COMP318

RDFS Semantics

www.csc.liv.ac.uk/~valli/Comp318

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Where were we

- RDF and RDFS
- Vocabulary and principles

RDF Vocabulary Description Language

- Types in RDF:
  - ⟨#john,rdf:type,#Student⟩
- Definition of what is “#Student” ⇒ A language for defining types in RDF:
  - Define classes:
    - “#Student is a class”
  - Relationships between classes:
    - “#Student is a sub-class of #Person”
  - Properties of classes:
    - “#Person has a property hasName”
- RDF Schema is such a language

RDF vs RDFS

- RDF language for describing structured information
  - **individuals**:
    - the book entitled “Lord of the rings”, the author “J.R.R Tolkien”...
  - **relations between individuals**:
    - The book “Lord of the rings” is authored by “J.R.R Tolkien”
  - **types of literals and resources**:
    - They belong to class of elements sharing the same characteristics
      - natural numbers, dates, ...

- How do we model classes of individuals?

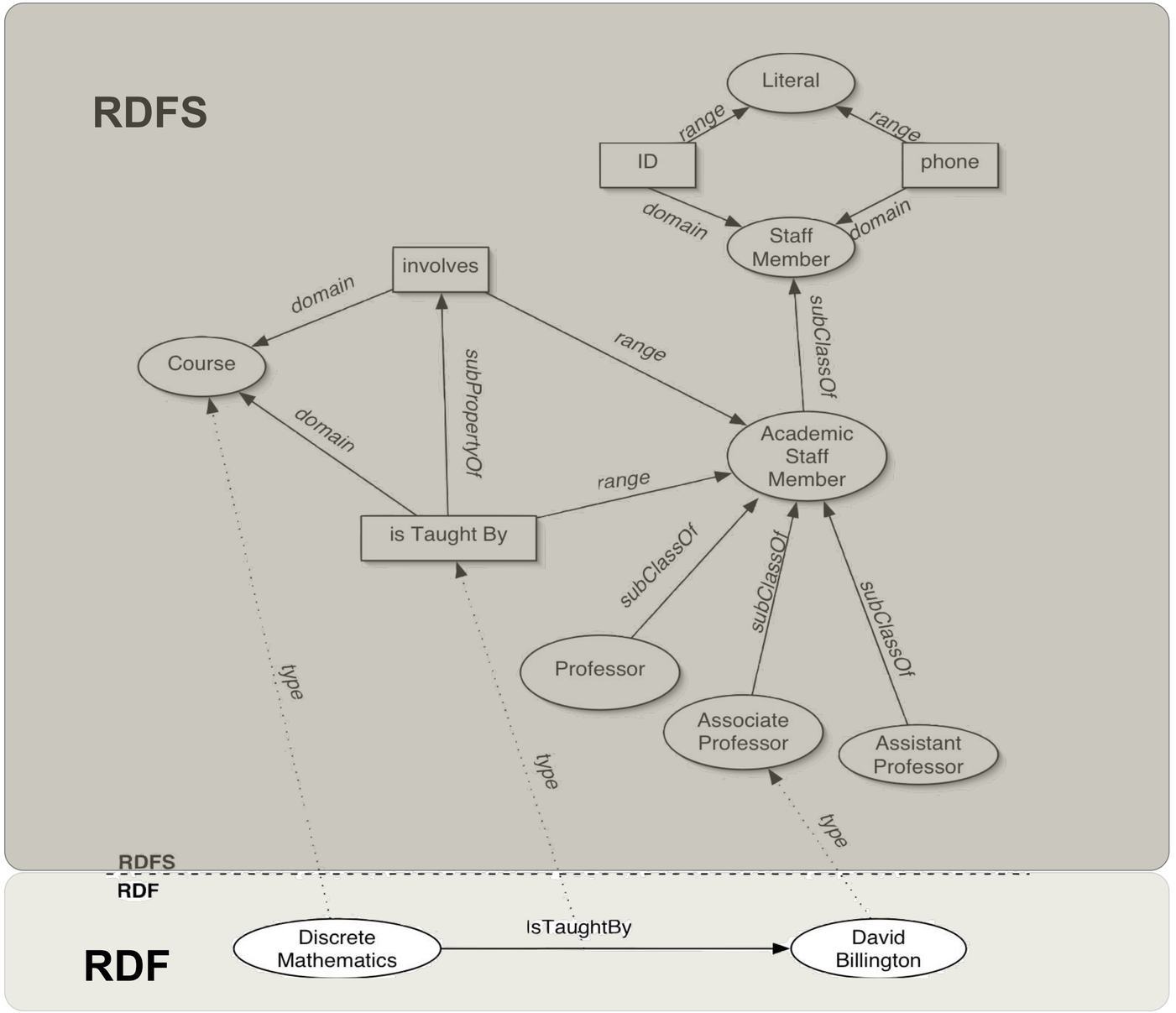
Basic Ideas of RDF Schema

- RDF is a universal language that lets users describe resources in their own vocabularies
  - RDF does not assume, nor does it define semantics of any particular application domain

