

RDF Schema

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Semantic Web

- Describe rules for using RDF properties
 - Are expressed in RDF
 - Extends original RDF vocabulary
 - Are not to be confused with XML Schemas
-
- RDFS defines a basic set of classes and properties, together with their **semantics** (interpretation) and **logic**

- RDFS namespace

<http://www.w3.org/2000/01/rdf-schema#>

- rdfs:Resource**

- rdfs:Class**

- rdfs:Literal**

- rdfs:Datatype**

- rdf:XMLLiteral

- rdf:Property

- rdfs:range**

- rdfs:domain**

- rdf:type

- rdfs:subClassOf**

- rdfs:subPropertyOf**

- rdfs:label**

- rdfs:comment**

- rdfs:Container**

- rdf:Bag

- rdf:Seq

- rdf:Alt

- rdfs:ContainerMembershipProperty**

- ♦ rdf:_1, rdf_2 ...

- rdfs:member**

- rdf:List

- rdf:first

- rdf:rest

- rdf:nil

- rdf:Statement

- rdf:subject

- rdf:predicate

- rdf:object

- rdfs:seeAlso**

- rdfs:isDefinedBy**

- rdf:value

- Are groups of Web resources
- Have URLs to identify them
- The special class “`rdfs:Literal`” consists of all possible RDF string values

- In typical OO classes, each class specifies completely what properties it has and what their types are
- In RDF classes, each property specifies what classes of subjects and objects it relates
- Therefore, new properties can be added to a class without modifying the class

- To specify a class, create an RDF resource of type `rdfs:Class`

```
<rdfs:Class id="MyClass">  
  <rdfs:label>My Class</rdfs:label>  
  <rdfs:comment>Sample demonstration Class</rdfs:comment>  
</rdfs:Class>
```

- To specify a property, create an RDF resource of type `rdfs:Property`

```
<rdfs:Property id="myProperty">  
  <rdfs:comment>Sample demo property</rdfs:comment>  
  <rdfs:domain resource="#MyClass" />  
  <rdfs:range resource="..#Literal" />  
</rdfs:Property>
```

- Ordinary XML namespace URIs are just to guarantee uniqueness: there is no assumption that the URI refers to anything useful (or even refers at all)
- URIs for namespaces used in RDF, though, should refer to an RDF schema document

- “`rdf:type`” relates any resource to its class
- “`rdfs:subClassOf`” relates a subclass to its superclass (multiple inheritance is OK)

`baby` `rdfs:subClassOf` `child`

- “`rdfs:subPropertyOf`” relates a subproperty to its superproperty

`mother` `rdfs:subPropertyOf` `parent`

- “`rdfs:seeAlso`” relates a resource to another resource explaining it (use a subproperty to specify the nature of the explanation)
- “`rdfs:isDefinedBy`” is a subproperty of “`rdfs:seeAlso`” and relates a resource to its definition, typically an RDF schema

- “`rdfs:domain`” specifies the domain of a property (the classes of its subjects); if unknown, anything can be a subject
- “`rdfs:range`” specifies the range of a property (the single class of its objects); if unknown, anything can be an object
- `domain` and `range` effectively restrict classes that can be in specific relationship

- “`rdf:subject`” is the property relating a reified statement to its subject (resource)
- “`rdf:predicate`” is the property relating a reified statement to its predicate (property)
- “`rdf:object`” is the property relating a reified statement to its object (value)

- “`rdfs:label`” specifies a human-readable name for this Class, Property, or whatever
- “`rdfs:comment`” specifies human-readable documentation
 - ◆ Multiple values are useful for specifying multiple languages

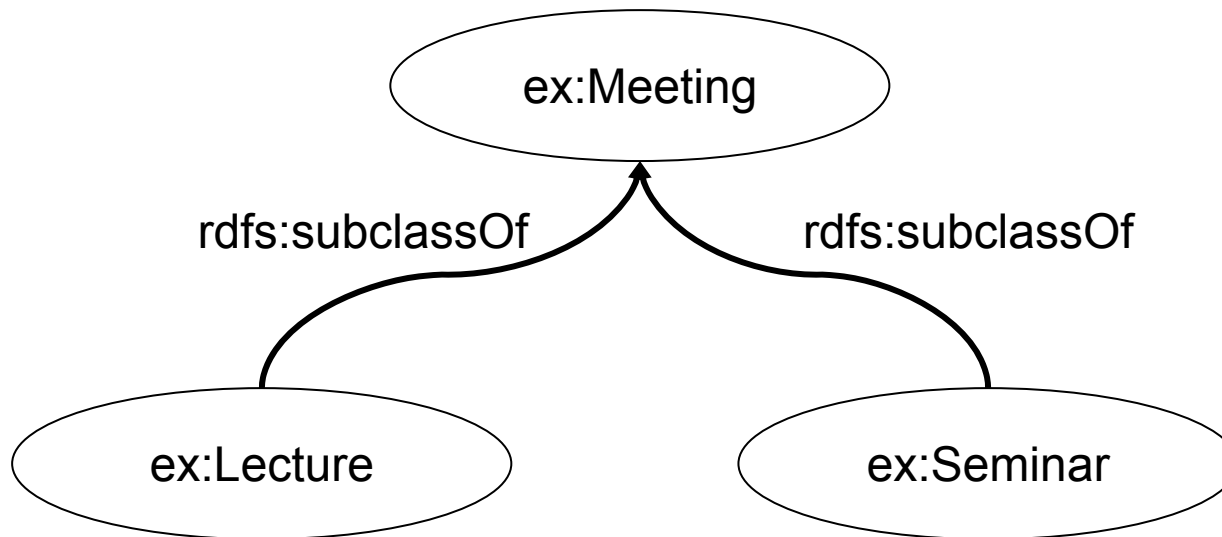
- “`rdfs:Resource`” is the class of all resources
- “`rdfs:Literal`” is the class of all strings
- “`rdfs:Class`” is the class of all classes
- “`rdfs:Property`” is the class of all properties
- “`rdf:Statement`” is the class of all asserted RDF statements

- “`rdfs:Container`” is the superclass of all container classes
- “`rdf:Bag`”, “`rdf:Seq`”, “`rdf:Alt`” are the classes of Bags (multi-set), Seqs (sequence), and Alts (alternative)
- Any other class that is a subclass of “`rdfs:Container`” can be used in RDF syntax in place of a standard container

