# Knowledge Representation for the Semantic Web

**Winter Quarter 2011**

**Slides 2 – 01/06/2011**

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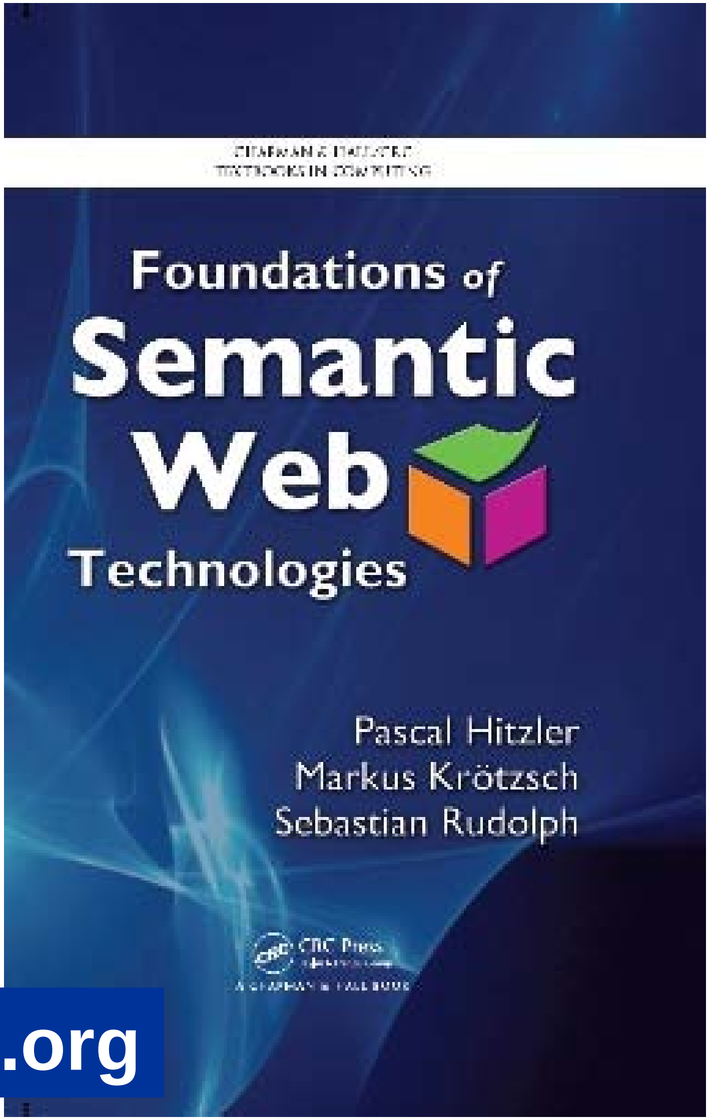
# Slides are based on