- The user can do so in RDF Schema using:
  - Classes and Properties
  - Class Hierarchies and Inheritance
  - Property Hierarchies

Classes and their Instances

- We must distinguish between
  - Concrete “things” (**individual** objects) in the domain: *Semantic Web*, *John Smith* etc.
  - Sets of individuals sharing properties called **classes**: *lecturers*, *students*, *courses* etc.
- Individual objects that belong to a class are referred to as instances of that class
- The relationship between instances and classes in RDF is through `rdf:type`


RDFS
Literal
range
range
ID
phone
domain
domain
Staff Member
involves
domain
subClassOf
Course
subPropertyOf
range
domain
Academic Staff Member
range
is Taught By
subClassOf
subClassOf
subClassOf
Professor
Associate Professor
Assistant Professor
type
type
type
RDFS
RDF
RDF
Discrete Mathematics
IsTaughtBy
David Billington

RDFS Primitives

- **Resource**:
  - All resources are implicitly instances of `rdfs:Resource`.
- **Class**: describe sets of resources
  - classes are resources themselves
    - e.g. Webpages, people, document types
  - Class hierarchy can be defined through `rdfs:subClassOf`
  - Every class is a member of `rdfs:Class`
- **Property**: subset of RDFS Resources that are properties
  - **domain**: class associated with property, `rdfs:domain`
  - **range**: type of the property values, `rdfs:range`
  - Property hierarchy defined through `rdfs:subPropertyOf`
- **Statements**
  - Resources that reify subject/predicate/object triples

RDFS Vocabulary

- RDFS is the RDF vocabulary description language
  - it can be used to build simple RDF vocabularies
  - it provides a data model for describing groups of related resources, and their relationships.
    - RDFS inherits RDF syntax, and thus RDFS specifications are RDF data.
    - RDFS has a simple model theoretic semantics that allows inference in the form of entailment rules.
  - RDFS vocabulary is defined in the namespace:
    - http://www.w3.org/2000/01/rdf-schema#

RDFS Vocabulary Description Language

- **Classes:**
  - ⟨`#Student,rdf:type,#rdfs:Class`⟩
- **Class hierarchies:**
  - ⟨`#Student,rdfs:subClassOf,#Person`⟩
- **Properties:**
  - ⟨`#hasName,rdf:type,rdf:Property`⟩
- **Property hierarchies:**
  - ⟨`#hasMother,rdfs:subPropertyOf,#hasParent`⟩
- **Associating properties with classes (a):**
  - “The property #hasName only applies to # Person:”
  - ⟨`#hasName,rdfs:domain,#Person`⟩
- **Associating properties with classes (b):**
  - “The type of the property #hasName is # xsd:string:”
  - ⟨`#hasName,rdfs:range,xsd:string`⟩

RDFS

- RDFS Classes
  - rdfs:Resource
  - rdfs:Class
  - rdfs:Literal
  - rdfs:Datatype
  - rdfs:Container
  - rdfs:Container Membership Property

```
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns:dc="http://purl.org/dc/elements/1.1/">

 <owl:Ontology
     rdf:about="http://www.w3.org/2000/01/rdf-schema#"
     dc:title="The RDF Schema vocabulary (RDFS)"/>

<rdfs:Class rdf:about="http://www.w3.org/2000/01/rdf-schema#Resource">
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/2000/01/rdf-schema#"/>
  <rdfs:label>Resource</rdfs:label>
  <rdfs:comment>The class resource, everything.</rdfs:comment>
</rdfs:Class>

<rdfs:Class rdf:about="http://www.w3.org/2000/01/rdf-schema#Class">
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/2000/01/rdf-schema#"/>
  <rdfs:label>Class</rdfs:label>
  <rdfs:comment>The class of classes.</rdfs:comment>
  <rdfs:subClassOf rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
</rdfs:Class>
...
```

