INF3580/4580 – Semantic Technologies – Spring 2017

Lecture 6: Introduction to Reasoning with RDF

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Department of Informatics

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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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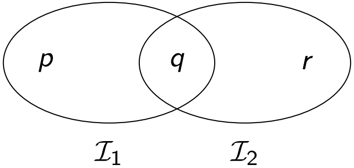

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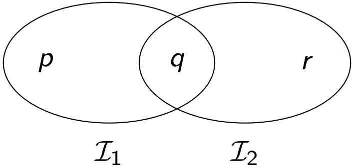

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Syntactic reasoning easier to understand and use than model semantics

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

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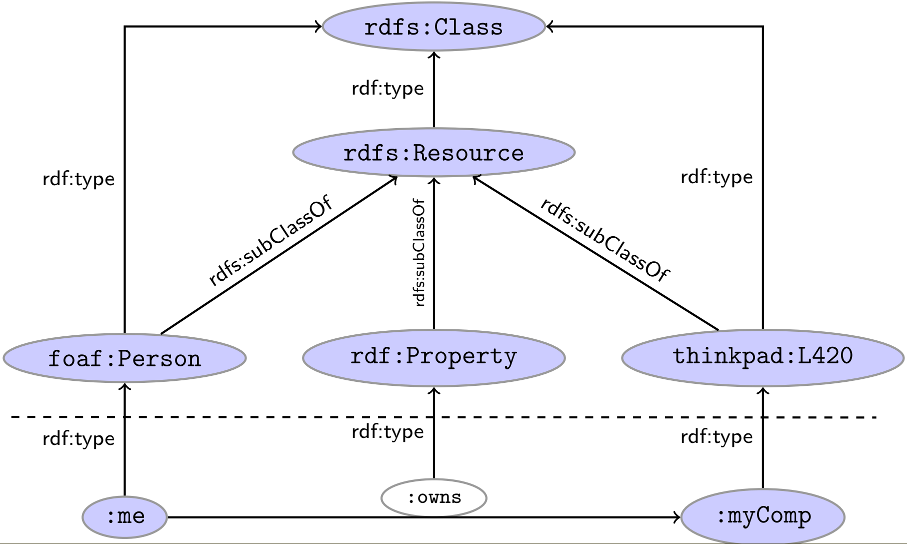
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RDFS	Set Theory
A `rdf:type rdfs:Class`	A is a set of resources
x `rdf:type` A	$x \in A$
A `rdfs:subClassOf` B	$A \subseteq B$

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RDFS supports three principal kinds of *reasoning pattern*:

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   - "All *father*s of people are *male*s. James is the *father* of Karl, therefore..."

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(... and also for the other classes)

A typical taxonomy

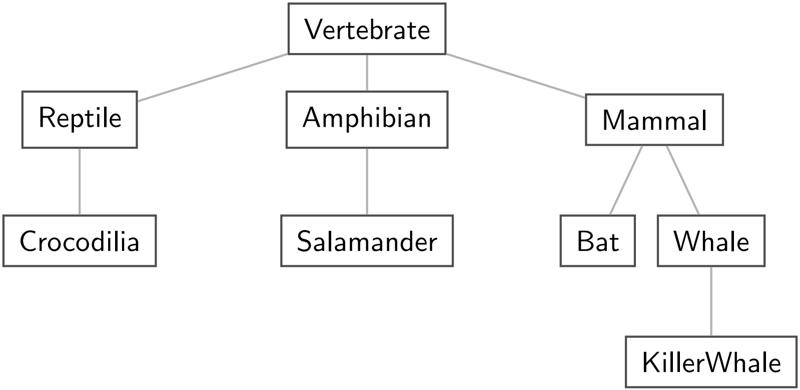

Figure: A typical taxonomy

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- A set is a subset of many other sets:

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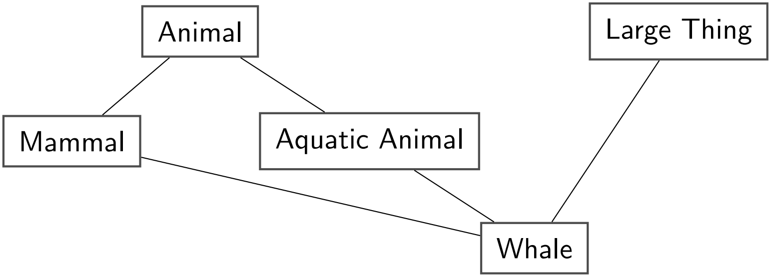

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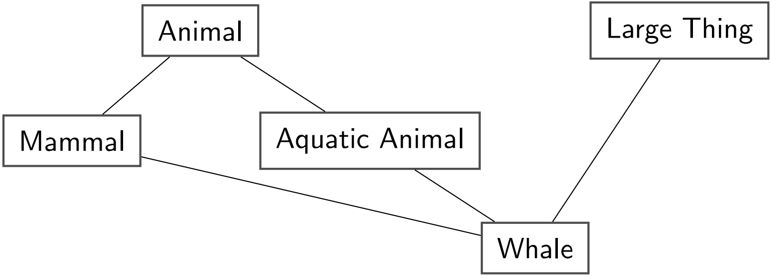

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:author rdfs:subPropertyOf dcterms:creator .
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- Legacy applications that use e.g. `author` can operate unmodified.

