
# Knowledge Representation for the Semantic Web

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**Slides 3 – 01/11/2011**

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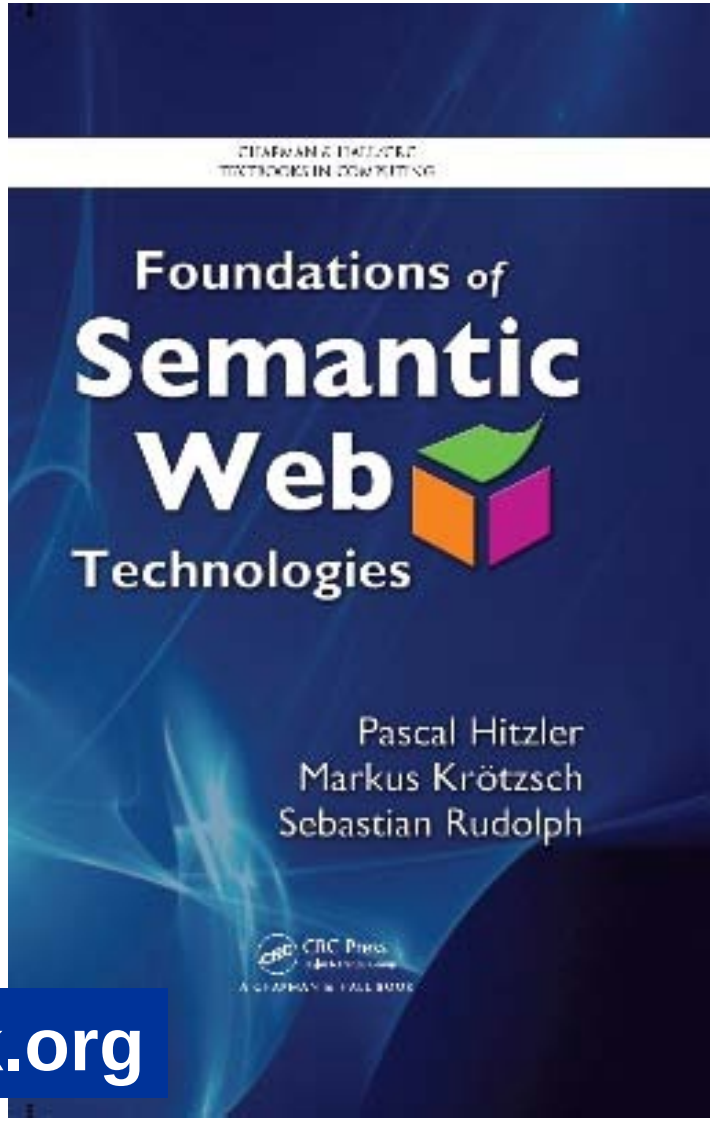
# Textbook (required)

**Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph**

**Foundations of Semantic Web Technologies**

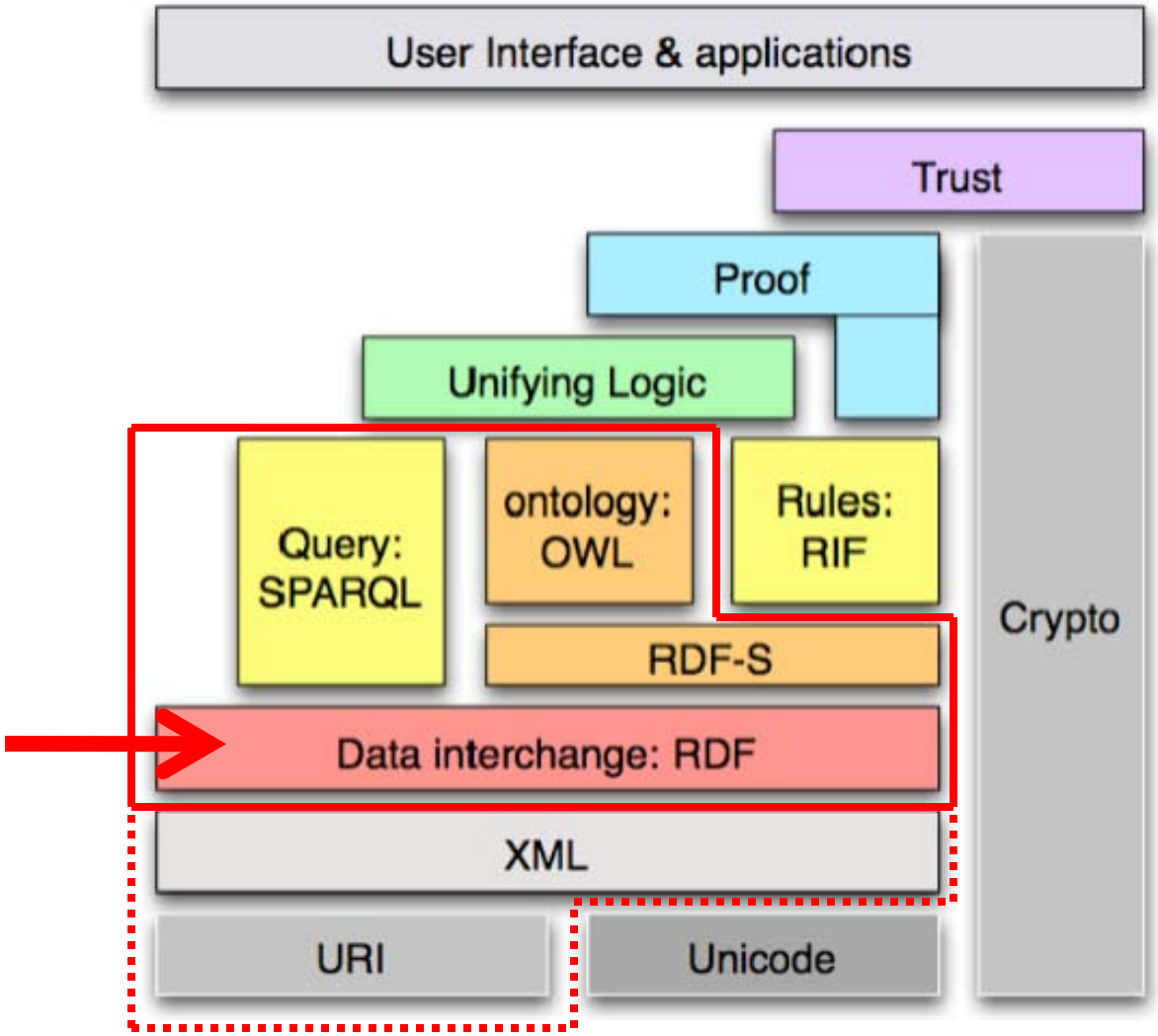
**Chapman & Hall/CRC, 2010**

**Choice Magazine Outstanding Academic Title 2010 (one out of seven in Information & Computer Science)**




**http://www.semantic-web-book.org**

# Today: RDF syntax



# Today's Session: RDF

1. **Motivation**
2. **Triples and Graphs**
3. **RDF syntaxes: Turtle and RDF/XML**
4. **Datatypes**
5. **n-ary relationships**
6. **Empty nodes**
7. **Lists**
8. **Class project**
9. **Class presentation**

# Two XML Problems

- **How do you encode the piece of knowledge "The book FOST is published by CRC Press"**

- **<book>**
  **<title>FOST</title>**
  **<publisher>CRC Press</publisher>**
  **</book>**

- **<publisher>**
  **<name>CRC Press</name>**
  **<book><title>FOST</title><book>**
  **</publisher>**

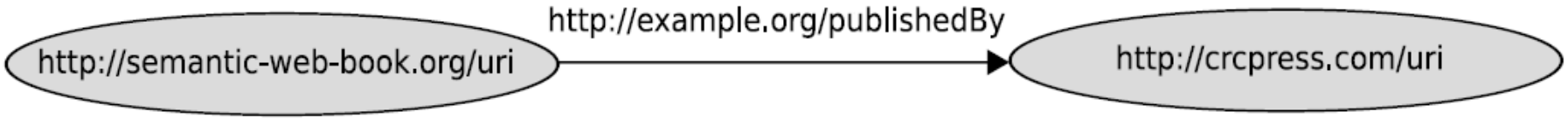
- **etc.**

# Two XML Problems

- **Merging trees is rather cumbersome and the result isn't always clear.**
  - **<publisher>**
    **<name>CRC Press</name>**
    **<book><title>FOST</title><book>**
    **</publisher>**
  - **<book>**
    **<title>Semantic Web</title>**
    **<publisher>Springer</publisher>**
    **</book>**

# RDF idea

- **Use (directed) graphs as data model**



# RDF

- **“Resource Description Framework”**
- **W3C Recommendation 2004**
  **http://www.w3.org/RDF/**
- **RDF is a data model**
  - **originally for describing metadata for web pages, but has grown beyond that**
  - **structured information**
  - **universal, machine-readable data exchange format**
  - **main syntax uses XML for serialization**

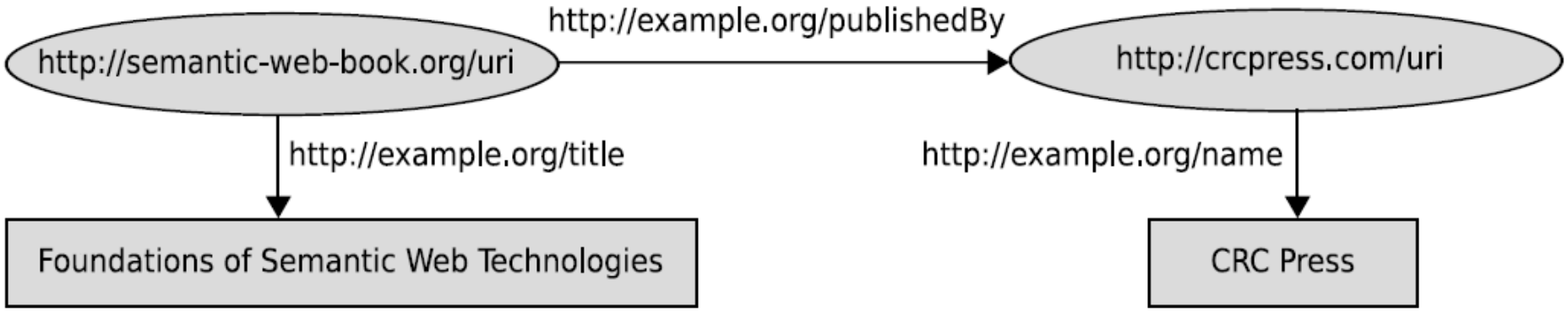
# Table of contents: RDF

# RDF components

- URIs
  - for referencing resources
- Literals
  - data values
- Empty nodes
  - talking about something which doesn't have a name (or the name of which isn't known)

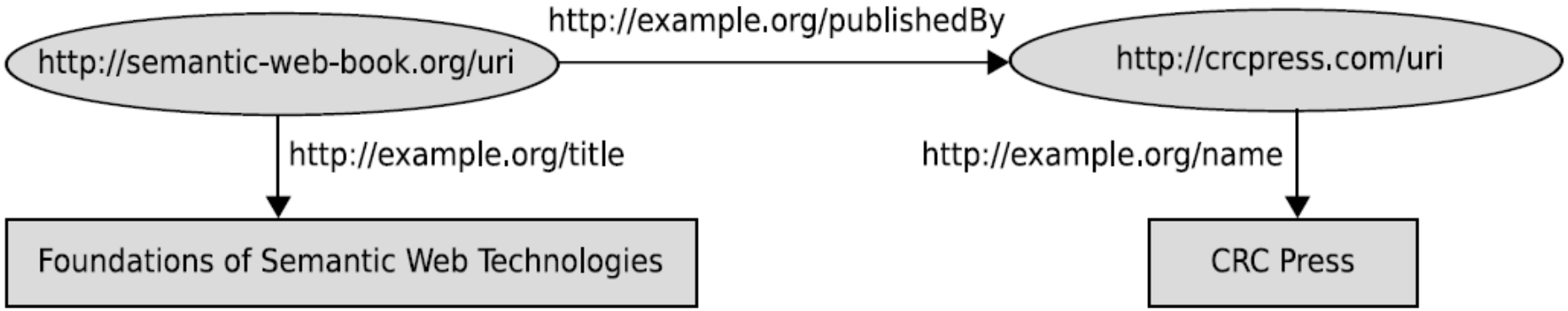
# Literals

- for representing data values
- encoded as strings
- interpreted by means of datatypes
- literals without datatype are treated the same as strings