RDFS

- RDFS Properties
  - rdfs:domain
  - rdfs:range
  - rdfs:subPropertyOf
  - rdfs:subClassOf
  - rdfs:member
  - rdfs:seeAlso
  - rdfs:isDefinedBy
  - rdfs:comment
  - rdfs:label

```
<rdf:Property rdf:about="http://www.w3.org/2000/01/rdf-schema#subClassOf">
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/2000/01/rdf-schema#"/>
  <rdfs:label>subClassOf</rdfs:label>
  <rdfs:comment>The subject is a subclass of a class.</rdfs:comment>
  <rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
  <rdfs:domain rdf:resource="http://www.w3.org/2000/01/rdf-schema#Class"/>
</rdf:Property>

<rdf:Property rdf:about="http://www.w3.org/2000/01/rdf-schema#subPropertyOf">
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/2000/01/rdf-schema#"/>
  <rdfs:label>subPropertyOf</rdfs:label>
  <rdfs:comment>The subject is a subproperty of a property.</rdfs:comment>
  <rdfs:range rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
  <rdfs:domain rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
</rdf:Property>

<rdf:Property rdf:about="http://www.w3.org/2000/01/rdf-schema#comment">
  <rdfs:isDefinedBy rdf:resource="http://www.w3.org/2000/01/rdf-schema#"/>
  <rdfs:label>comment</rdfs:label>
  <rdfs:comment>A description of the subject resource.</rdfs:comment>
  <rdfs:domain rdf:resource="http://www.w3.org/2000/01/rdf-schema#Resource"/>
  <rdfs:range rdf:resource="http://www.w3.org/2000/01/rdf-schema#Literal"/>
</rdf:Property>
...
```

Why Classes are Useful

- Impose restrictions on what can be stated in an RDF document using the schema
  - As in programming languages
    - E.g. A+1, where A is an array
    - All Lecturers must hold a PhD, so `has_title = "PhD"` for the members of the class Lecturer
  - Disallow nonsense from being stated

