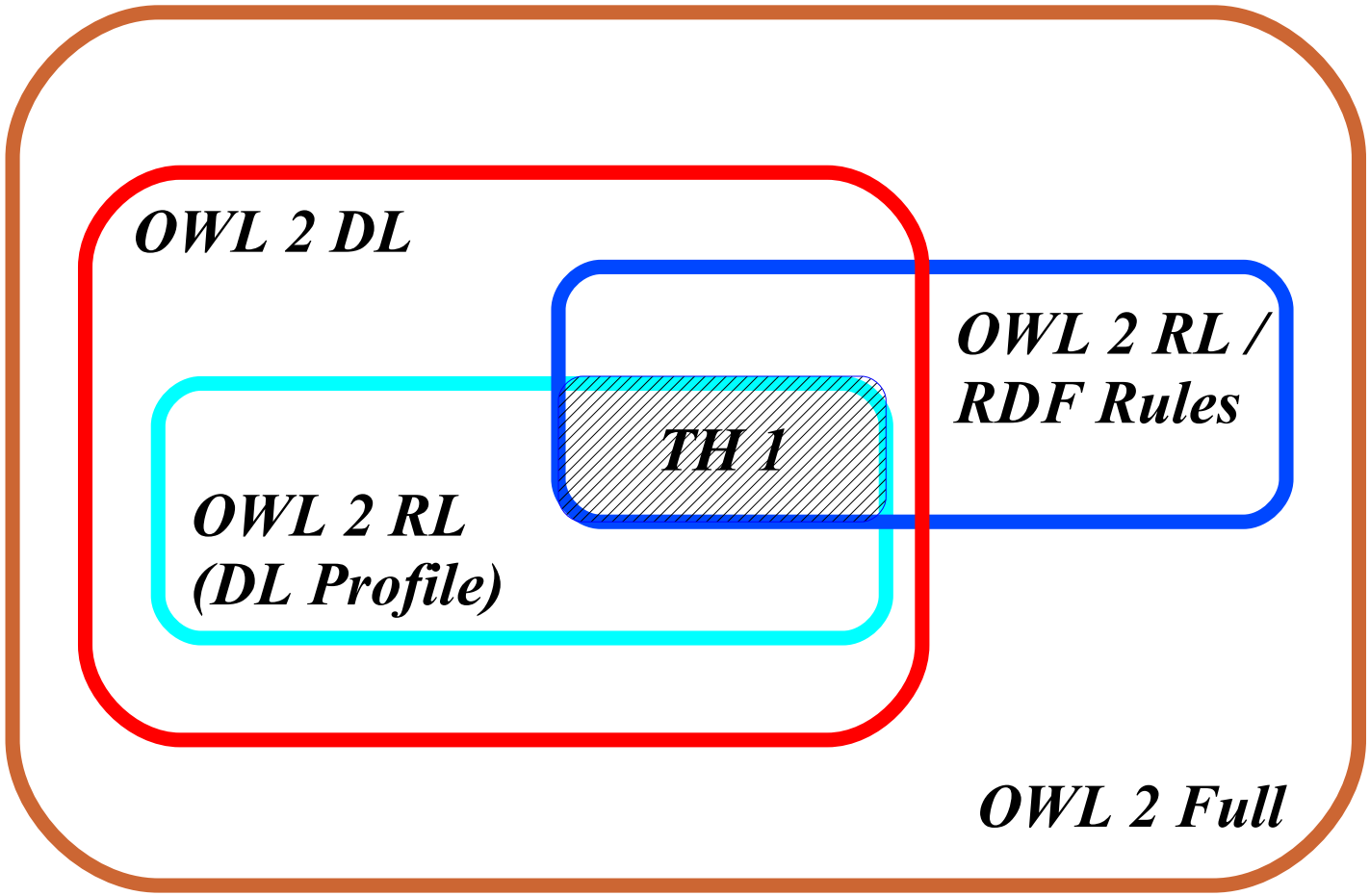
iswc09:generalChair rdf:type owl:FunctionalProperty .
iswc09:conference iswc09:generalChair iswc09:EnricoMotta .
iswc09:conference iswc09:generalChair motta:me .
---
iswc09:EnricoMotta owl:sameAs motta:me .