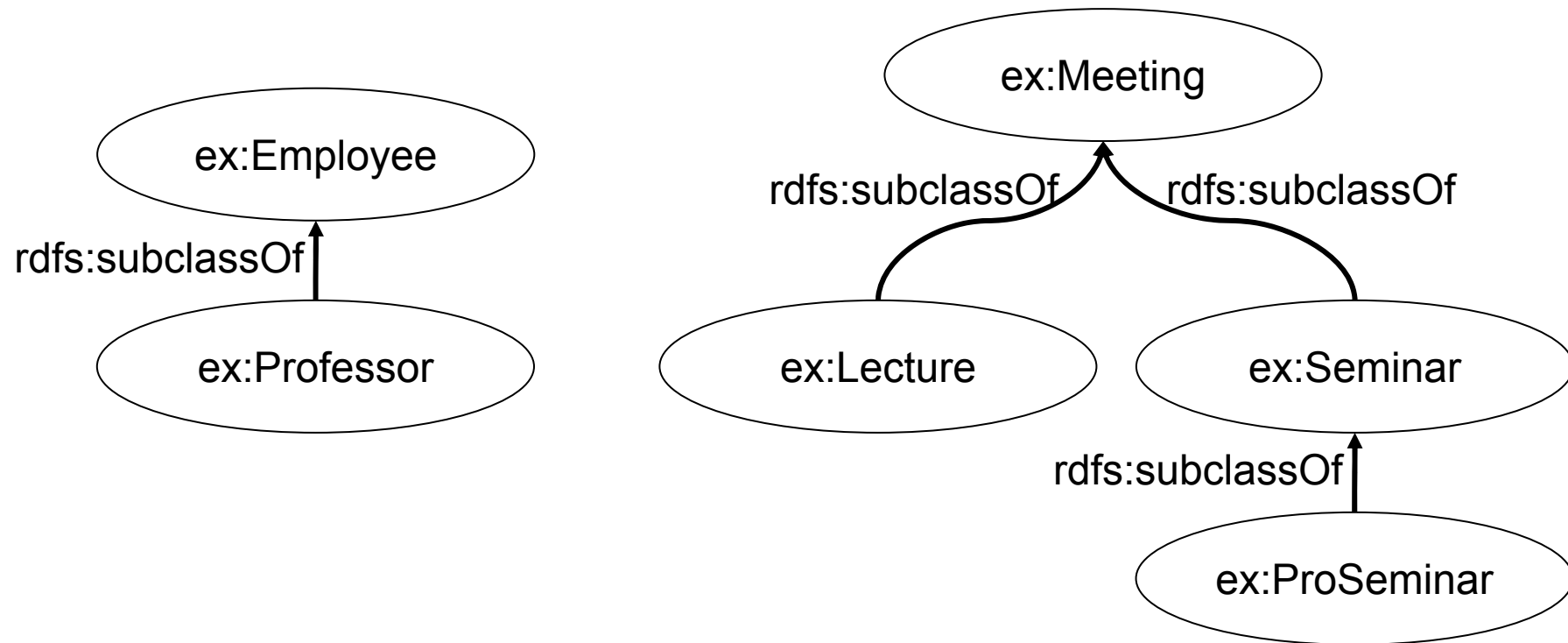
ex:Seminar rdfs:subClassOf ex:Meeting

ex:Proseminar rdfs:subClassOf ex:Seminar

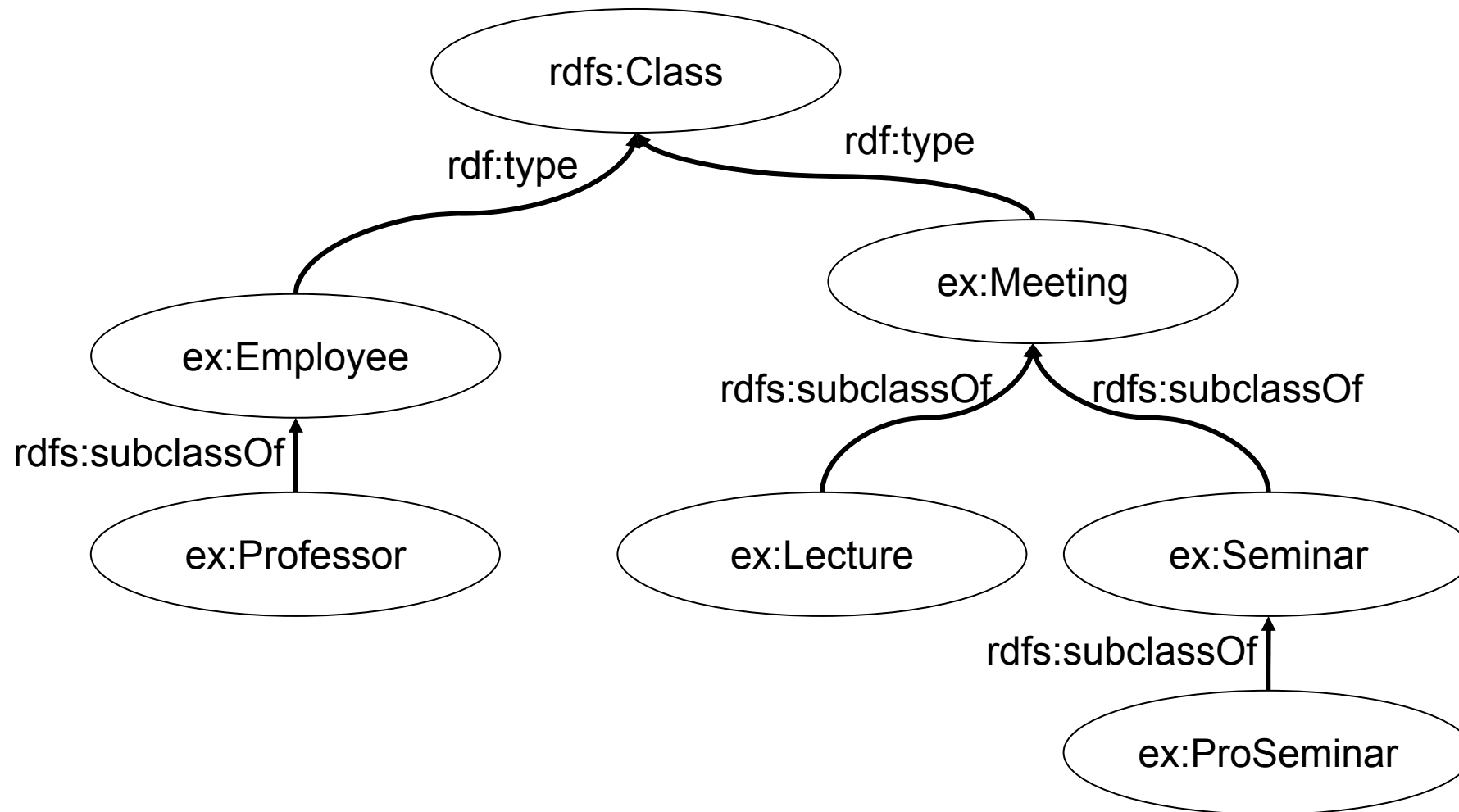
ex:Lecture rdfs:subClassOf ex:Meeting



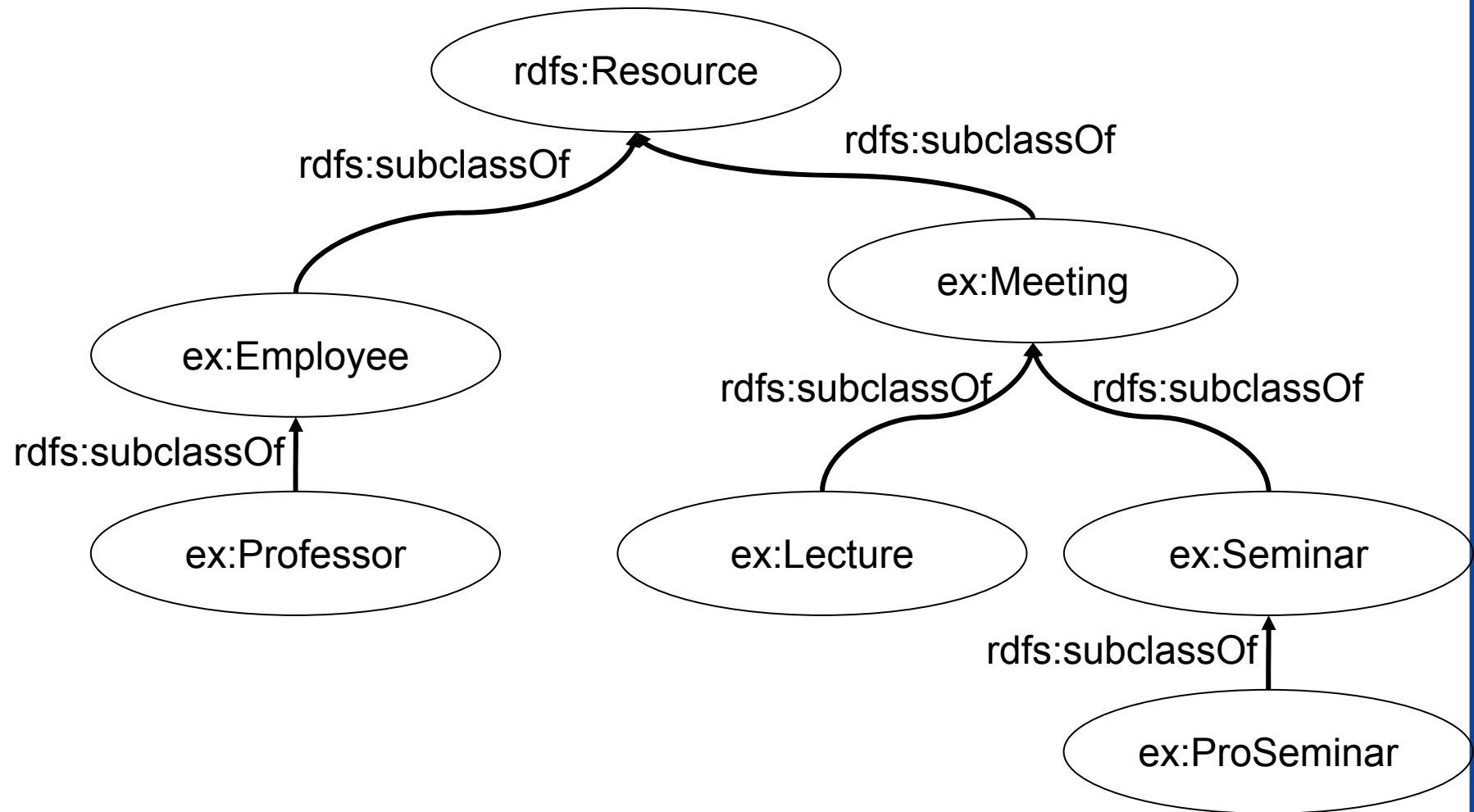
ex:Seminar rdfs:subClassOf ex:Meeting
ex:Proseminar rdfs:subClassOf ex:Seminar
ex:Lecture rdfs:subClassOf ex:Meeting
ex:Professor rdfs:subClassOf ex:Employee