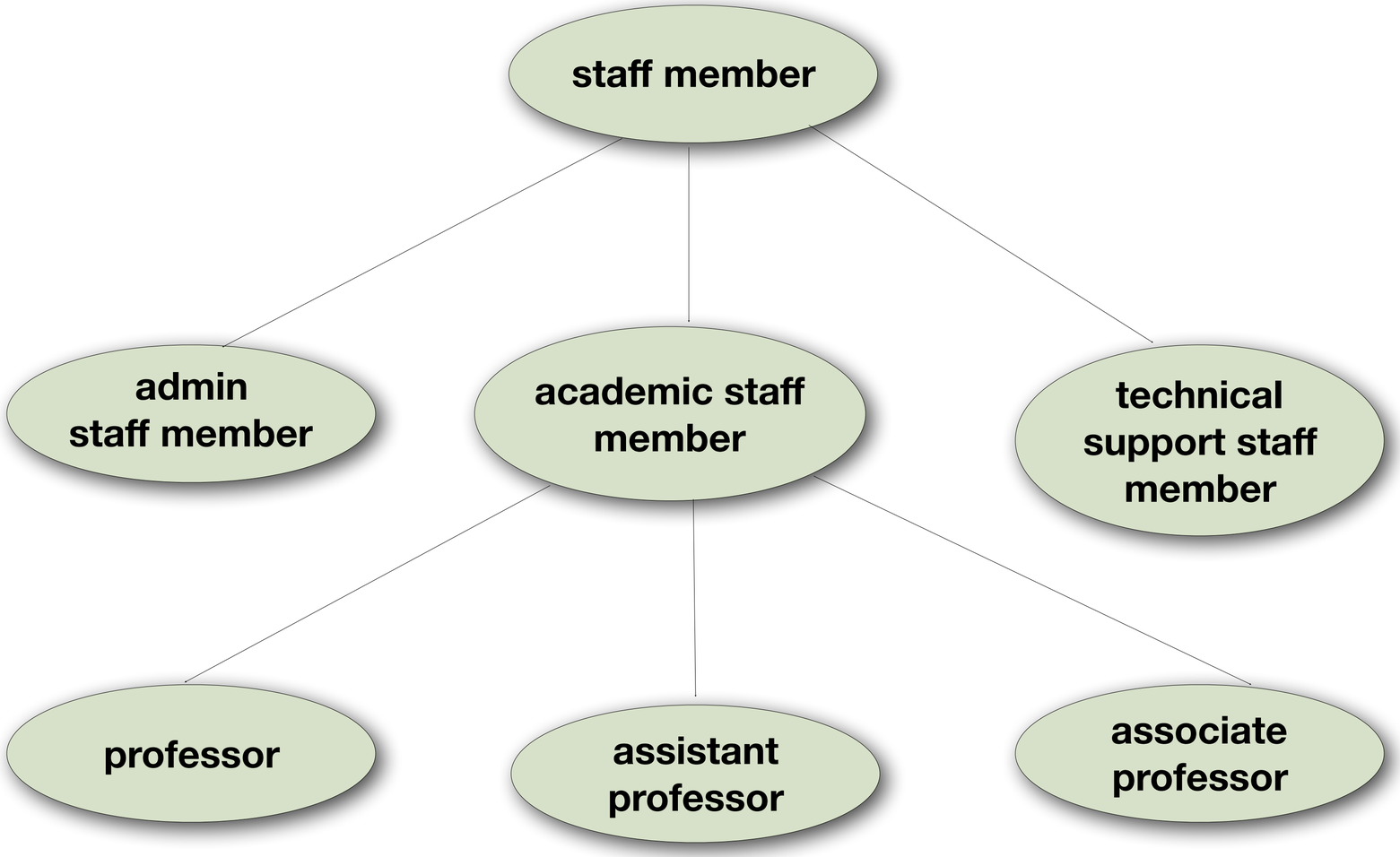
Disallow nonsensical statements

- Semantic Web is taught by Advanced Web Technologies
  - We want courses to be taught by lecturers only
  - Restriction on values of the property “is taught by” (range restriction)
- Room MZH5760 is taught by John Smith
  - Only courses can be taught
  - This imposes a restriction on the objects to which the property can be applied (domain restriction)

Class Hierarchies

- Classes can be organised in hierarchies
  - A is a subclass of B if every instance of A is also an instance of B
  - Then B is a superclass of A
- A subclass graph need not be a tree
- A class may have multiple superclasses

Class Hierarchy Example



Inheritance in Class Hierarchies

- Range restriction: Courses must be taught by academic staff members only