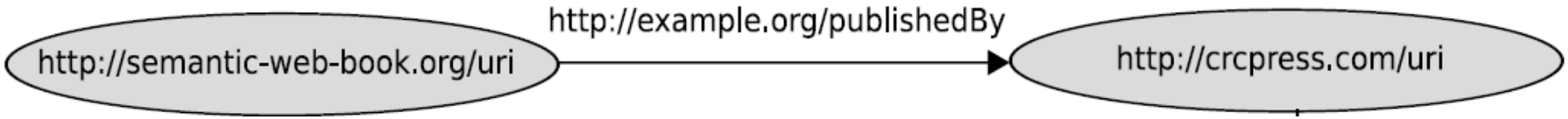
# Graphs as sets of triples

- **there are several possibilities for representing graphs**
- **we use: graph as list of (node-edge-node) triples**



# RDF triples

- **An RDF triple consists of**




**Subject** **Predicate** **Object**

**(borrowed from linguistics)**

- **allowed are:**
  - **In the subject : URIs and empty nodes**
  - **In the predicate: URIs (usually called *properties*)**
  - **In the object: URIs and empty nodes and literals**

- **Note that the graph can be reconstructed from the list of triples.**

# Table of contents : RDF

# Turtle – Terse RDF Triple Language

- simple syntax for RDF
- triples are directly listed as such
  - URIs are in <angle brackets>
  - Literals are ”enclosed in quotes”
  - triples end with a full-stop .
  - whitespace (blanks, line feeds) is ignored

```
<http://semantic-web-book.org/uri>
    <http://example.org/publishedBy>  <http://crcpress.com/uri> .
<http://semantic-web-book.org/uri>
    <http://example.org/title>
        "Foundations of Semantic Web Technologies" .
<http://crcpress.com/uri>
    <http://example.org/name>         "CRC Press" .
```

# Turtle

- **shortcuts for prefixes**

```
@prefix book: <http://semantic-web-book.org/> .
@prefix ex: <http://example.org/> .
@prefix crc: <http://crcpress.com/> .

book:uri  ex:publishedBy  crc:uri .
book:uri  ex:title        "Foundations of Semantic Web Technologies" .
crc:uri   ex:name         "CRC Press" .
```

# Turtle

```
@prefix book: <http://semantic-web-book.org/> .
@prefix ex: <http://example.org/> .
@prefix crc: <http://crcpress.com/> .

book:uri  ex:publishedBy  crc:uri .
book:uri  ex:title        "Foundations of Semantic Web Technologies" .
crc:uri   ex:name         "CRC Press" .
```

- **grouping of triples with the same subject**
- **grouping of triples with same subject and predicate**

```
@prefix book: <http://semantic-web-book.org/> .
@prefix ex: <http://example.org/> .
@prefix crc: <http://crcpress.com/> .

book:uri  ex:publishedBy  crc:uri ;
          ex:title        "Foundations of Semantic Web Technologies" .
crc:uri   ex:name         "CRC Press", "CRC" .
```

# XML syntax for RDF

- Turtle is easy to read and write
- But XML is the basis for data transfer on the web
- There's a lot of tool (and programming library) support for XML
- Hence, the main syntax for RDF is XML-based.
- Turtle is not a W3C recommendation
- The normative syntax for RDF is it's XML syntax

# XML syntax for RDF

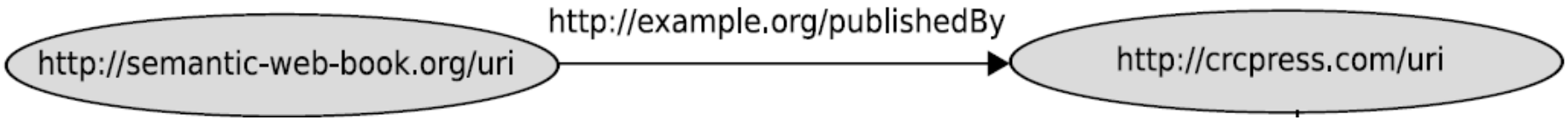
- namespaces are used for disambiguating tags
- tags belonging to the RDF language come with a fixed namespace, usually abbreviated 'rdf'

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

  <rdf:Description rdf:about="http://semantic-web-book.org/uri">
    <ex:publishedBy>
      <rdf:Description rdf:about="http://crcpress.com/uri">
      </rdf:Description>
    </ex:publishedBy>
  </rdf:Description>

</rdf:RDF>
```

# XML syntax for RDF




**subject node**

**URI of the subject**

**property**

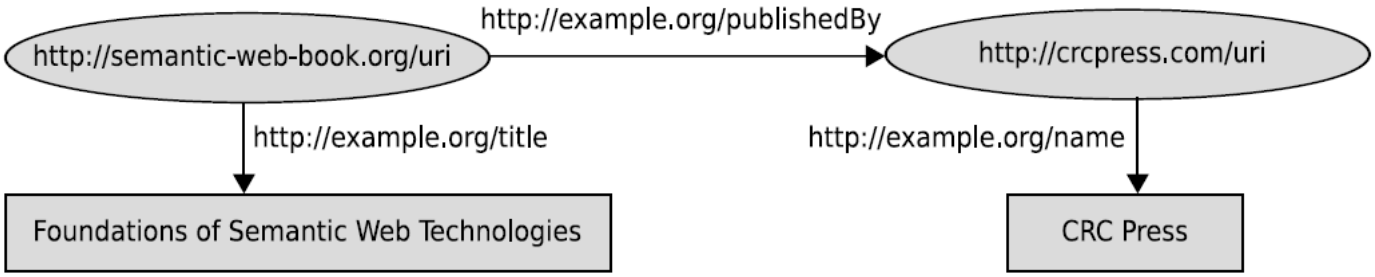
**object node**

**URI of the object**