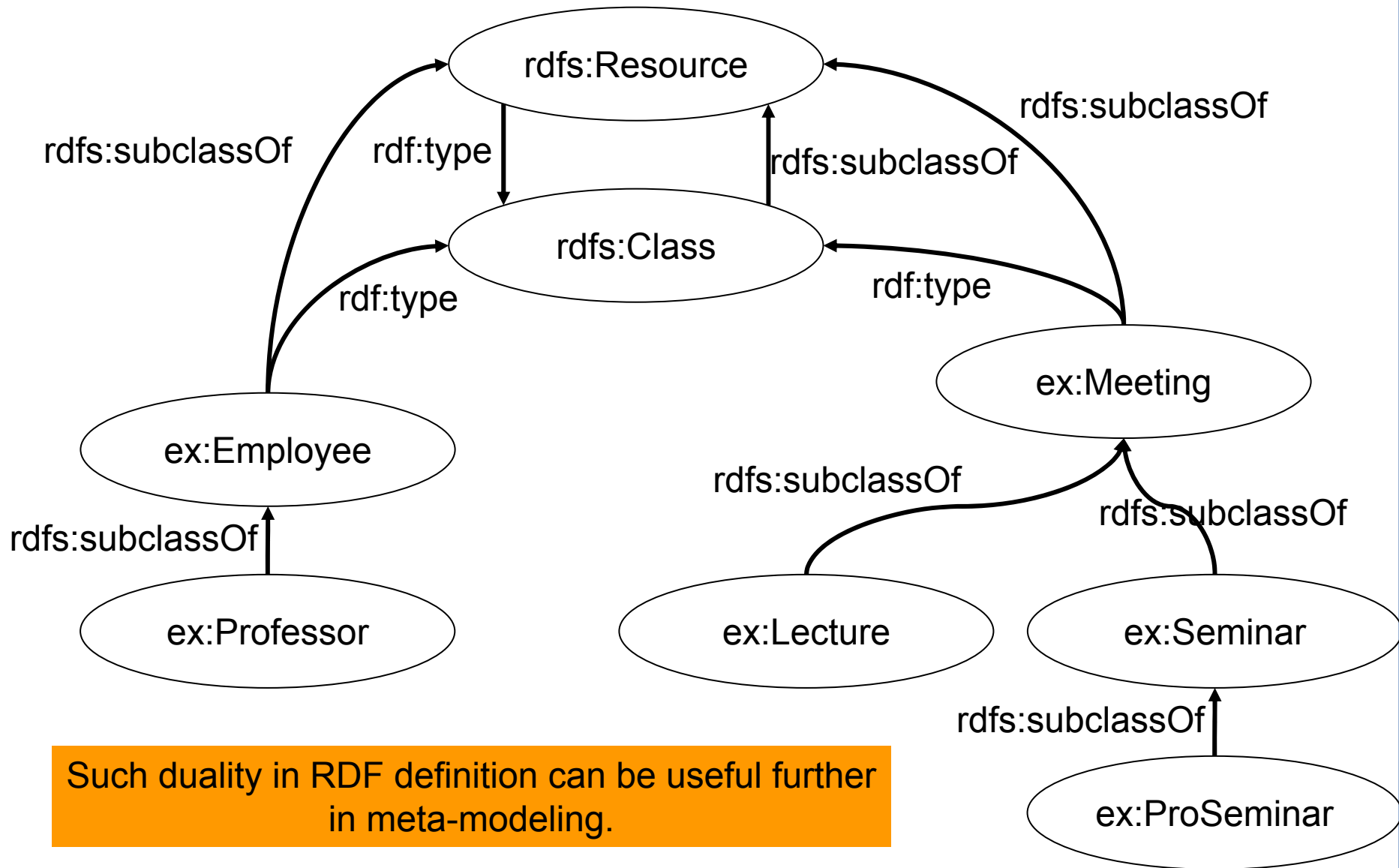


All classes are instances of **rdfs:Class**

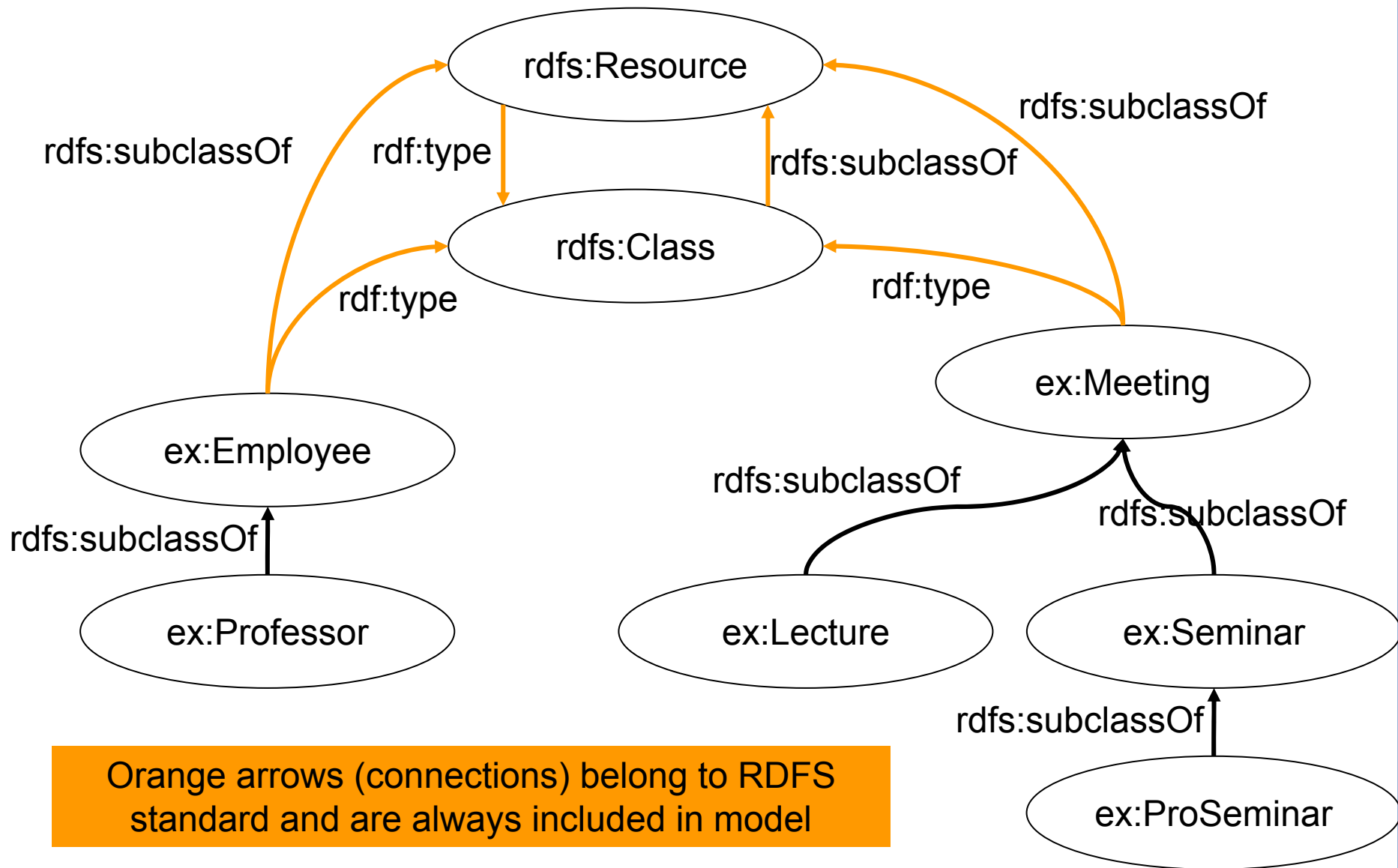


All classes are sub-classes of **rdfs:Resource**