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

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Organising the properties

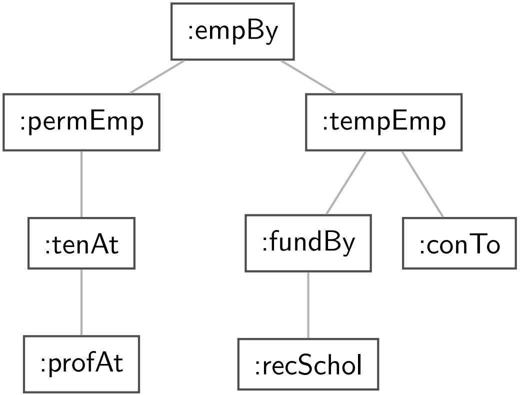

Figure: A hierarchy of employment relations

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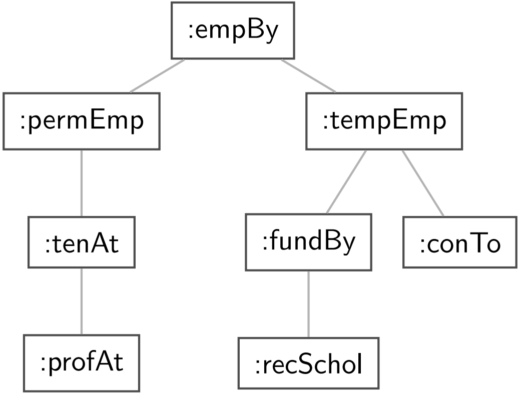

Figure: A hierarchy of employment relations

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

Querying the inferred model

Formalising the tree:

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Given a data set such as:

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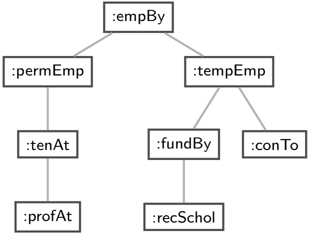

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We may now query on different levels of abstraction :

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All employees

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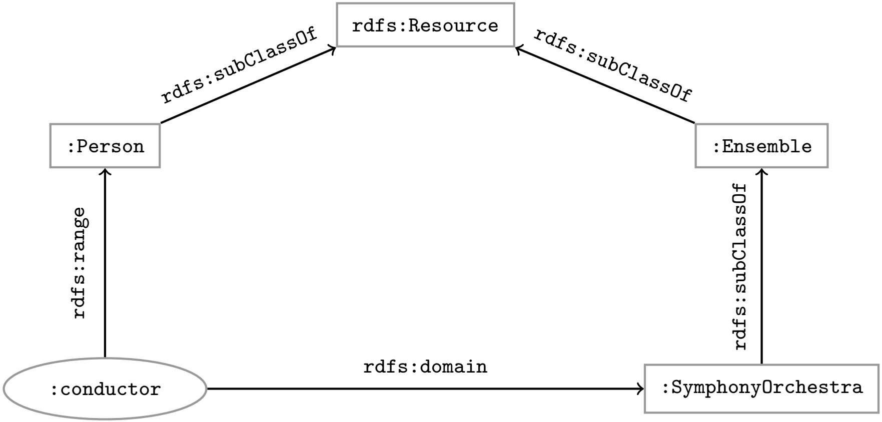
Conductors and ensembles



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

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

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Outline

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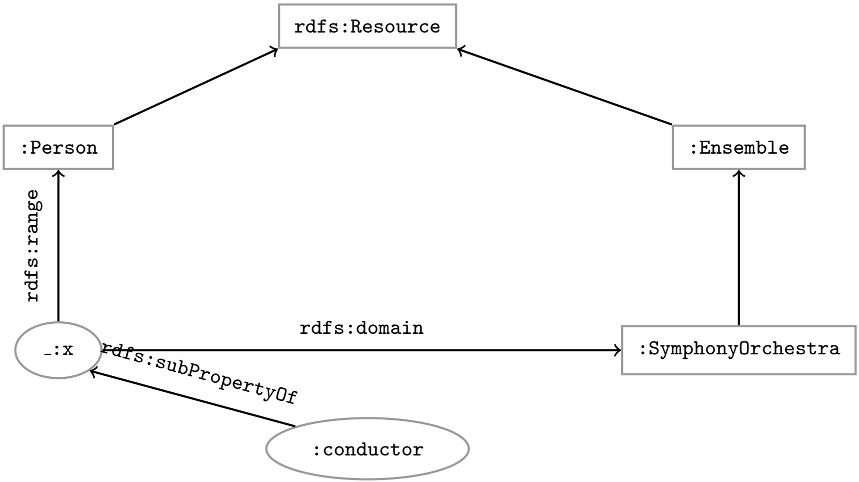
- RDFS supports no reasoning services that require consistency-checking.
- If consistency-checks are needed, one must turn to OWL.
- More about that in a few weeks.

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):

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4. `_:x rdfs:domain :Person .` – P
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,
- which is not legitimate RDF.
- Hence, the conclusion is not derivable.

Nevertheless,

- this really *is a semantically valid inference*,
- ... you are hereby encouraged to check this for yourself,
- whence the RDFS rules are *incomplete* wrt. RDFS semantics.

Assessing the situation

RDFS reasoners usually implement only the standardised incomplete rules, so

- they do not guarantee complete reasoning.

Better therefore;

- if all you need is the three RDFS reasoning patterns,
- to use OWL and OWL reasoners instead.

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.
- 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, SNOMED: `http://browser.ihtsdotools.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, SNOMED: `http://browser.ihtsdotools.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!