```
<rdf:Description rdf:about="http://semantic-web-book.org/uri">
  <ex:publishedBy>
    <rdf:Description rdf:about="http://crcpress.com/uri">
    </rdf:Description>
  </ex:publishedBy>
</rdf:Description>
```

# XML syntax for RDF

- **Untyped literals can be left as free text**
- **A subject can contain several property elements**
- **Object-descriptions can be used as subject-descriptions for further triples**




```
<rdf:Description rdf:about="http://semantic-web-book.org/uri">
  <ex:title>Foundations of Semantic Web Technologies</ex:title>
  <ex:publishedBy>
    <rdf:Description rdf:about="http://crcpress.com/uri">
      <ex:name>CRC Press</ex:name>
    </rdf:Description>
  </ex:publishedBy>
</rdf:Description>
```

# XML syntax for RDF

- **Equivalent representation of literals using XML attribues**
  - **the attribute-name is then the property-URI**

- **Equivalent representation of objects by giving their URIs as value of a rdf:resource attribute within a property tag.**

```
<rdf:Description rdf:about="http://semantic-web-book/uri"
                 ex:title= "Foundations of Semantic Web Technologies">
  <ex:publishedBy rdf:resource="http://crcpress.com/uri" />
</rdf:Description>
<rdf:Description rdf:about="http://crcpress.com/uri"
                                                ex:Name="CRC Press" />
```

# XML syntax for RDF

- **The use of namespaces is essential since the use of the colon ':' in XML attributes is not allowed unless it is used with a namespace.**
- **Problem: namespaces cannot be used in values of XML attributes: `rdf:about="book:uri"` is wrong since 'book' would be interpreted in the sense of a URI schema.**
- **Solution: use XML ENTITYs.**

```
<?xml version="1.0" encoding="utf-8"?> <!DOCTYPE rdf:RDF[
        <!ENTITY book 'http://semantic-web-book.org/'>
]>

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:ex ="http://example.org/">

  <rdf:Description rdf:about="&book;uri">
    <ex:title>Foundations of Semantic Web Technologies</ex:title>
  </rdf:Description>

</rdf:RDF>
```

# XML Syntax for RDF

- **Use of the base namespace**

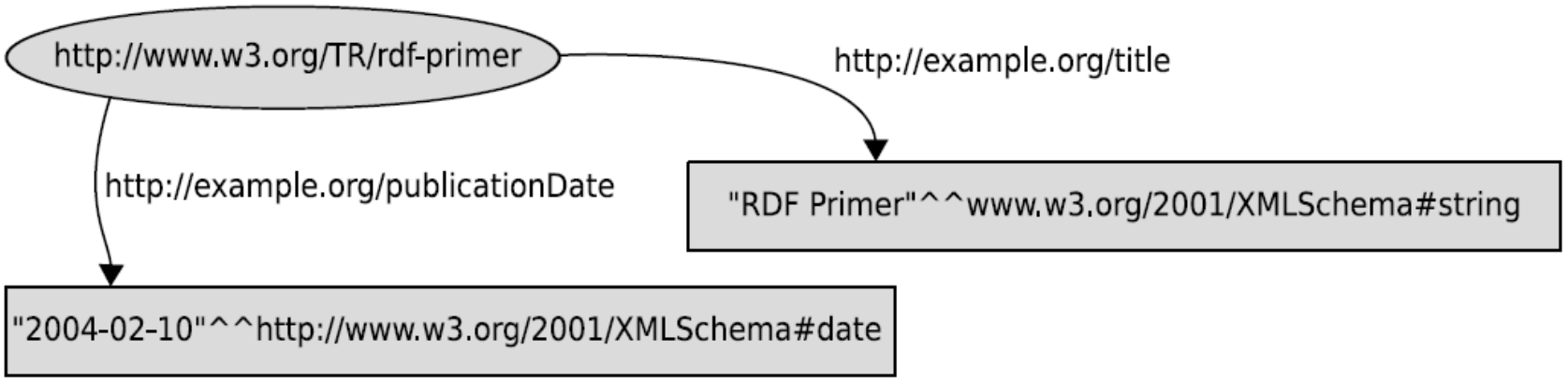
```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:ex ="http://example.org/"
         xml:base ="http://semantic-web-book.org/" >

  <rdf:Description rdf:about="uri">
    <ex:publishedBy rdf:resource="http://crcpress.com/uri" />
  </rdf:Description>

</rdf:RDF>
```

# Table of contents : RDF

# Datatypes in RDF




```
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
<http://www.w3.org/TR/rdf-primer>
        <http://example.org/title>  "RDF Primer"^^xsd:string ;
        <http://example.org/publicationDate> "2004-02-10"^^xsd:date .
```

```
<rdf:Description rdf:about="http://www.w3.org/TR/rdf-primer">
  <ex:title rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
    RDF Primer
  </ex:title>
  <ex:publicationDate
              rdf:datatype="http://www.w3.org/2001/XMLSchema#date">
    2004-02-10
  </ex:publicationDate>
</rdf:Description>
```

# Datatypes

- usually use of XML Schema datatype
- Note that the same data value can have different representations:
  ”3.14”^^xsd:decimal is the same as ”+03.14”^^xsd:decimal
  but
  ”3.14”^^xsd:string is not the same as ”+03.14”^^xsd:string
- there is only one required datatype in RDF, called rdf:XMLLiteral
  - arbitrary (balanced) XML fragments
  - special syntax:

