

Programming

THE SEMANTIC WEB

Build an application upon Semantic Web models. Brief overview of Apache Jena and OWL-API.



POLITECNICO
DI TORINO



Recap: Tools

- Editors (<http://semanticweb.org/wiki/Editors>)
 - Most common editor: **Protégé 5**
 - Other tools: TopBraid Composer (\$), NeOn toolkit
 - Special purpose apps, esp. for light-weight ontologies (e.g., FOAF editors)
- Reasoners (<http://semanticweb.org/wiki/Reasoners>)
 - OWL DL: Pellet 2.0*, **HermiT**, FaCT++, RacerPro (\$)
 - OWL EL: CEL, SHER, snorocket (\$), ELLY
 - OWL RL: OWLIM, Jena, Oracle OWL Reasoner (\$)
 - OWL QL: Oowlgres, QuOnto, Quill

* The next-gen reasoner (version 3) is part of Stardog, a closed source RDF database

Recap: How to create an ontology



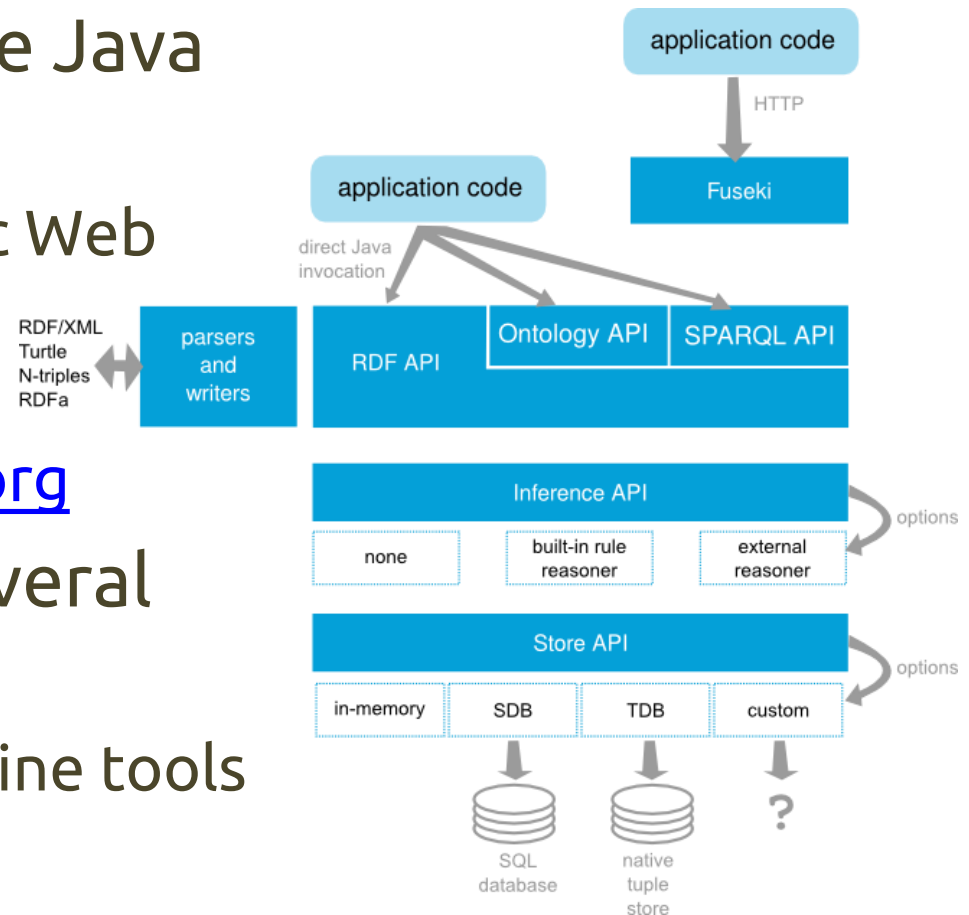
1. Determine the scope
2. Consider reuse
3. Enumerate terms
4. Define classes
5. Define properties
6. Define constraints
7. Create instances

Now what?

- You created a OWL ontology...
- ... or you want to query some SPARQL endpoints...
- How to do this programmatically?
 - e.g., from a software application
- Good news: frameworks exist!
 - They are written in Java...
 - Apache Jena (RDF/SPARQL/...)
 - OWL API (OWL2)

Apache Jena

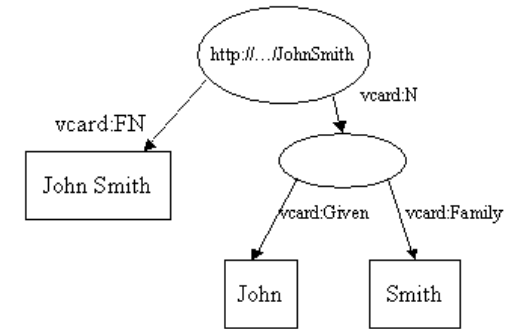
- Free and open source Java framework
 - for building Semantic Web and Linked Data applications
 - <https://jena.apache.org>
- It is composed by several APIs
 - as well as command line tools



Apache Jena

- Tutorials available
 - <https://jena.apache.org/tutorials/index.html>
 - sample code:
<https://github.com/apache/jena/tree/master/jena-core/src-examples/jena/examples/rdf>
- It has a limited support to OWL 1.1
 - no OWL2
 - basically, do not use Jena for ontologies!

