INF3580/4580 – Semantic Technologies – Spring 2018

Lecture 6: Introduction to Reasoning with RDF

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Department of Informatics

University of Oslo

Mandatory exercises

- Oblig 4 published after this lecture.

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- Hand-in by Tuesday in two weeks.

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- Exercises mostly from this week's lecture, but one from next week's lecture, Reasoning with Jena.

Today's Plan

1. Inference rules
2. RDFS Basics
3. Open world semantics

Outline

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2. RDFS Basics
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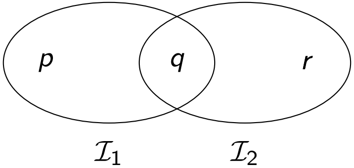

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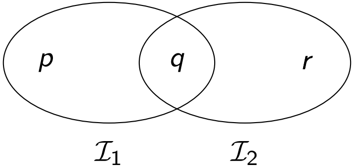

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Syntactic reasoning easier to understand and use than model semantics

- we will show that first.

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Where $\models$ is the entailment relation, $\vdash$ is the inference relation. We write $\Gamma \vdash P$ if we can deduce P from the assumptions Γ.

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Inference rules in propositional logic

(Part of) Natural dedcution calclulus for propositional logic:

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- "If $P_1, \ldots, P_n$ are all in the store, *add* P to the store."

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- and (for our purposes) a subset of OWL.

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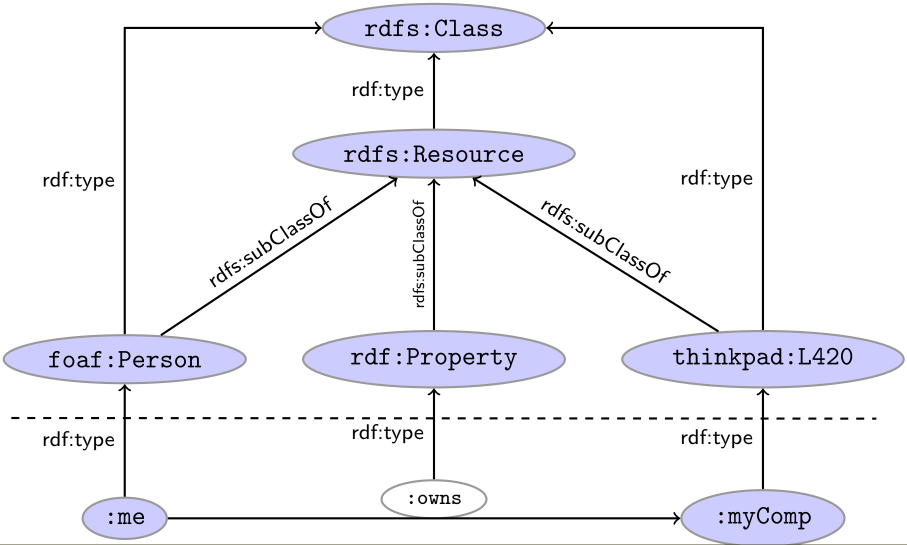
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RDFS	Set Theory
A `rdf:type rdfs:Class`	A is a set of resources
x `rdf:type` A	$x \in A$
A `rdfs:subClassOf` B	$A \subseteq B$

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   - "All *fathers* of people are *males*. James is the *father* of Karl, therefore..."

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(... and also for the other classes)

A typical taxonomy

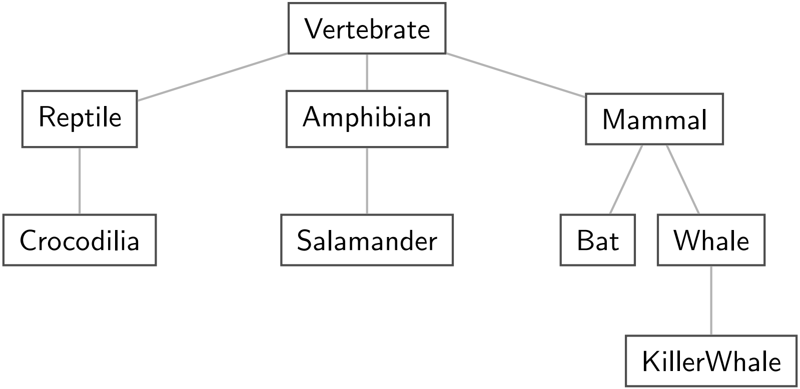

Figure: A typical taxonomy

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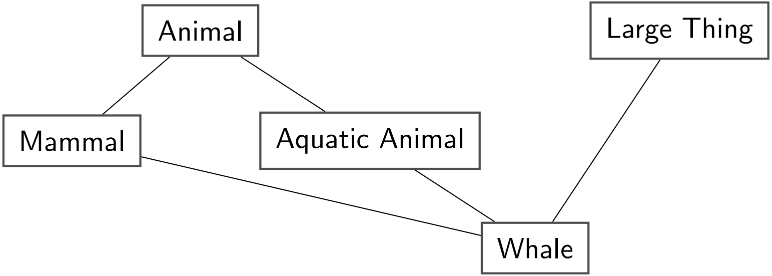