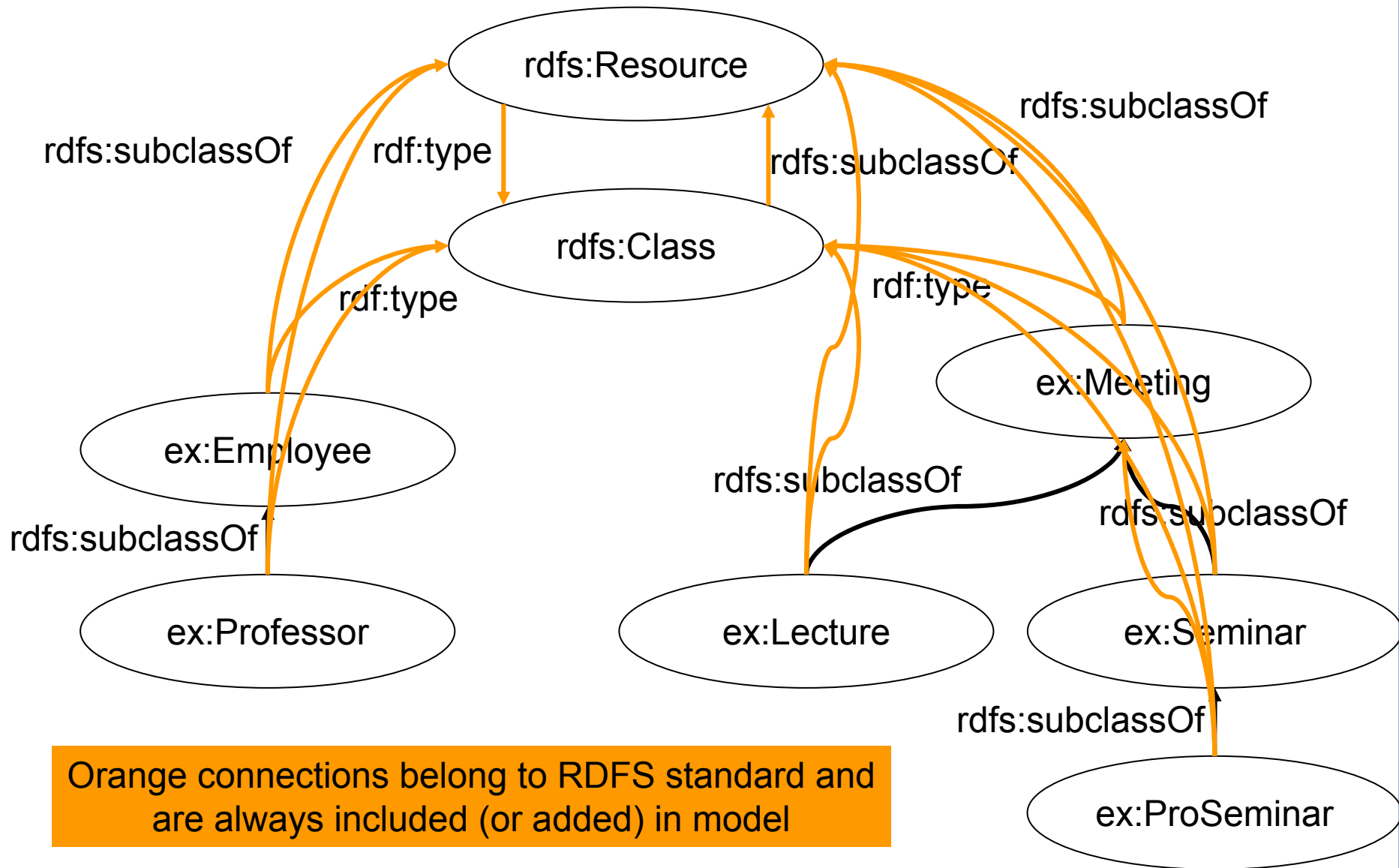


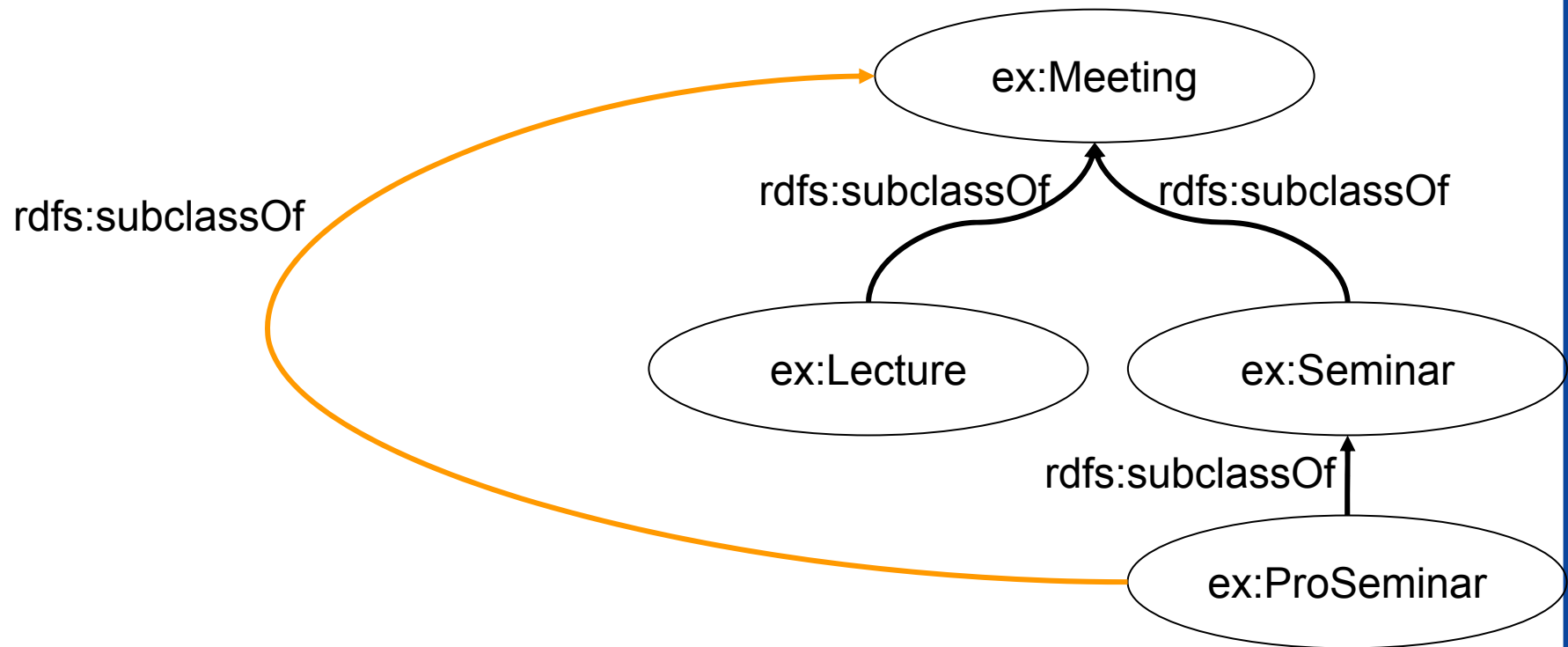


Such duality in RDF definition can be useful further in meta-modeling.