```
<rdf:Description rdf:about="http://semantic-web-book/uri">
   <ex:title rdf:parseType="Literal">
      Foundations of
      <br />
      <b>Semantic Web Technologies</b>
   </ex:title>
</rdf:Description>
```

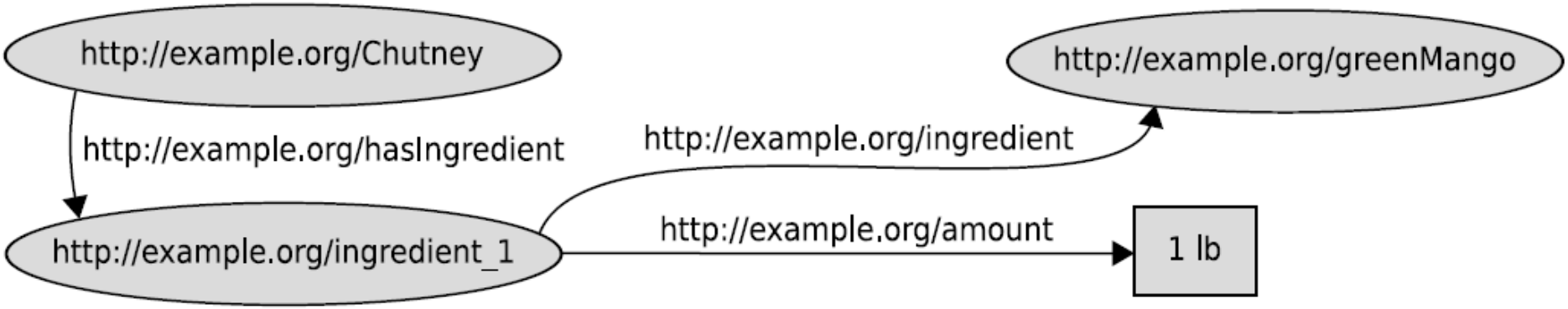
# Table of contents : RDF

# What is wrong with these?

```
@prefix ex: <http://example.org/> .
ex:Chutney  ex:hasIngredient   "1lb green mango",
                               "1tsp. Cayenne pepper" .
```

```
@prefix ex: <http://example.org/> .
ex:Chutney  ex:ingredient   ex:greenMango;     ex:amount   "1lb" ;
            ex:ingredient   ex:CayennePepper;  ex:amount   "1tsp." .
```

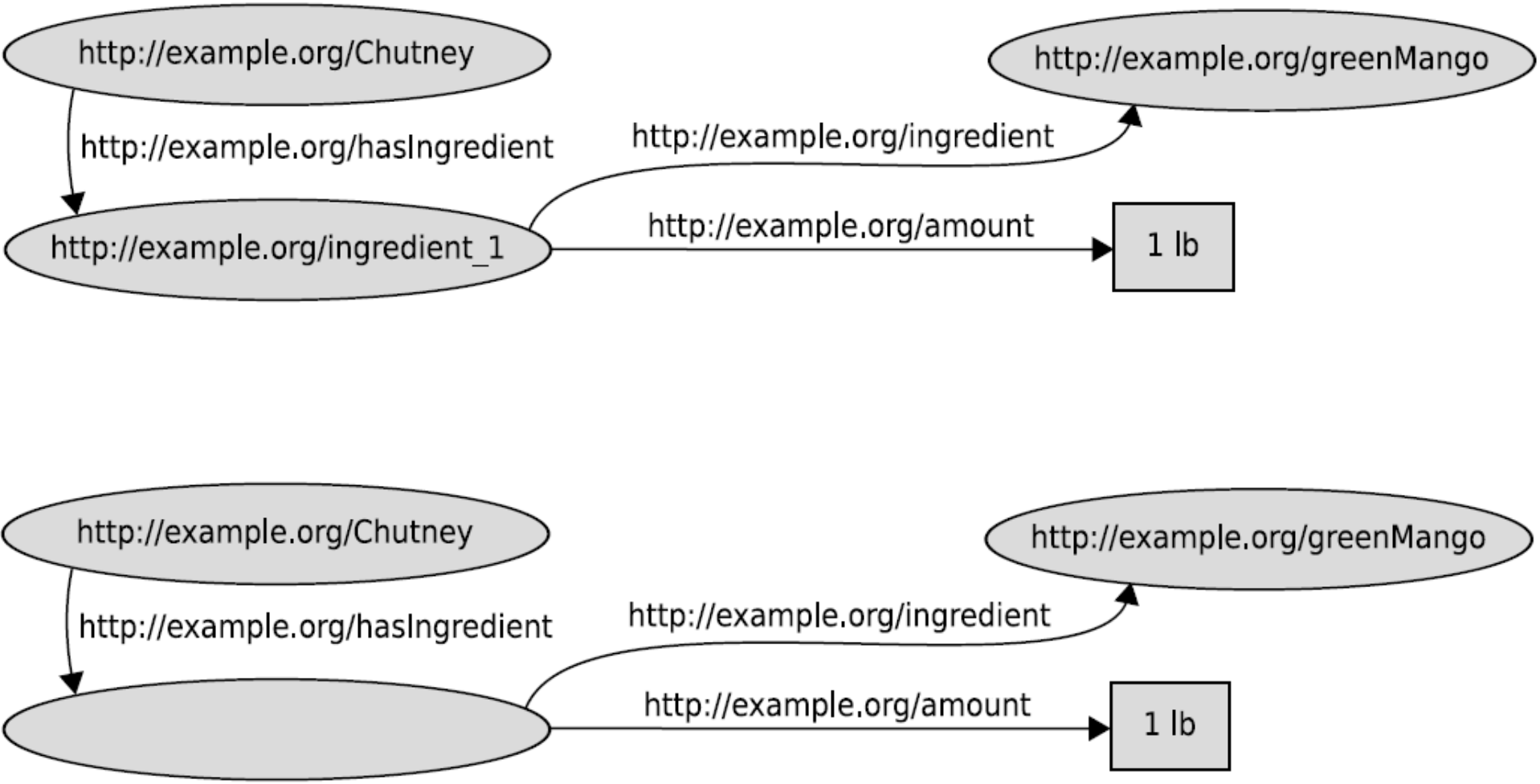
# It’s a ternary relationship!