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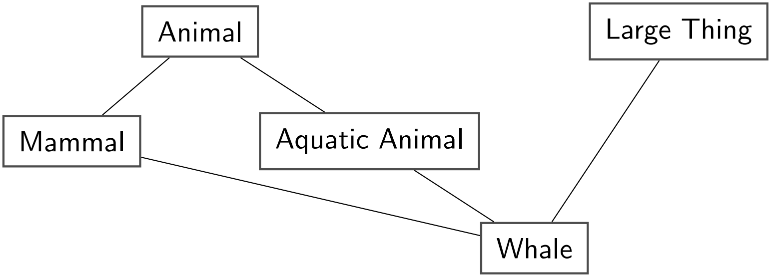

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- Legacy applications that use e.g. `author` can operate unmodified.

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Employer/employee information can be read off from properties such as:

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Organising the properties

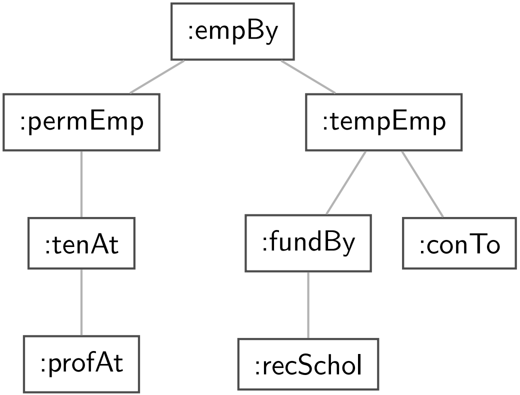

Figure: A hierarchy of employment relations

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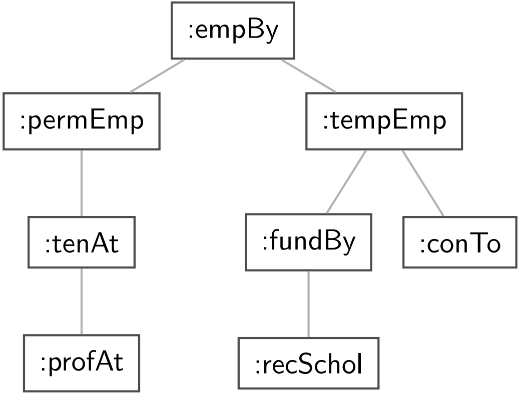

Figure: A hierarchy of employment relations

- Note: doesn't have to be tree-shaped.

Querying the inferred model

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Given a data set such as:

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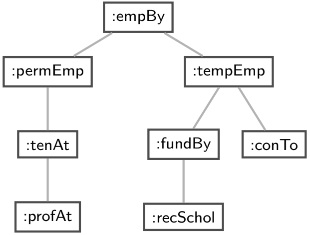

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- Rules:

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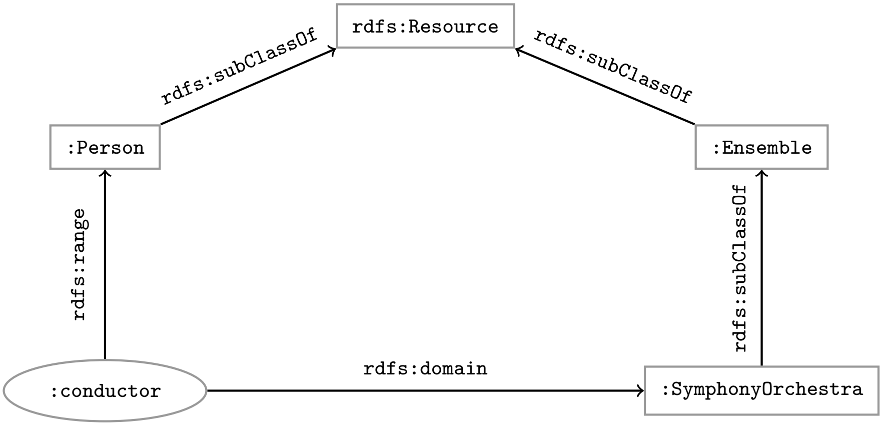
Conductors and ensembles



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and may be used as a type in SPARQL (reasoner presupposed):

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  - `rdf:Property rdf:type rdfs:Class`
  - `:Person rdfs:type rdfs:Resource`
  - `rdfs:Class rdfs:type rdfs:Class`
  - ...
- In OWL, there are some simplification which make this superfluous.