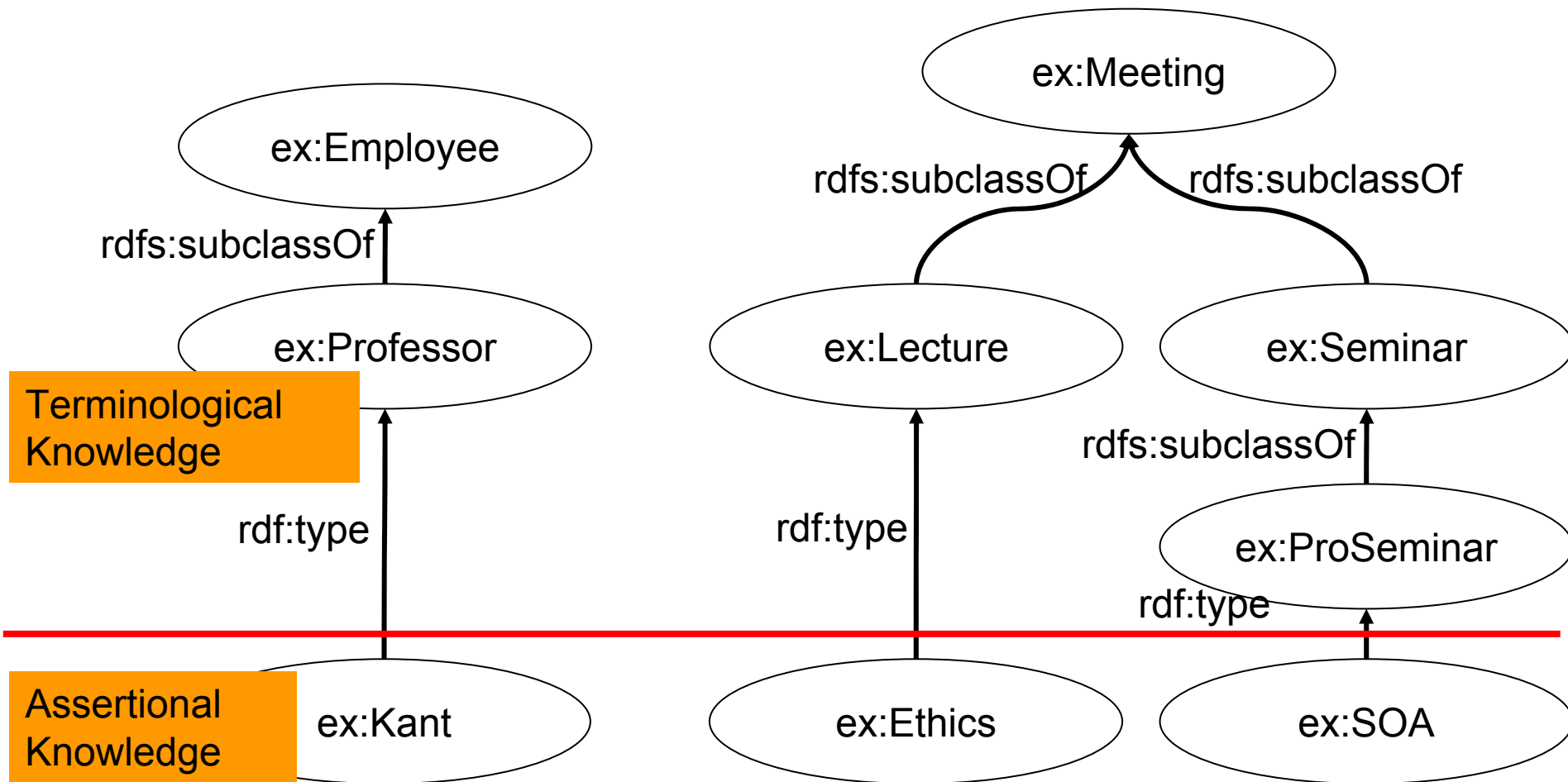


Inference (2) - without property names





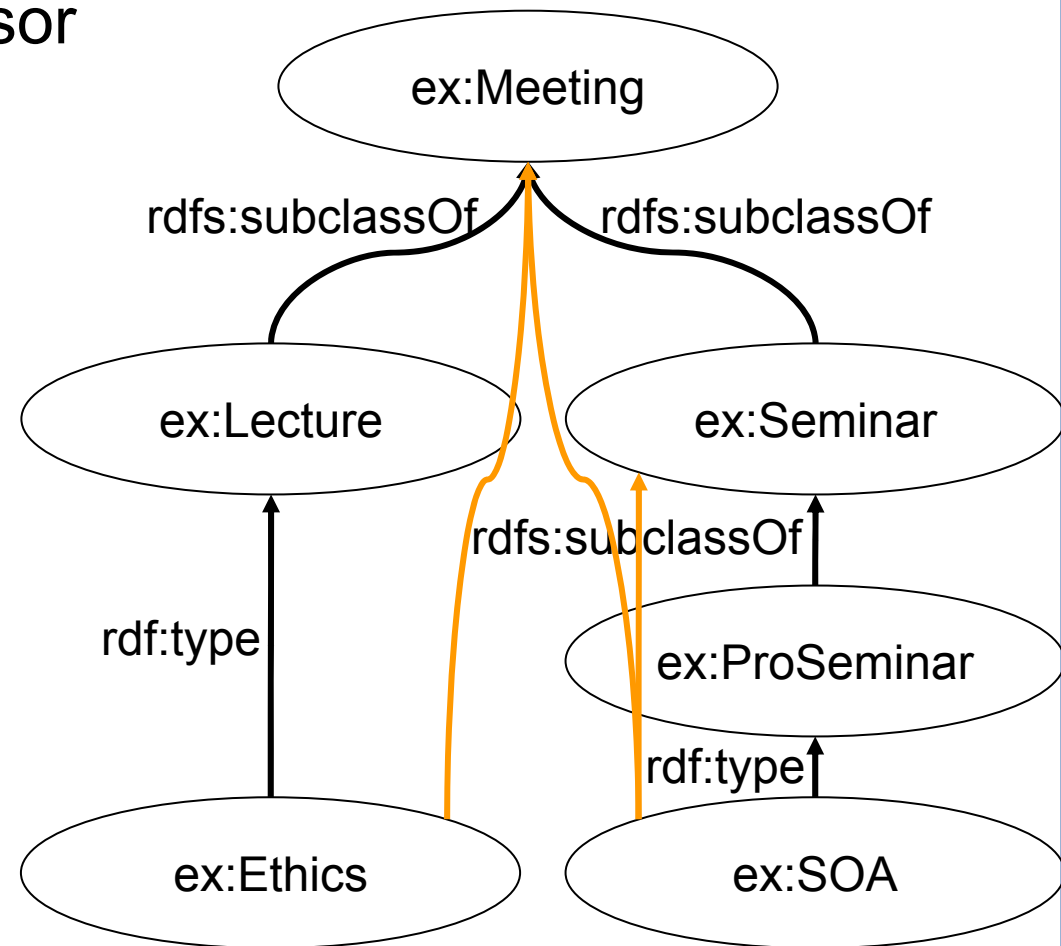
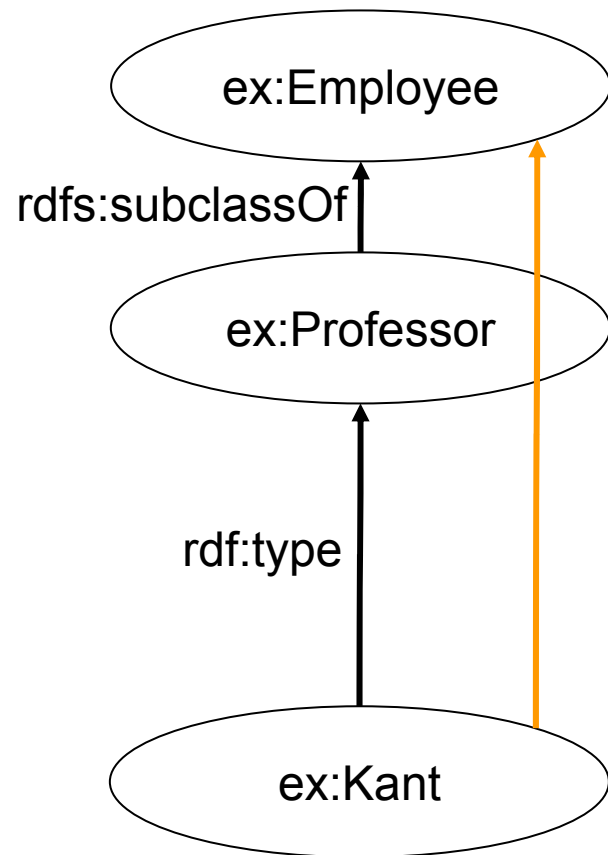
ex:Ethics rdf:type ex:Lecture ex:SOA rdf:type ex:Seminar
ex:Kant rdf:type ex:Professor