  - John Smith is a professor
  - He inherits the ability to teach from the class of academic staff members

- This is done in RDF Schema by fixing the semantics of "`rdfs:subClassOf`"
  - It is not up to an application (RDF processing software) to interpret "`rdfs:subClassOf`"

Property Hierarchies

- Hierarchical relationships for properties
  - E.g., **`“is taught by”`** is a sub-property of **`“involves”`**
  - If a course C is taught by an academic staff member A, then C also involves A

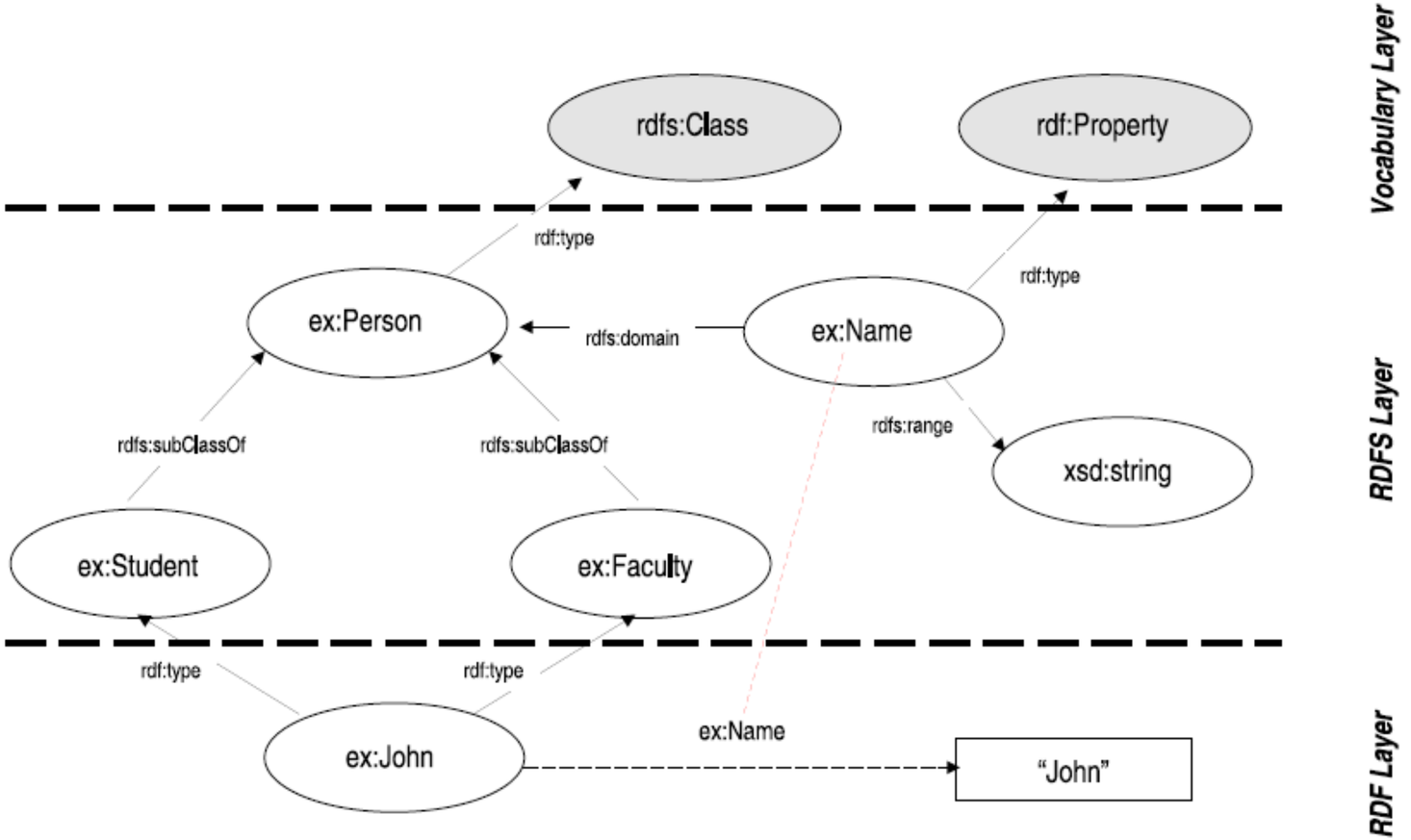
- The converse is not necessarily true
  - E.g., A may be the teacher of the course C, or
  - a tutor who marks student homework but does not teach C
  - P is a subproperty of Q, if Q(x,y) is true whenever P(x,y) is true