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Outline

1. Inference rules
2. RDFS Basics
3. Open world semantics

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This is *the* most important difference between relational DBs and RDF.

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     - (It is not possible to in RDFS to say that `ex:Smoker` and `ex:nonSmoker` are disjoint).

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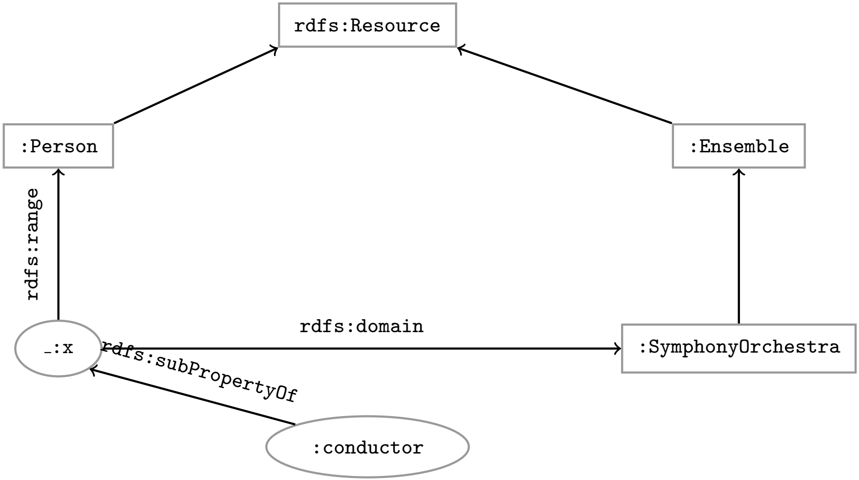
- RDFS supports no reasoning services that require consistency-checking.
- If consistency-checks are needed, one must turn to OWL.
- More about that in a few weeks.

A conspicuous non-pattern

Suppose we elaborate on our music example in the following way:



The incompleteness of RDFS

That is:

- We make `:conductor` a subproperty of `_:x`,
- `_:x` is a generic relation between people and orchestras,
- to be used whenever we want the associated restrictions.

We would then *want to be able* to reason as follows (names abbreviated):

1. `:Oslo :cond :Abadi .` – P

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5. `:Abadi rdfs:type :Person .` – rdfs2, 3, 4

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- However, we cannot use `rdfs2` and `rdfs7` in this way,
- since it requires putting a blank in predicate position,
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Nevertheless,

- this really *is a semantically valid inference*,
- thus the RDFS rules are *incomplete* wrt. RDFS semantics.
- There are also other cases where the RDFS rules are not sufficient for deriving all entailed triples (e.g. deriving domains and ranges), more on this in three weeks.

Assessing the situation

RDFS reasoners usually implement only the standardised incomplete rules, so

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Unless, of course

- you need to talk about properties and classes as objects,
- that is, you need the meta-modelling facilities of RDFS,
- but people rarely do.

Conclusion

- We have seen that by modelling knowledge using the URIs in the RDF and RDFS vocabularies (e.g. `rdf:type`, `rdfs:subClassOf`, `rdfs:range`), the computer can derive *new* triples, that follows from our original triples.

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- However, note that even the most complex mathematical proofs can be broken down into equally simple steps.
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- Example of large ontology, BabelNet: `http://www.babelnet.org/`

Conclusion

- We have seen that by modelling knowledge using the URIs in the RDF and RDFS vocabularies (e.g. `rdf:type`, `rdfs:subClassOf`, `rdfs:range`), the computer can derive *new* triples, that follows from our original triples.
- The rules were very simple (e.g. if `x rdf:type A` and `A rdfs:subClassOf B` then `x rdf:type B`).
- However, note that even the most complex mathematical proofs can be broken down into equally simple steps.
- It is when we have large knowledge bases and we can apply thousands or millions of derivations that the reasoning becomes really interesting.
- Example of large ontology, BabelNet: `http://www.babelnet.org/`
- OWL will also allow us to express more complex statements and use more complex types of reasoning.

That's it for today!

Remember the oblig!