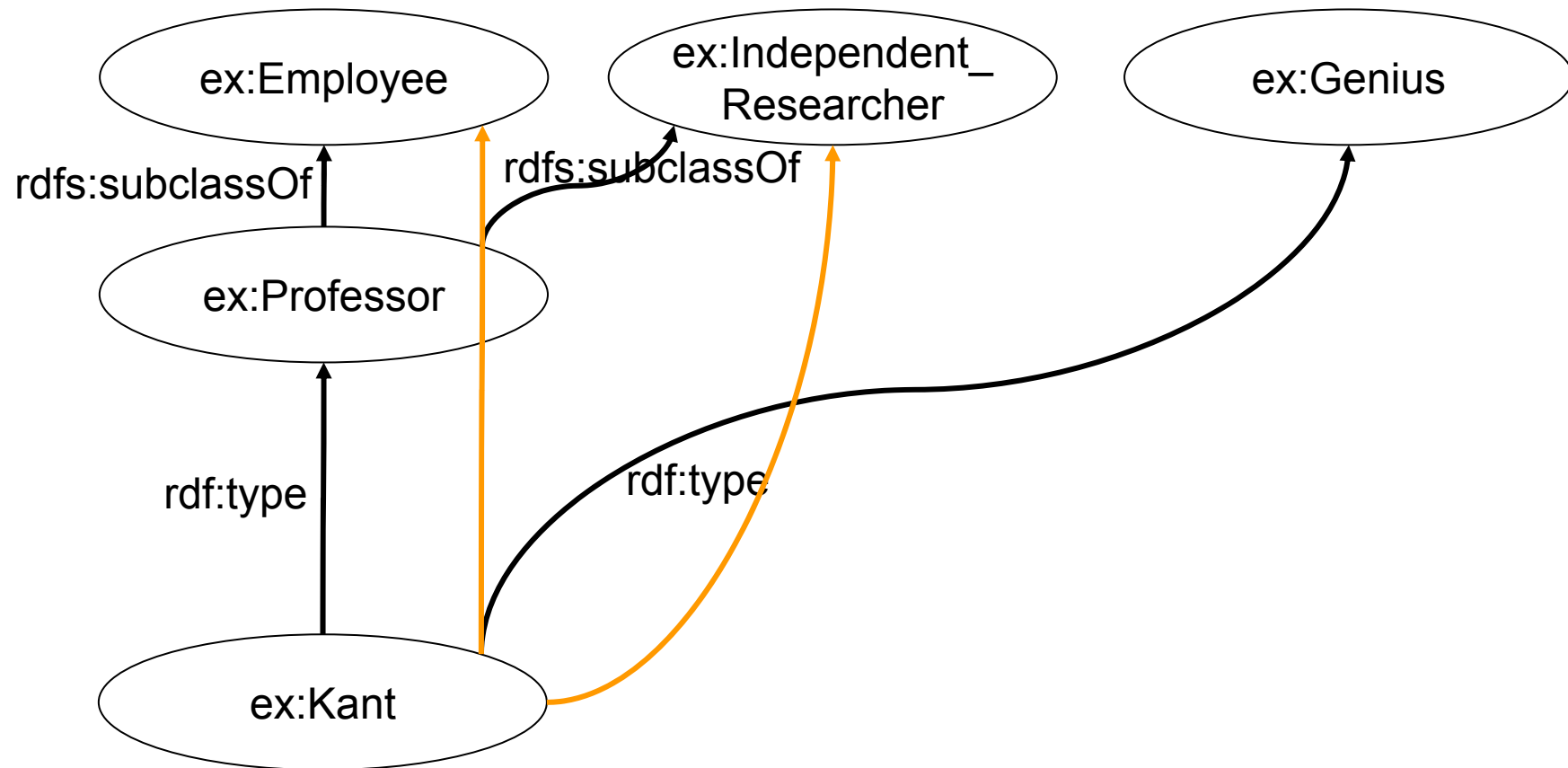


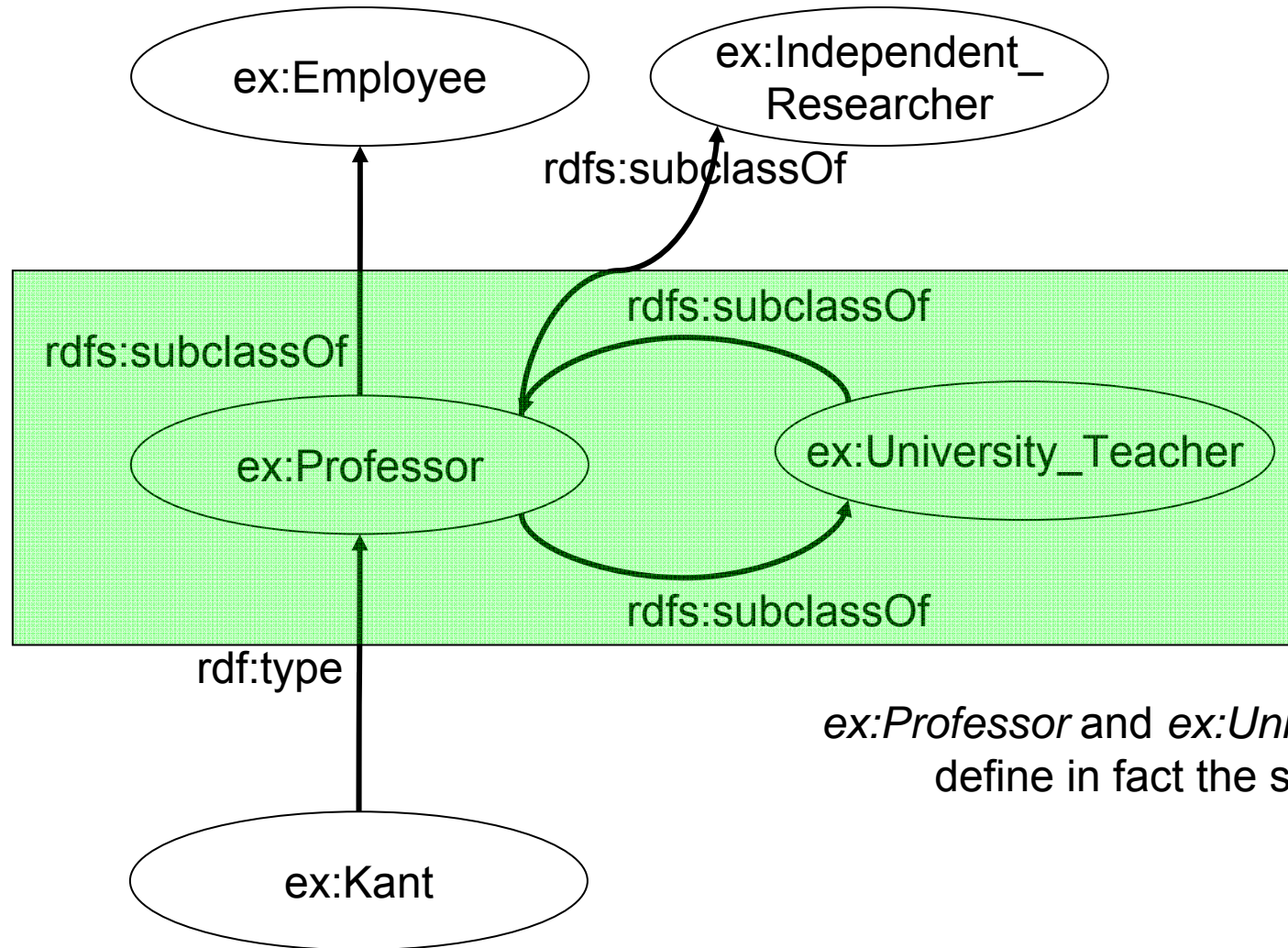
ex:Ethics rdf:type ex:Lecture

ex:SOA rdf:type ex:Seminar

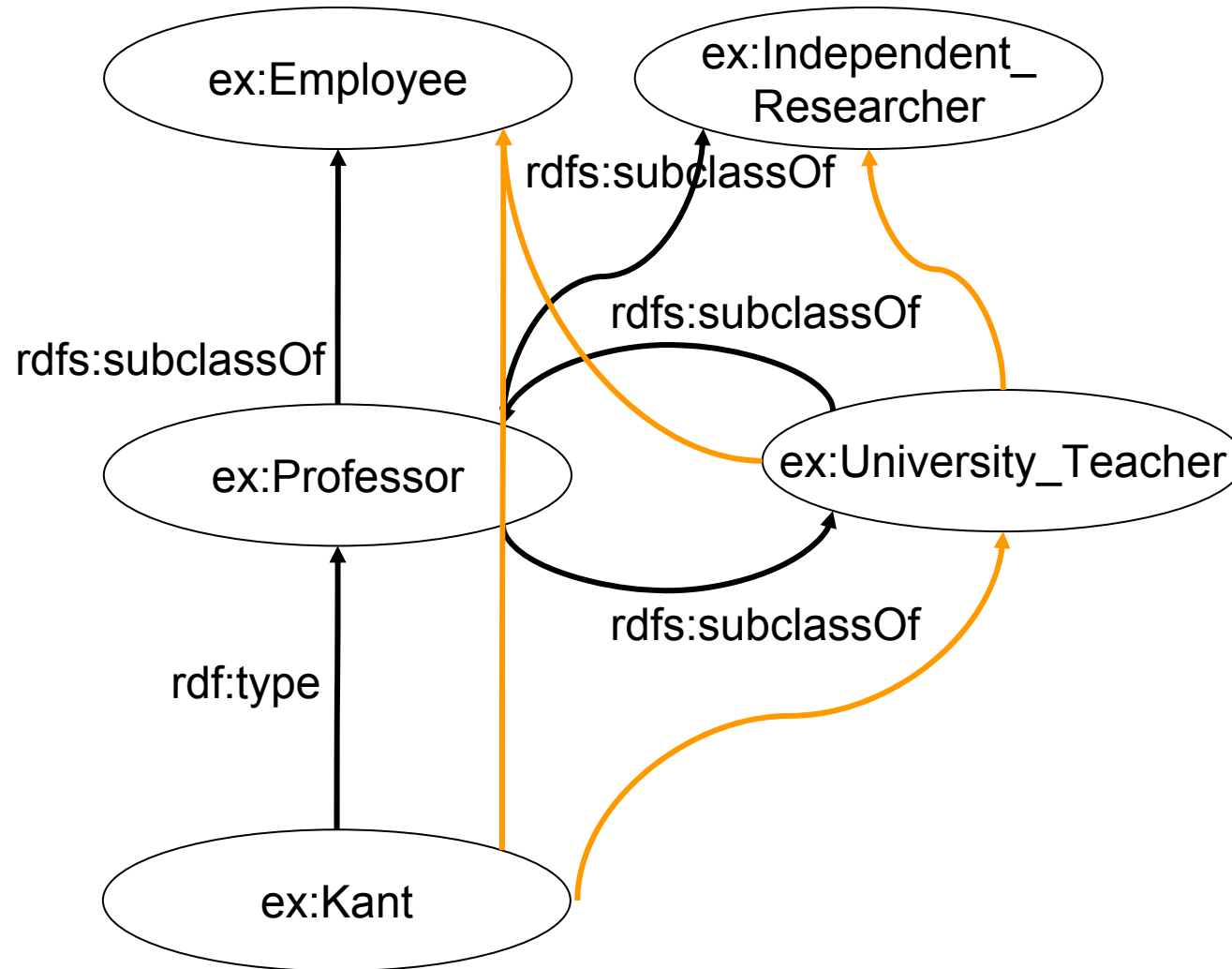
ex:Kant rdf:type ex:Professor







ex:Professor and *ex:University_Teacher*
define in fact the same class



```
<?xml version="1.0" encoding="utf-8"?>  
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"  
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"  
  xml:base="http://example.org"  
  xmlns:ex="http://example.org/">
```

```
<rdfs:Class rdf:about="Proseminar">  
  <rdfs:subClassOf rdf:resource="Seminar">  
    <rdfs:subClassOf rdf:resource="Meeting"/>  
  </rdfs:subClassOf>  
</rdfs:Class>
```

```
<rdfs:Class rdf:about="Lecture">  
  <rdfs:subClassOf>Meeting</rdfs:subClassOf>  
  <rdfs:label>Lecture at the University</rdfs:label>  
  <rdfs:comment>Comment goes here ...</rdfs:comment>  
</rdfs:Class>
```

```
<ex:Lecture rdf:ID="Ethics"/>  
<ex:Seminar rdf:ID="SOA">  
  <ex:taughtBy>Staab</ex:taughtBy>  
  <ex:taughtBy>Grimm</ex:taughtBy>  
</ex:Seminar>  
</rdf:RDF>
```

ex:taughtBy

rdf:type rdfs:Property

rdfs:domain ex:Lecture

rdfs:range ex:Professor

ex:Ethics ex:taughtBy ex:Kant

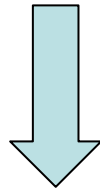


ex:Ethics rdf:type ex:Lecture

ex:taughtBy
rdf:type rdfs:Property
rdfs:domain ex:Lecture
rdfs:range ex:Professor

ex:taughtBy
rdfs:domain ex:Book

ex:Ethics ex:taughtBy ex:Kant



ex:Ethics rdf:type ex:Lecture



ex:Ethics rdf:type ex:Book

<http://university.org>

```
uni:taughtBy
  rdfs:domain ex2:Lecture
  rdfs:range ex1:Professor
  rdf:type rdfs:Property
```

This is NOT object-oriented

<http://example1.org>

```
ex1:Professor rdf:type rdfs:Class.
```

<http://example2.org>

```
ex2:Lecture rdf:type rdfs:Class.
```

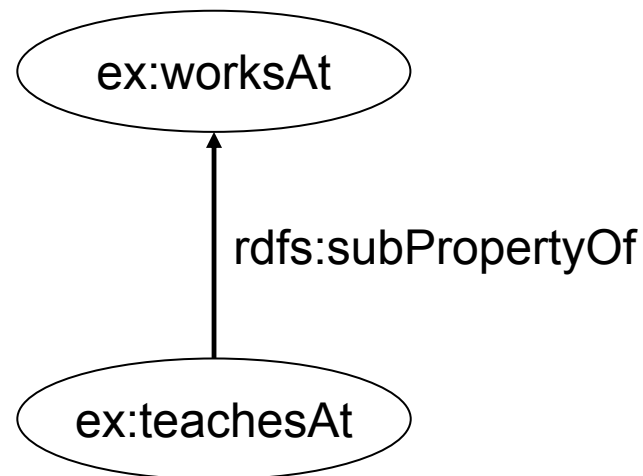
ex:worksAt

rdfs:domain ex:Person
rdfs:range ex:Institution
rdf:type rdfs:Property

ex:teachesAt

rdfs:domain ex:Professor
rdfs:range ex:Institution
rdf:type rdfs:Property

ex:teachesAt **rdfs:subPropertyOf** ex:worksAt



ex:worksAt

rdfs:domain ex:Person
rdfs:range ex:Institution
rdf:type rdfs:Property

ex:teachesAt

rdfs:domain ex:Professor
rdfs:range ex:Institution
rdf:type rdfs:Property

ex:teachesAt **rdfs:subPropertyOf** ex:worksAt

ex:Kant ex:teachesAt ex:University

ex:Kant ex:worksAt ex:University

ex:Kant rdf:type ex:Person

ex:Kant rdf:type ex:Professor