```
@prefix ex:  <http://example.org/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
ex:Chutney          ex:hasIngredient  ex:ingredient1 .
ex:ingredient1      rdf:value         ex:greenMango;
                    ex:amount         "1lb" .
```

# Table of contents : RDF

# It doesn't need a name :)



# Blank nodes syntax

```
<rdf:Description rdf:about="http://example.org/Chutney">
   <ex:hasIngredient rdf:nodeID="id1" />
</rdf:Description>
<rdf:Description rdf:nodeID="id1">
   <ex:ingredient rdf:resource="http://example.org/greenMango" />
   <ex:amount>1lb</ex:amount>
</rdf:Description>
```

**shortcut:**

```
<rdf:Description rdf:about="http://example.org/Chutney">
   <ex:hasIngredient rdf:parseType="Resource">
     <ex:ingredient rdf:resource="http://example.org/greenMango" />
     <ex:amount>1lb</ex:amount>
   </ex:hasIngredient>
</rdf:Description>
```

# Blank nodes syntax

```
<rdf:Description rdf:about="http://example.org/Chutney">
   <ex:hasIngredient rdf:nodeID="id1" />
</rdf:Description>
<rdf:Description rdf:nodeID="id1">
   <ex:ingredient rdf:resource="http://example.org/greenMango" />
   <ex:amount>1lb</ex:amount>
</rdf:Description>
```

**Turtle:**

```
@prefix ex:  <http://example.org/> .
ex:Chutney    ex:hasIngredient  _:id1 .
_:id1         ex:ingredient  ex:greenMango;   ex:amount  "1lb" .
```

# Blank nodes syntax

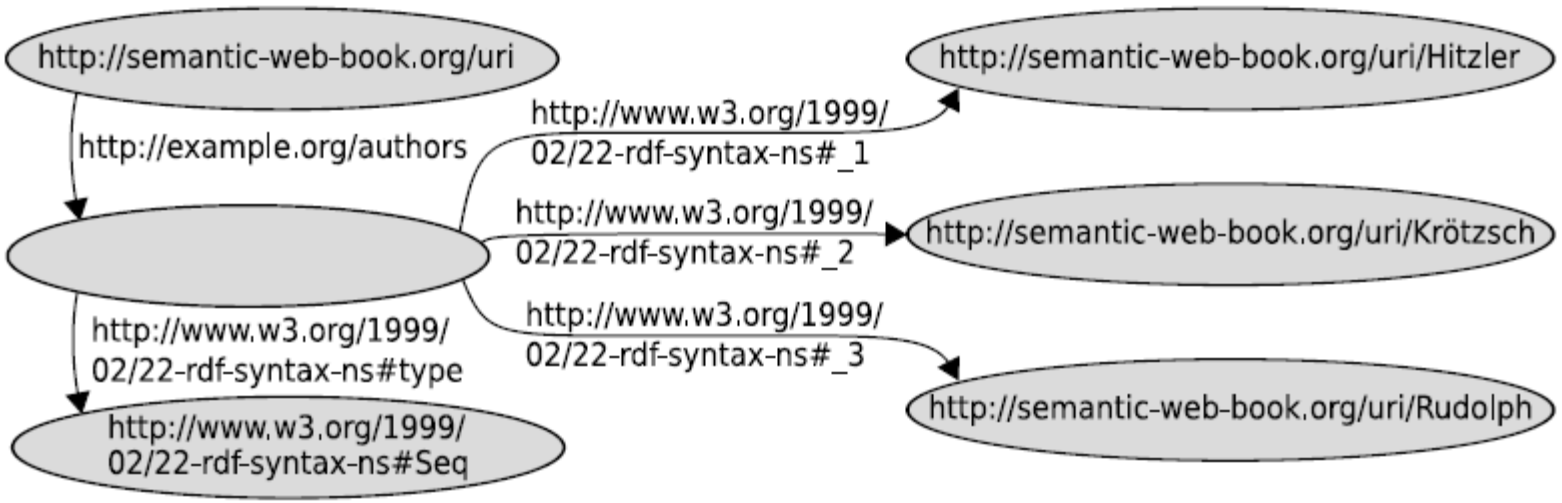
```
@prefix ex:  <http://example.org/> .
ex:Chutney    ex:hasIngredient  _:id1 .
_:id1         ex:ingredient  ex:greenMango;   ex:amount  "1lb" .
```

**shortcut:**

```
@prefix ex:  <http://example.org/> .
ex:Chutney    ex:hasIngredient
            [ ex:ingredient  ex:greenMango;   ex:amount  "1lb" ] .
```

# Table of contents : RDF

# Open lists (containers)