RDF Layer vs RDF Schema Layer

- "*Semantic Web is taught by John Smith*"

- The schema is itself written in RDF Schema, that can express its components:
  - subClassOf, Class, Property, subPropertyOf, Resource, etc.

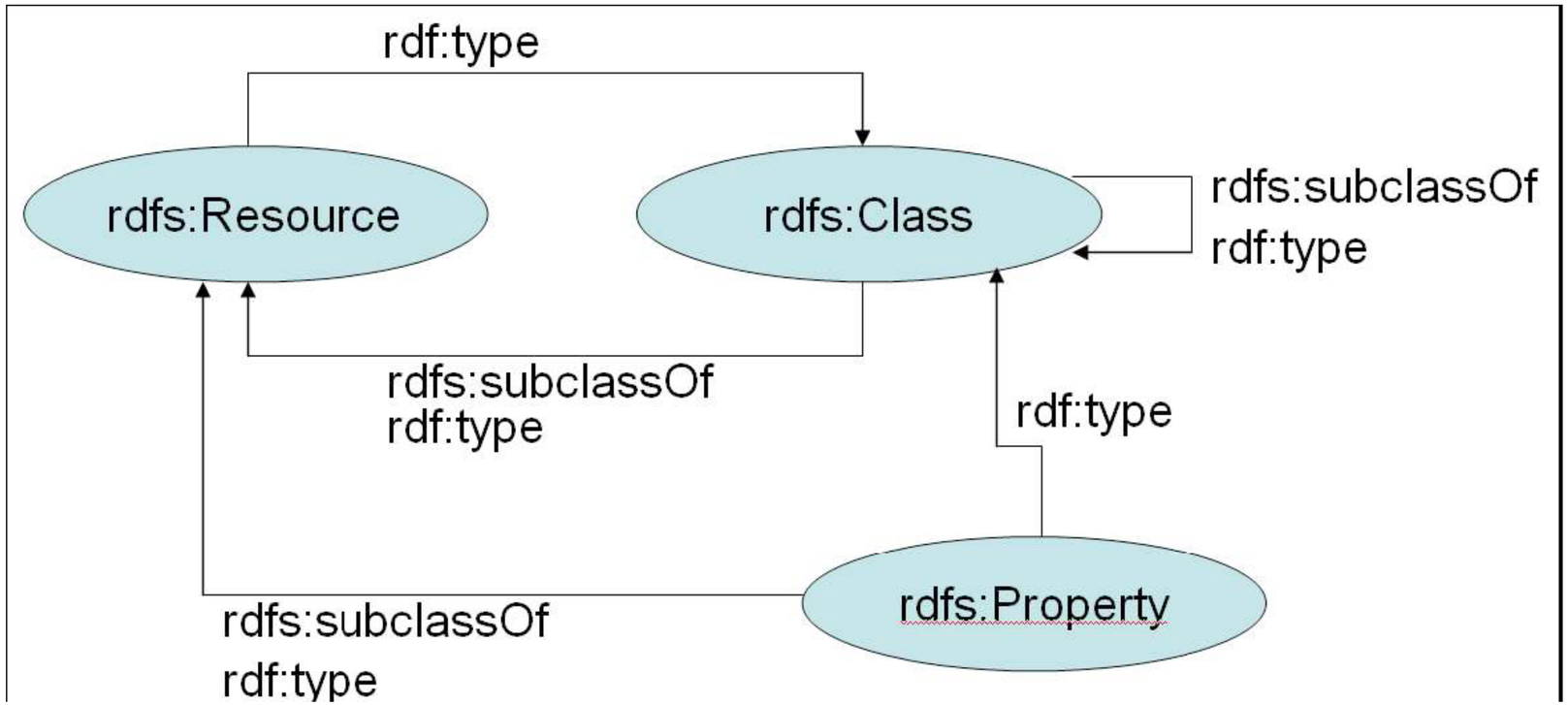
RDFS Example

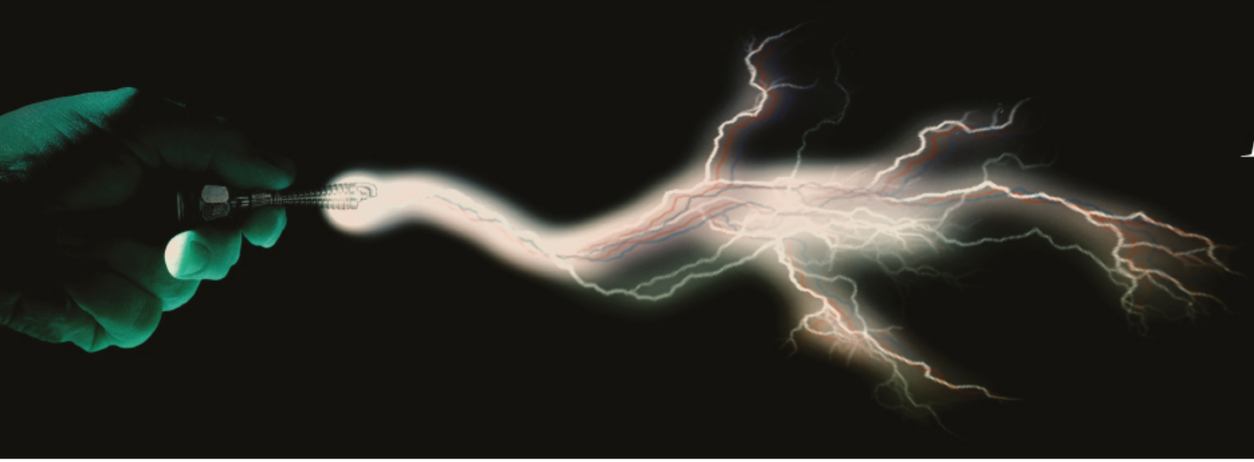


Literals in RDFS

- Each literal is an rdfs:Literal
  - if we have:
    - ⟨#john,#hasName,“John”⟩
  - Which is interpreted as:
    - ⟨ < #john,#hasName, _:X >
    - <_:X,rdf:type,rdfs:Literal >)

RDFS Vocabulary





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Department of Computer Science
University of Liverpool

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Build your network of contacts as you go, bringing you closer to your next internship, placement or job.

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SCAN ME

Computer Science Hackathon
Saturday 8 February, 10am - 7pm

How to network
Monday 10 February, 1pm - 3pm

Exploring alternative careers
Monday 10 February, 5pm - 7pm

Now you SME me!
Tuesday 11 February, 2pm - 3pm

Careers in cyber security
Tuesday 11 February, 5pm - 8pm

Computer Science skills session
Wednesday 12 February, from 1.30pm

ISE Careers Fair - Amsterdam
Thursday 13 February, all day event

Making a successful application
Thursday 13 February, 1pm - 2pm

Alumni & friends networking event
Thursday 13 February, 5pm - 8pm

Recap

- RDF as a data modelling language
  - RDF syntax
- RDFS schema language