

## 4. Unit: Reasoners, Rules & Ontology Updates

### 4.1. Unit: Reasoner & Rules

**Exercise 4.1** This exercise is like an experiment in a chemical lab course (but there are no explosions, except from maybe nullpointers):

- Run the examples from the lecture that need a reasoner both with activating (i) Pellet (which is an OWL-DL Reasoner that solves most of the exercises), and (ii) Jena's internal Rule-based (OWL-RL?) reasoner.
- do not use the Web Service, but use the jar from commandline. (note that calls of the form  
`user@foo> time java -cp ... ..`  
also return the time needed for execution)
- do a kind of a protocol report that compares the results.
- try to explain discrepancies whenever they occur, and also explain how the reasoner solves the exercise if it comes to the same result.

**Exercise 4.2** Express the food-wine-example from the "Deductive Databases" lecture in OWL. Run it both with pellet, and with the internal Jena reasoner.

(DB-Lecture slides from <https://www.dbis.informatik.uni-goettingen.de/Lectures/>, somewhere around Slide 658).

**Exercise 4.3 (Hybrid Rules)** Transitivity is a "syntactically second-order property" which can be mapped to its first-order instantiated pattern.

Use a hybrid rule to apply transitivity for

- `mon:reachable` as transitive closure of the (symmetrically stored) `mon:neighbor` relationship, and
- `mon:transitiveFlowsInto` as transitive closure for the `mon:flowsInto` relationship.
- State a SPARQL query against the result that answers all countries that are reachable from Germany,
- State a SPARQL query that computes the length of the total rivernetwork for all rivers that flow directly into some sea.

### 4.2. Unit: Ontology Updates

**Exercise 4.4 (Close-the-World: Win-Move)** For the win-move-game in the lecture, for every node, the out-degree was given explicitly, and the file "winmove-closure.n3" contained additional auxiliary classes.

Goal: write a java class that needs as input only "winmove-axioms.n3" and a graph consisting only of edges and nodes. The class should then automatically define the required auxiliary classes and make each node a member of the appropriate one.

- write an appropriate method `closeWorld(URL property, OntClass class)` that takes a property and a (domain) class and adds all necessary information to close the property wrt. this class. This method should be called as `closeWorld(<foo://bla#edge>, <foo://bla#Node>)`.
- experiment with different input win-move graphs (maybe the ones from the DD/SemWeb exercises).
- Optional: if you know some good graph visualization program, visualize the outcome with it.

**Exercise 4.5 (Close-the-World: Mondial)** Goal: check with Mondial which organizations are subsets of others (e.g., BeNeLux is a subset of the NATO, EU, and UN).

- load mondial-europe into a model.
- state a SPARQL SELECT query that outputs for each organization its name and the number of members.
- derive from this a SPARQL CONSTRUCT query that creates all classes  $\exists^n \text{hasMember.T}$  that describe things with  $n$  members that are needed. make each organization a member of the appropriate class.
- define for each organization a class  $O\text{members}$ , e.g.  $\text{EUmembers}$  that contains all its members.
- state a SPARQL query that returns all pairs  $O_1, O_2$  of organizations such that  $O_1\text{members}$  `rdfs:subClassOf`  $O_2\text{members}$ .
- verify your solution by stating a suitable simple SPARQL query against mondial.n3.

**Exercise 4.6 (Planning)** The “furniture” example of the lecture (Slide 512 ff.) can be seen as a small planning problem:

- consider the input as “furniture truck unloaded, where to place the pieces in the house?”
- There is some furniture given/already placed, and the reasoner concludes for some elements (here: the table) where they have to be placed.
- For the other ones (the three beds), there are different possibilities.
- How can these possibilities be computed (consider that this is not StableModels)?
- Choose one of the possibilities where to put it, update the ontology accordingly, and ask the reasoner for the consequences. If there are still several solutions choose again.
- program it in a general way such that it can be applied to arbitrarily big furniture problems.
- Extend the scenario with two plants  $\text{Plant}(\text{yucca})$  and  $\text{Plant}(\text{bonsai})$  and a music instrument  $\text{Instrument}(\text{piano})$ . It is known that in the livingroom, there is a plant, and in each the bedroom and the guestroom, there is *either* a plant or a music instrument.  
Compute the solutions in this case.

**Exercise 4.7 (OWL Ontology to Relational Schema)** This is a long-term real-world-exercise to be done in several steps.

Consider the transformation from an ER model to a relational model. An OWL ontology like mondial-meta.n3 contains more information than an ER model. So it is possible to derive a relational schema from it algorithmically.

How to do that? You can use Java/Jena, SPARQL queries, and create appropriate auxiliary classes. Use mondial-er.n3 from <https://www.dbis.informatik.uni-goettingen.de/RDF2Rel/> additionally. It uses owl:AnnotationProperties to distinguish between different types of classes:

- **er:Concrete:** the classes for which relational tables should be created.
- **er:Abstract:** classes for which no tables should be created.
- **er:Interface:** classes that are not from the main geo domain, but rather general geometrical notions.

The solution should work for general ontologies, not only for the Mondial example.

As a very first step, create inverse-definitions automatically for all properties that do not yet have some and add them to the ontology.

First bigger step: compute all pairs (*class*, *property*) such that instances of an **er:Concrete** *class* might have *property*. At first sight,  $\text{class} \sqsubseteq \text{domain}(\text{property})$  looks reasonable. This would not

consider that e.g. mountains might have a **lastEruption** property from their **Volcano** subclass. What is the correct condition? How to verify it with OWL/SPARQL?

What are the next steps?