Kant must be BOTH Professor and Person

RDF Common Vocabulary

Commonly used vocabularies on the web

- Dublin Core
 - ◆ Metadata initiative – annotation of resources

- RSS 1.0
 - ◆ RDF Site Summary 1.0

- FOAF
 - ◆ Friend of a friend – social networks

- SWRC
 - ◆ Semantic Web for Research Communities

- Originally
 - ◆ A set of fifteen (15) basic properties for describing generalized Web resources

- Now
 - ◆ *Dublin Core Metadata Initiative*: open organization engaged in the development of interoperable online **metadata standards** that support a broad range of purposes and business models
 - ◆ Core set of metadata terms (DCMI Metadata Terms)
 - Core vocabulary size over 100 **common agreed** terms
 - ◆ Multiple working groups / communities dedicated to specific issues

1. “**Title**”: the name given to the resource
2. “**Creator**”: the person or organization primarily responsible for the resource
3. “**Subject**”: what the resource is about
4. “**Description**”: a description of the content
5. “**Publisher**”: the person or organization responsible for making the resource available
6. “**Contributor**”: someone who has provided content to the resource other than the creator
7. “**Date**”: date of creation or publication
8. “**Type**”: type of resource, such as home page, technical report, novel, photograph...
9. “**Format**”: data format of the resource
10. “**Identifier**”: URL, ISBN number, ...
11. “**Source**”: another resource that this resource is derived from
12. “**Language**”: the language of the content
13. “**Relation**”: another resource and its relationship to this one
14. “**Coverage**”: the portion of time or space described by this resource (atlases, histories, etc.)
15. “**Rights**”: the intellectual property rights adhering to this resource, or a pointer to them

- RSS
 - ◆ Really Simple Syndication protocol → RDF Site Summary
- RSS 1.0 is a lightweight multipurpose extensible metadata description and syndication format.
- Syndication
 - ◆ making data available online for retrieval and further transmission, aggregation, or online publication.
- RSS
 - ◆ Almost anything that can be broken down into discrete items can be syndicated via RSS: news, recent changes page of a wiki, blog entries ...
 - ◆ News aggregators are popular in the weblogging community
 - ◆ Many weblogs and sites make content available in RSS.