Maybe not so obvious example:

rdfs:subClassOf rdf:type owl:FunctionalProperty .
ex:c1 rdfs:subClassOf ex:c2 .
ex:c1 rdfs:subClassOf ex:c3 .
---
ex:c2 owl:sameAs ex:c3 .
---
ex:c3 owl:equivalentClass ex:c3 .

(via other rules)

OWL 2 RL / RDF Rules: Relationship between Languages



OWL 2 RL / RDF Rules: Conformance

- Compliant Reasoners may implement rule-semantics differently
- Compliant Reasoners may even go beyond original rule set:
  - Only must (actually: should) be complete w.r.t. rule-set
  - Only must be sound w.r.t. RDF-Based Semantics (OWL 2 Full)
- Hence: Reasoners
  - may implement semantics in ***range*** between rules and OWL 2 Full
  - may compete in expressivity
  - may make trade-offs between expressivity and performance
- Role of OWL 2 Full: not for being implemented completely, but rather serves as a conformance scope for OWL 2 RL reasoners

The Test Suite: Overview

- Purpose: support reasoner implementers to get their product right
  - in particular, if reasoner follows non-RDF-rule-based approach
  - in particular, if reasoner goes beyond original rule set

- Basic Approach:
  - Check each rule (or „semantic condition“) by at least one test case
  - Try to be as close to the rules as possible (don't produce artifacts)
  - Cluster tests systematically according to RDF Based Semantics

- Test suite overall size: 733 test cases
  - all manually created
  - all well documented

- Download (free):
  <http://www.fzi.de/downloads/ipe/testsuite-owl2-rdfbased.zip>

The Test Suite: Overview

- Example OWL 2 RL/RDF Rule:

prp-fp	T(?p, rdf:type, owl:FunctionalProperty) T(?x, ?p, ?y_1) T(?x, ?p, ?y_2)	T(?y_1, owl:sameAs, ?y_2)

- Corresponding test case:

```
TESTCASE rdfbased-sem-char-functional-inst
p owl1full owl2rl
For two triples with the same functional property as their predicates
and with the same subject, the objects are the same.
+
ex:p rdf:type owl:FunctionalProperty .
ex:x ex:p ex:y1 .
ex:x ex:p ex:y2 .
+
ex:y1 owl:sameAs ex:y2 .
+
```

- Testcase creation generally straight-forward for OWL 2 RL/RDF Rules
- Often more complicated for rest of OWL 2 RDF-Based Semantics

- BTW: Testsuite also useful for learning about OWL 2 Full inference :-)

OWL 2 RL/RDF Implementations

- Ivan Herman's Online Reasoner (try it!)
  <http://www.ivan-herman.net/Misc/2008/owlrl/>
- Oracle 11g built-In reasoner
  (see OWL 2 Implementation Report)
- Jena-based forward chaining reasoner (HP / Aberdeen University)
  (see OWL 2 Implementation Report)
- Under construction: Extension of Jena's hybrid OWL reasoner (FZI)
  - will cautiously go beyond original OWL 2 RL / RDF rules

- ... and some of them have used / are using our testsuite for bug fixing

- In addition: OWL 2 RL in RIF (W3C Working Draft, 2009-09-01)
  <http://www.w3.org/TR/rif-owl-rl/>

Conclusion and Outlook

- OWL can be used for semantically enriching existing RDF data
- OWL 2 RL / RDF rules can be applied to arbitrarily RDF data
- Reasoners allowed to go beyond the OWL 2 RL / RDF rules only limited by the OWL 2 RDF-Based Semantics
- Our conformance test suites covers the whole range between the OWL 2 RL / RDF rules and the OWL 2 RDF-based semantics
- Several Implementations exist or are under development, some of them have used / are using the test suite for bug-fixing

- Free **download of testsuite** at:
  <http://www.fzi.de/downloads/ipe/testsuite-owl2-rdfbased.zip>

- EU-Project SEALS („Semantic Evaluation At Large Scale“)
  <http://www.seals-project.eu>
  Will cover reasoners „targeted“ for use on top of RDF triple-stores (additional „higher-level“ conformance tests and performance tests)