Creating a RDF...



```
String personURI = "http://somewhere/JohnSmith";
String givenName = "John";
String familyName = "Smith";
String fullName = givenName + " " + familyName;

// create an empty model
Model model = ModelFactory.createDefaultModel();

// create the resource and add the properties cascading style
Resource johnSmith = model.createResource(personURI)
    .addProperty(VCARD.FN, fullName)
    .addProperty(VCARD.N,
        model.createResource()
            .addProperty(VCARD.Given, givenName)
            .addProperty(VCARD.Family, familyName));
```

Writing RDF...


- **Write the previous model on a OutputStream**
`// now write the model in XML form to a file`
`model.write(System.out);`

- **You can also specify the format**
`// you can also specify the format, e.g.,`
`// model.write(System.out, "TURTLE");`

Reading RDF...

- Read from a `InputStream`

```
String inputFileName = "vc-db-1.rdf";  
InputStream in =  
FileManager.get().open(inputFileName);  
  
// read the RDF/XML file  
model.read(in, "");
```



The base URI to be used when converting
relative URI's to absolute URI's

SPARQL

- Jena supports SPARQL querying through the ARQ engine
 - Standard SPARQL
 - Free text search via Lucene
 - Access and extension of the SPARQL algebra
 - Property functions for custom processing of semantic relationships
 - Aggregation, GROUP BY and assignment as SPARQL extensions
 - Client-support for remote access to any SPARQL endpoint
 - ...

SPARQL with ARQ

[...]

```
// Create a new query
String queryString =
    "PREFIX foaf: <http://xmlns.com/foaf/0.1/> " +
    "SELECT ?url " +
    "WHERE {" +
    "    ?contributor foaf:name \"Luigi De Russis\" . " +
    "    ?contributor foaf:weblog ?url . " +
    "    }";

Query query = QueryFactory.create(queryString);

// Execute the query and obtain results
QueryExecution qe = QueryExecutionFactory.create(query, model);
ResultSet results = qe.execSelect();

// Output query results
ResultSetFormatter.out(System.out, results, query);

// Free up resources used running the query
qe.close();
```

OWL API

- A Java API and reference implementation
 - for creating, manipulating and serializing OWL 2 Ontologies
 - <http://owlcs.github.io/owlapi>
- Free and open source
- Created and maintained by the University of Manchester
 - <http://owl.cs.manchester.ac.uk>

OWL API

- It includes the following components
 - API for OWL 2 and an efficient in-memory reference implementation
 - RDF/XML parser and writer
 - OWL/XML parser and writer
 - OWL Functional Syntax parser and writer
 - Turtle parser and writer
 - SWRL
 - Reasoner interfaces
 - towards, e.g., FaCT++, Hermit, Pellet, and Racer

OWL API

- Documentation and Javadocs
 - <https://github.com/owlcs/owlapi/wiki>
 - http://owlcs.github.io/owlapi/apidocs_4/index.html
 - scarce and not updated, sometimes
- Versions
 - 5.0, cutting edge, Java 8 only
 - 4.0, stable, Java 7+
 - currently used by Protégé
 - several examples are available, right now

OWL API Fundamentals

- `OWLOntology`
 - an interface
 - modelling a set of logical and nonlogical `OWLAxioms`, with a name (an `IRI`) and convenience methods to retrieve such axioms
- `OWLEntity`
 - anything that can be identified with an `IRI`, i.e., class names, data and object properties, named individuals, ...

OWL API Fundamentals

- `OWLAxiom`
 - the basic unity
 - TBox axioms describe relations between classes and class expressions (equivalence, subsumption, disjointness)
 - ABox axioms (assertions) describe relations between individuals and between individuals and classes/class expressions
 - RBox axioms describe relations between properties

Load (or create) an ontology...

- **Ontology creation**

```
OWLOntologyManager m =  
    OWLManager.createOWLOntologyManager();  
OWLOntology o = m.createOntology(example_iri);
```

- **Ontology loading**

```
OWLOntologyManager m =  
    OWLManager.createOWLOntologyManager();  
OWLOntology o =  
    m.loadOntologyFromOntologyDocument(ont_iri);
```

 a File or a IRI

Save an ontology...

- Save in OWL/XML format

```
m.saveOntology(ontology, new  
OWLXMLOntologyFormat(), file);
```

- Save in RDF/XML format

```
m.saveOntology(ontology, file);
```

Learning by Example

- We are going to use the University ontology we developed few weeks ago
- We would like to
 - load the ontology
 - compute logical inferences
 - ask for
 - university individuals
 - which degrees each university offers
 - which courses each degree offers
 - who is enrolled in those courses

We are going to use...

- Eclipse (neon)
 - <https://www.eclipse.org/downloads/>
- OWL API 4.2.8
- HermiT reasoner 1.3.8.413
 - download from <https://github.com/owlcs/owlapi/wiki/Reasoners,-OWL-API-Support,-papers-about-the-OWL-API>
- Gradle 3.4
 - for handling the OWL API/HermiT set up and dependencies
 - <https://gradle.org/>
 - Eclipse supports Gradle through the Buildship plugin

Questions?




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