**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)**

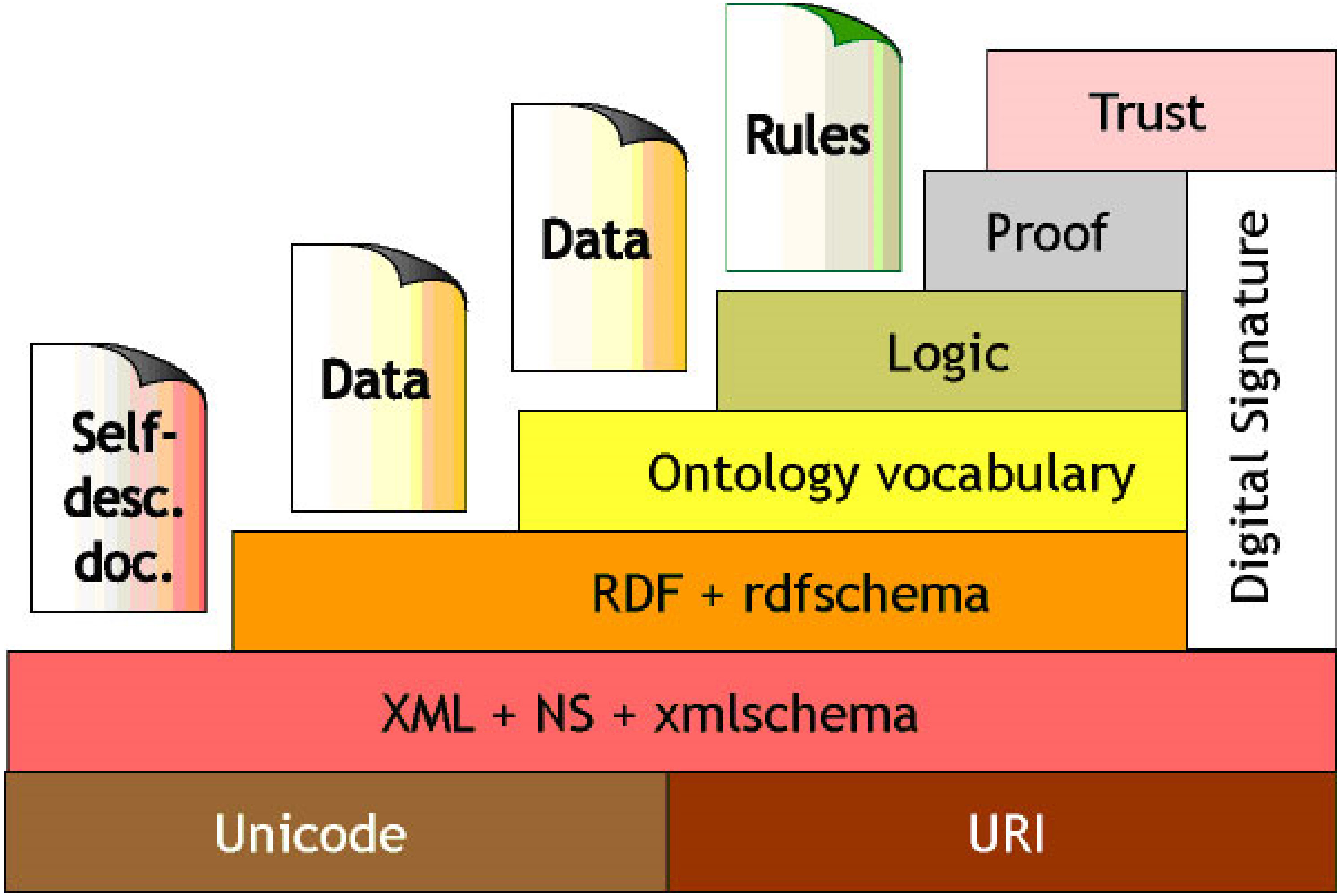


**http://www.semantic-web-book.org**

# Today’s Session

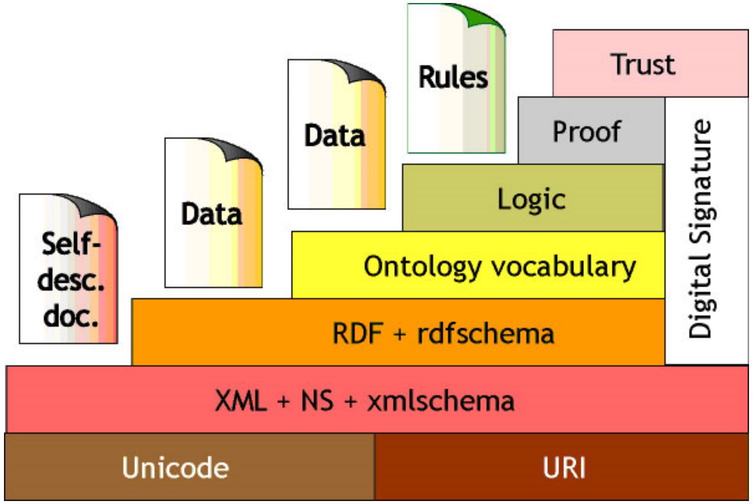
1. The Semantic Web Layer Cake
2. Essentials of the eXtensible Markup Language XML
3. Class project – status
4. Class presentations – first topics