```
<rdf:Description rdf:about="http://semantic-web-book/uri">
 <ex:authors>
  <rdf:Seq>
   <rdf:li rdf:resource="http://semantic-web-book.org/uri/Hitzler" />
   <rdf:li rdf:resource="http://semantic-web-book.org/uri/Krötzsch" />
   <rdf:li rdf:resource="http://semantic-web-book.org/uri/Rudolph" />
  </rdf:Seq>
 </ex:authors>
</rdf:Description>
```

# Types of containers

- **“open”: new elements can be added.**

- **rdf:Seq – ordered list**
- **rdf:Bag – unordered set**
- **rdf:Alt – set of alternatives**

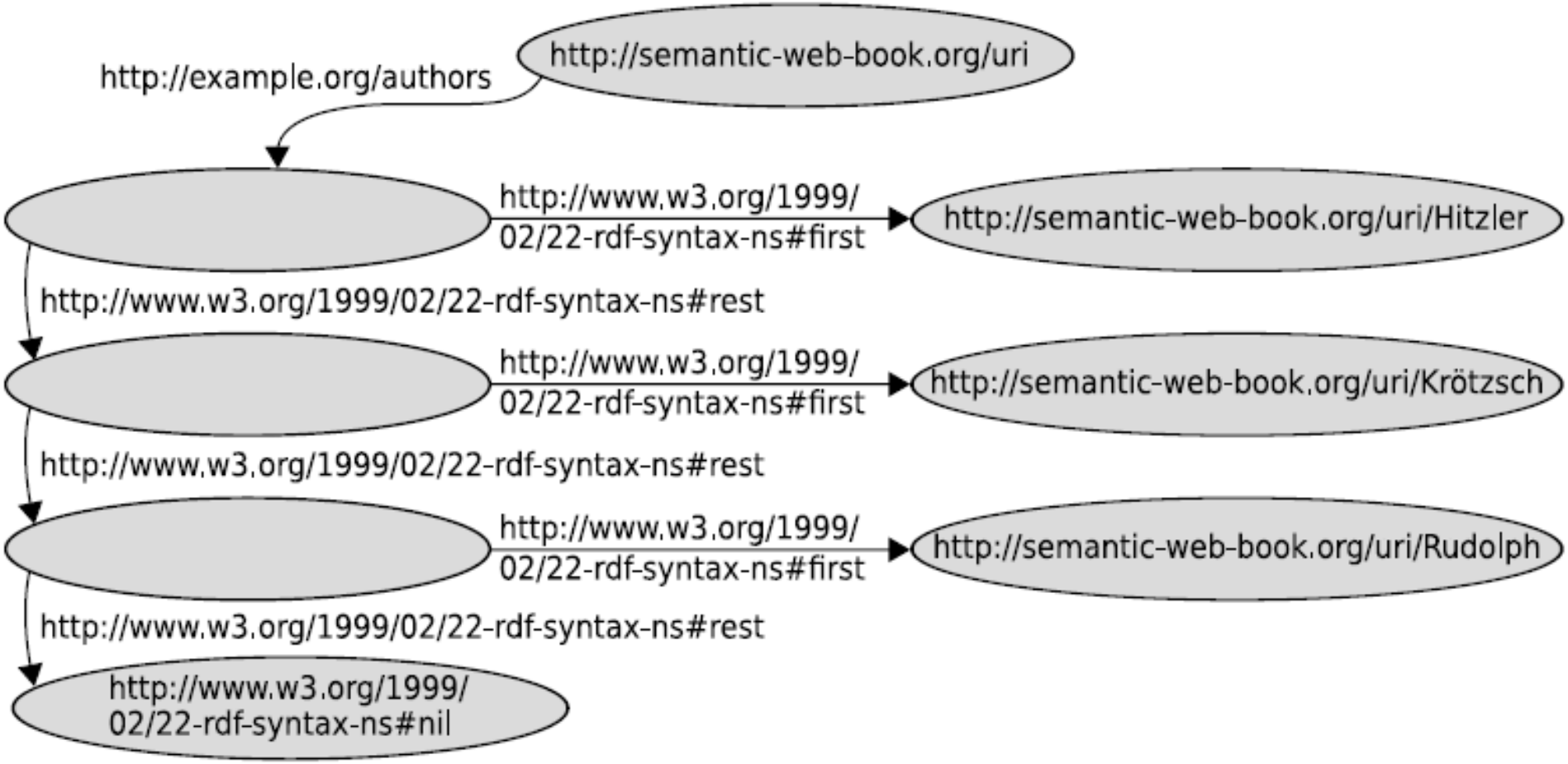
- **Lists are actually hardly reflected in the formal semantics (more about this later)**

# Closed lists (collections)

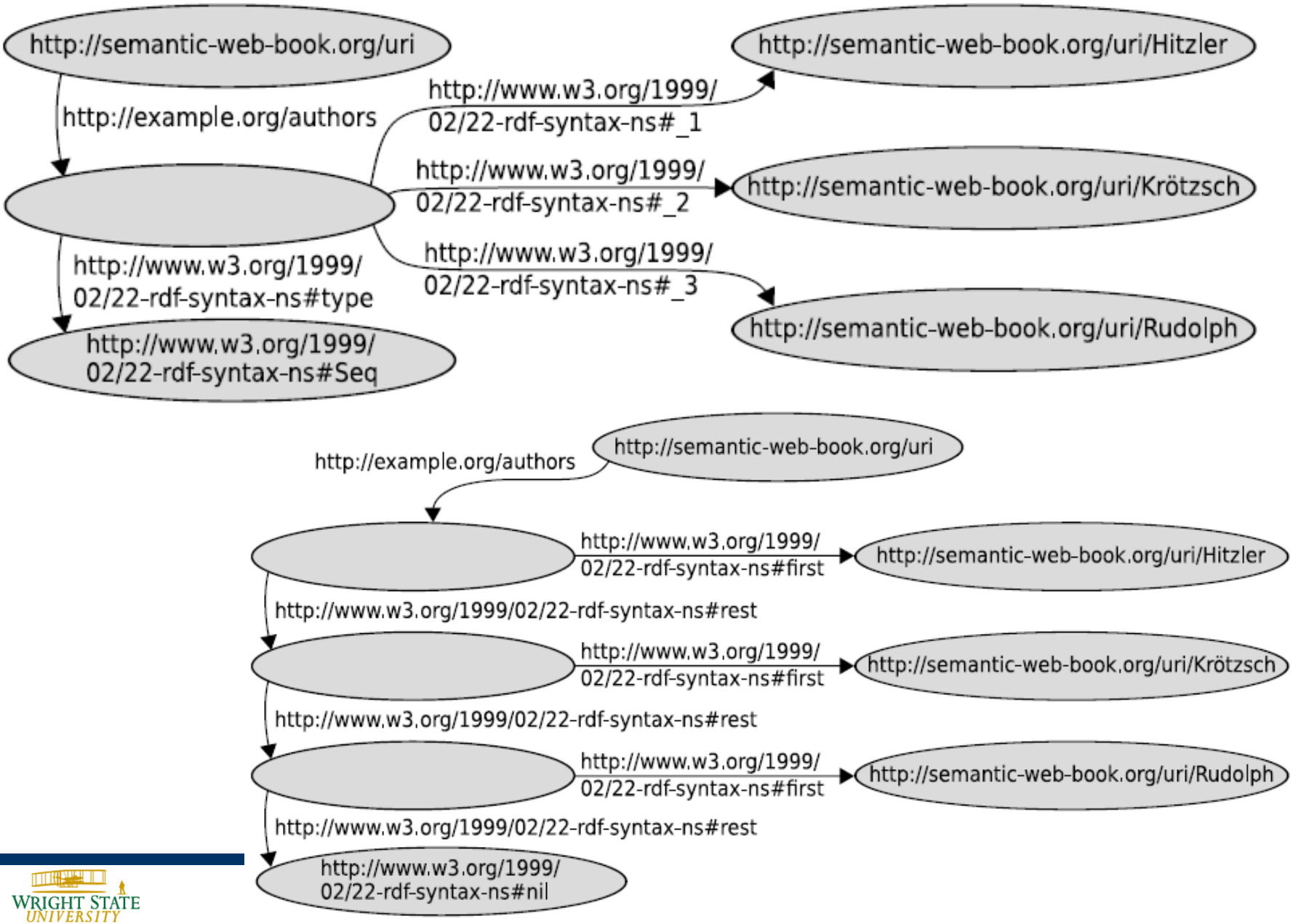
```
<rdf:Description rdf:about="http://semantic-web-book/uri">
  <ex:authors rdf:parseType="Collection">
     <rdf:Description
           rdf:about="http://semantic-web-book.org/uri/Hitzler" />
     <rdf:Description
           rdf:about="http://semantic-web-book.org/uri/Krötzsch" />
     <rdf:Description
           rdf:about="http://semantic-web-book.org/uri/Rudolph" />
  </ex:authors>
</rdf:Description>
```