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns="http://purl.org/rss/1.0/">
  <channel rdf:about="http://www.xml.com/xml/news.rss">
    <title>XML.com</title>
    <link>http://xml.com/pub</link>
    <description> XML.com description </description>
    <image rdf:resource="http://xml.com/universal/images/xml_tiny.gif" />
    <items>
      <rdf:Seq>
        <rdf:li resource="http://xml.com/pub/2000/08/09/rdfdb/index.html" />
        <rdf:li resource="http://..." />
      </rdf:Seq>
    </items>
  </channel>
  <image rdf:about="http://xml.com/universal/images/xml_tiny.gif">
    <title>XML.com</title>
    <link>http://www.xml.com</link>
    <url>http://xml.com/universal/images/xml_tiny.gif</url>
  </image>
  <item rdf:about="http://xml.com/pub/2000/08/09/rdfdb/index.html">
    <title>Putting RDF to Work</title>
    <link>http://xml.com/pub/2000/08/09/xslt/xslt.html</link>
    <description> Description goes here ... </description>
  </item>
  <item rdf:about="http://...">
    ...
  </item>
</rdf:RDF>
```



FOAF

- ◆ Friend-Of-A-Friend
- ◆ machine-readable **ontology** describing *persons*, their *activities* and their *relations* to other people and objects
- ◆ interlinks people and explicitly defines social relationships (friend), building a global social network
- ◆ facilitates the creation of the Semantic Web equivalent of the **archetypal personal homepage**
 - “My name is Leigh, this is a picture of me, I'm interested in XML, and here are some links to my friends.”

- ### FOAF Basics
- [Acent](#)
 - [Person](#)
 - [name](#)
 - [nick](#)
 - [title](#)
 - [homepage](#)
 - [mbox](#)
 - [mbox_sha1sum](#)
 - [img](#)
 - [depiction](#) ([depicts](#))
 - [surname](#)
 - [family_name](#)
 - [givenname](#)
 - [firstName](#)

- ### Personal info
- [weblog](#)
 - [knows](#)
 - [interest](#)
 - [currentProject](#)
 - [pastProject](#)
 - [plan](#)
 - [based_near](#)
 - [workplaceHomepage](#)
 - [workInfoHomepage](#)
 - [schoolHomepage](#)
 - [topic_interest](#)
 - [publications](#)
 - [geekcode](#)
 - [riversBriggs](#)
 - [dnaChecksum](#)

- ### Online Accounts / IM
- [OnlineAccount](#)
 - [OnlineChatAccount](#)
 - [OnlineEcommerceAccount](#)
 - [OnlineGamingAccount](#)
 - [olcsAccount](#)
 - [accountServiceHomepage](#)
 - [accountName](#)
 - [cqChatID](#)
 - [msrChatID](#)
 - [aimChatID](#)
 - [abberID](#)
 - [yahooChatID](#)

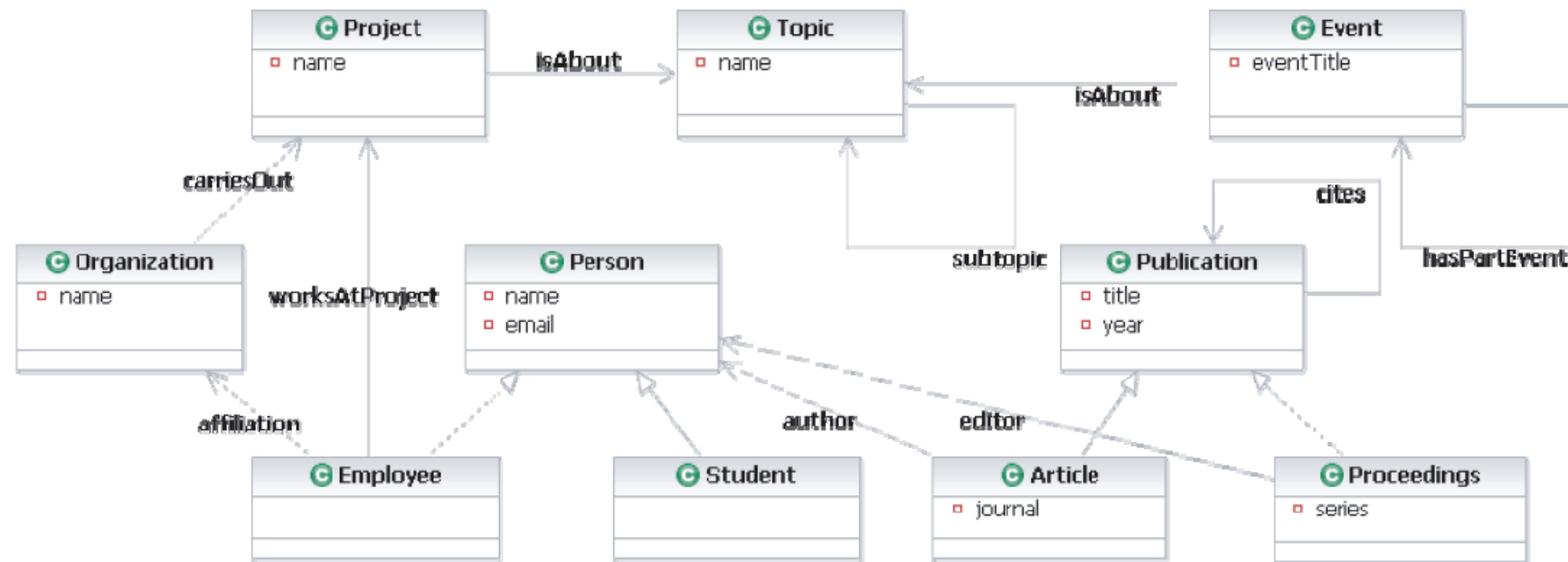
- ### Projects and Groups
- [Project](#)
 - [Organization](#)
 - [Group](#)
 - [member](#)
 - [membershipClass](#)
 - [fundedBy](#)
 - [theme](#)

- ### Documents and Images
- [Document](#)
 - [Image](#)
 - [PersonaProfileDocument](#)
 - [topic](#) ([page](#))
 - [primaryTopic](#)
 - [tipjar](#)
 - [sha1](#)
 - [made](#) ([maker](#))
 - [thumbnail](#)
 - [logo](#)

```
<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:foaf="http://xmlns.com/foaf/0.1/">

<foaf:Person rdf:ID="me">
  <foaf:name>Maciej Janik</foaf:name>
  <foaf:title>Dr</foaf:title>
  <foaf:givenname>Maciej</foaf:givenname>
  <foaf:family_name>Janik</foaf:family_name>
  <foaf:mbox_sha1sum>809d...a3f</foaf:mbox_sha1sum>
  <foaf:homepage rdf:resource="http://isweb.uni-koblenz.de/~janik"/>
  <foaf:depiction rdf:resource="http://.../MaciejJanik.jpg"/>
  <foaf:phone rdf:resource="tel:00492612872718"/>
  <foaf:schoolHomepage rdf:resource="http://www.agh.edu.pl"/>
  <foaf:knows>
    <foaf:Person>
      <foaf:name>Steffen Staab</foaf:name>
      <foaf:mbox_sha1sum>ae8f...f90</foaf:mbox_sha1sum>
    </foaf:Person>
  </foaf:knows>
</foaf:Person>
</rdf:RDF>
```

- SWRC
 - ◆ Semantic Web for Research Communities
 - ◆ ontology for modeling entities of research communities such as persons, organizations, publications (bibliographic metadata) and their relationships
- Main concepts of the SWRC ontology



Scope

Local Peer
 All Peer
 Select

Search

*Database

Search D

- Publica
 - Art
 - Boo
 - Boo
 - InE
 - InC
 - InP

title
 abstract
 keywords
 year
 author
 journal
 url

ACMTopic

- + General_Literature
- + Hardware
- + Computer_Systems_Organizatio
- + Software
- + Data
- + Theory_Of_Computation
- + Mathematics_Of_Computing
- + Information_Systems
- + Computing_Methodologies

| rdfs:label | swrc:author | swrc:year | swrc:pages | rdf:type |
|-------------------------|----------------------|-----------|------------|---------------|
| {Towards Automated ... | Kurt P. Brown and... | 1994 | 72--84 | InProceedings |
| {Composite Events fo... | S. Chakravarthy a... | 1994 | 606--617 | InProceedings |
| | | 1994 | 618--629 | InProceedings |
| | | 1994 | 120--131 | InProceedings |
| | | 1994 | 655--667 | InProceedings |
| | | 1994 | 676--685 | InProceedings |
| | | 1994 | 487--499 | InProceedings |
| | | 1994 | 582--593 | InProceedings |
| | | 1994 | 500--509 | InProceedings |
| | | 1994 | 24--35 | InProceedings |
| | | 1994 | 669--675 | InProceedings |

Property editor

In this work, control strategies for combining two potentially powerful buffer management techniques in object bases were devised and evaluated: (1) buffer pool segmentation with segment-specific replacement criteria, and (2) dual buffering consisting of copying objects from pages into object buffers. Two dimensions exist for exerting control on the buffer pool: (1) the `{\it copying\}` time which determines at what time objects are copied from their memory-resident home page, and (2) the `{\it relocation\}` time which determines when a (copied) object is to be transferred back to its home page. Along both dimensions, it is possible to differentiate between an `{\it eager\}` and a `{\it lazy\}` strategy. The extensive experimental results indicate that lazy object copying combined with an eager relocation strategy is almost always superior and significantly outperforms page-based buffering in most applications.

Bibliographical entry editor

Edit bibliographical entry

| Property | Value |
|-----------|---|
| abstract | In this work, control strategies for combining two potenti... |
| type | InProceedings |
| isAbout | Buffering |
| key | vldb:KK94 |
| pages | 427--438 |
| author | Alfons Kemper and Donald Kossmann |
| label | {Dual-Buffering Strategies in Object Bases} |
| year | 1994 |
| booktitle | Proceedings of the Twentieth International Conference o... |
| address | Santiago, Chile |
| title | {Dual-Buffering Strategies in Object Bases} |

BibTeXView

```

strategy is almost always superior and significantly
page-based buffering in most applications.',
isAbout = 'Buffering',
key = 'vldb:KK94',
pages = '427--438',
author = 'Alfons Kemper and Donald Kossmann',
label = '{Dual-Buffering Strategies in Object Ba
year = '1994',
booktitle = 'Proceedings of the Twentieth Int
address = 'Santiago, Chile',
title = '{Dual-Buffering Strategies in Object Bas
    
```

- Extended vocabulary of RDF
- Class and property (relationship) inheritance
- Inference schemes
 - ◆ Classes
 - ◆ Properties
 - ◆ Transitivity of some properties (subClass, subPropertyOf)
- Division to schema (definitions) and instances (factual knowledge)
- Domain and range restrictions (with its implications)
- Many widely used vocabularies
- Still not expressive enough ...

→ OWL (Web Ontology Language)