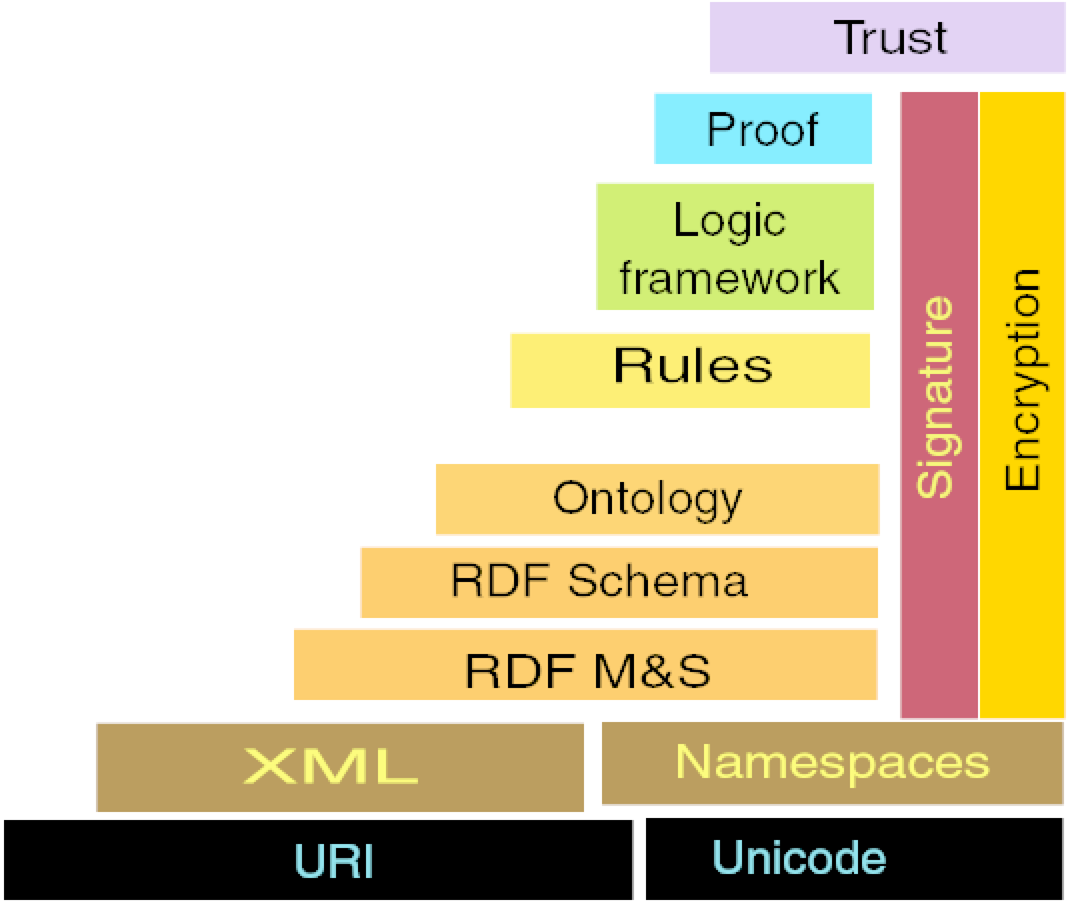
# Tim Berners-Lee version, 2000



**http://www.w3.org/2000/Talks/1206-xml2k-tbl/Overview.html**

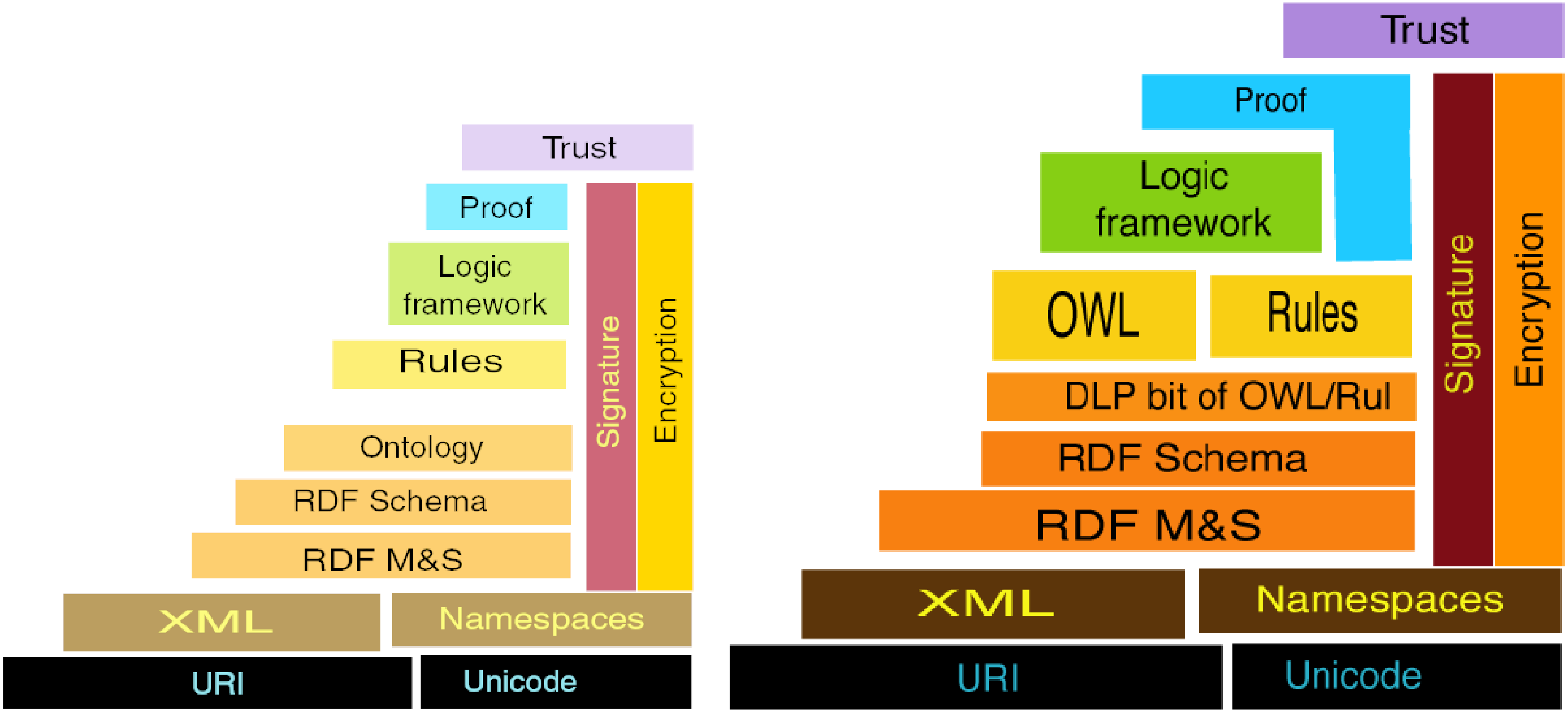