```
@prefix book:  <http://semantic-web-book.org/> .
book:uri   <http://example.org/authors>
      ( book:uri/Hitzler  book:uri/Krötzsch  book:uri/Rudolph ) .
```

# Closed lists (collections)



# Comparison


http://semantic-web-book.org/uri
http://example.org/authors
http://www.w3.org/1999/02/22-rdf-syntax-ns#type
http://www.w3.org/1999/02/22-rdf-syntax-ns#Seq
http://www.w3.org/1999/02/22-rdf-syntax-ns#_1
http://www.w3.org/1999/02/22-rdf-syntax-ns#_2
http://www.w3.org/1999/02/22-rdf-syntax-ns#_3
http://semantic-web-book.org/uri/Hitzler
http://semantic-web-book.org/uri/Krötzsch
http://semantic-web-book.org/uri/Rudolph
http://example.org/authors
http://semantic-web-book.org/uri
http://www.w3.org/1999/02/22-rdf-syntax-ns#first
http://semantic-web-book.org/uri/Hitzler
http://www.w3.org/1999/02/22-rdf-syntax-ns#rest
http://www.w3.org/1999/02/22-rdf-syntax-ns#first
http://semantic-web-book.org/uri/Krötzsch
http://www.w3.org/1999/02/22-rdf-syntax-ns#rest
http://www.w3.org/1999/02/22-rdf-syntax-ns#first
http://semantic-web-book.org/uri/Rudolph
http://www.w3.org/1999/02/22-rdf-syntax-ns#rest
http://www.w3.org/1999/02/22-rdf-syntax-ns#nil

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9. Class presentation

# Class project – status

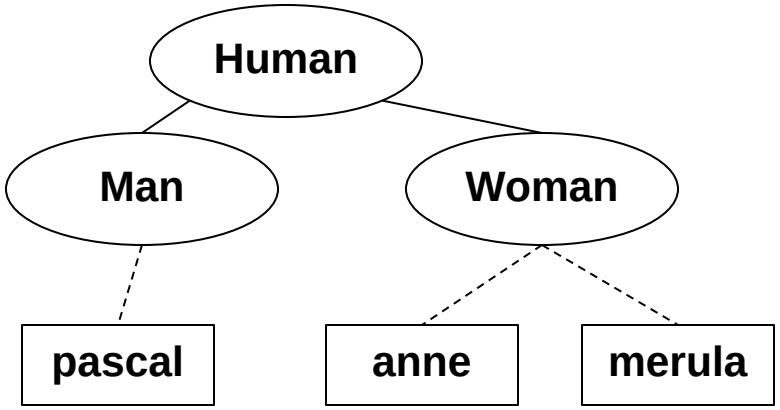
**Domains:**

- **vehicles**
- **university**
- **stock exchange**
- **language**
- **computers**
- **butterflies**
- **games**
- **hostile human action**
- **social networks**

- **Be punctual!**
- **Send me readable input!**

# Class project: next step

- re-check your taxonomy for correctness!
- add ca. 10 instances to your taxonomy




- add ca. 8 subject-predicate-object triples to your taxonomy, reusing the instances you created, and inventing suitable predicates (RDF properties). Use Turtle syntax for these.

  anne motherOf merula .

- introduce changes to your ontology in whatever way needed
- document briefly what you have done and why (in particular if you find bugs!
- send to me by Thursday noon

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# Class presentations – first topics

- **SPARQL 1.1 entailment regimes: http://www.w3.org/TR/2010/WD-sparql11-entailment-20100126/ http://www.w3.org/2009/sparql/docs/entailment/xmlspec.xml**
- **Aidan Hogan, Andreas Harth, Axel Polleres: SAOR: Authoritative Reasoning for the Web. ASWC 2008: 76-90**
- **Jacopo Urbani, Spyros Kotoulas, Jason Maassen, Frank van Harmelen, Henri E. Bal: OWL Reasoning with WebPIE: Calculating the Closure of 100 Billion Triples. ESWC (1) 2010: 213-227**
- **Yuan Ren, Jeff Z. Pan, Yuting Zhao: Soundness Preserving Approximation for TBox Reasoning. AAAI 2010**
- **Franz Baader, Sebastian Brandt, Carsten Lutz: Pushing the EL Envelope. IJCAI 2005: 364-369**

# Class Planning

**Thursday 13th of January: RDFS Part I**
**Tuesday 18th of January: Exercise Session**
**Thursday 25th of January: RDF and RDFS Semantics**

**Estimated breakdown of sessions:**

**Intro + XML: 2**

**RDF: 3**

**OWL and Logic: 6**

**SPARQL and Querying: 2**

**Class Presentations: 3**

**Exercise sessions: 3**