# Tim  Berners-Lee version, 2003





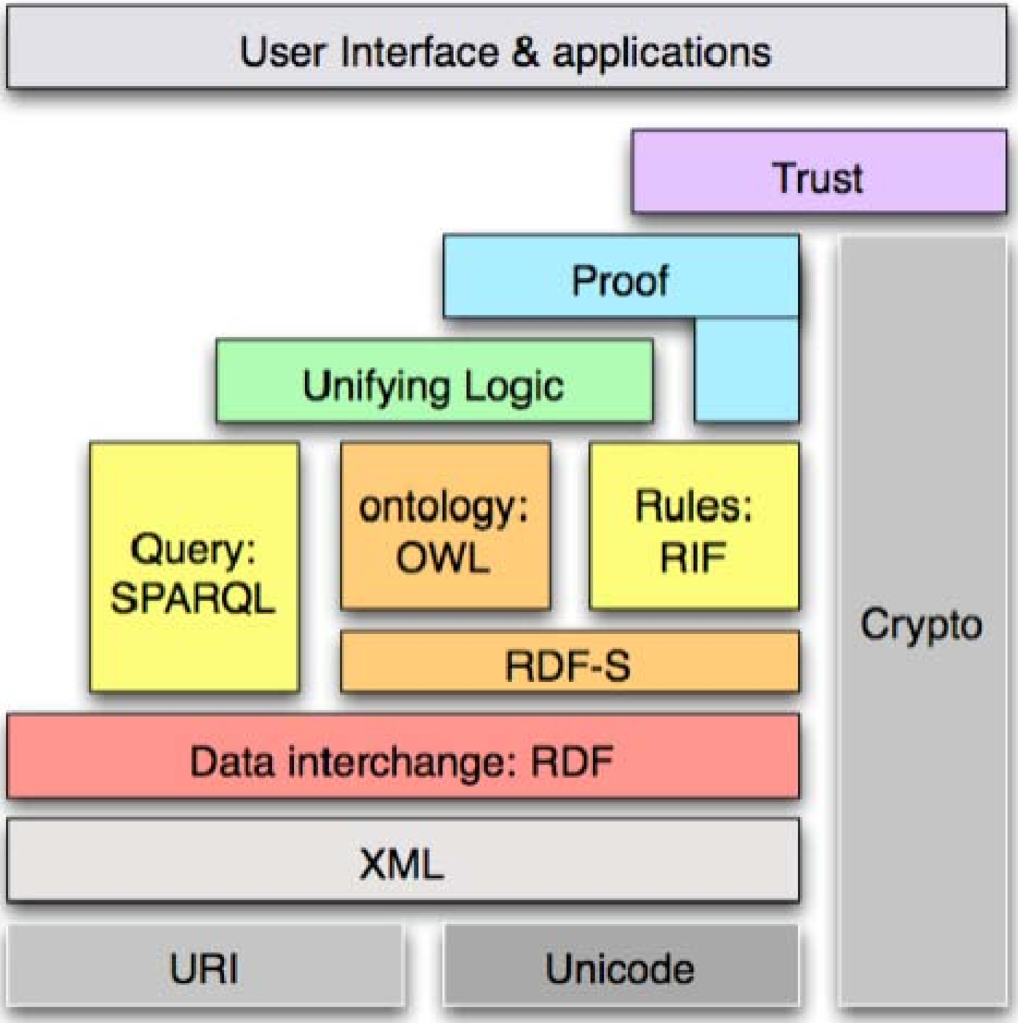
**http://www.w3.org/2003/Talks/0922-rsoc-tbl/**

# Horrocks et al, 2005



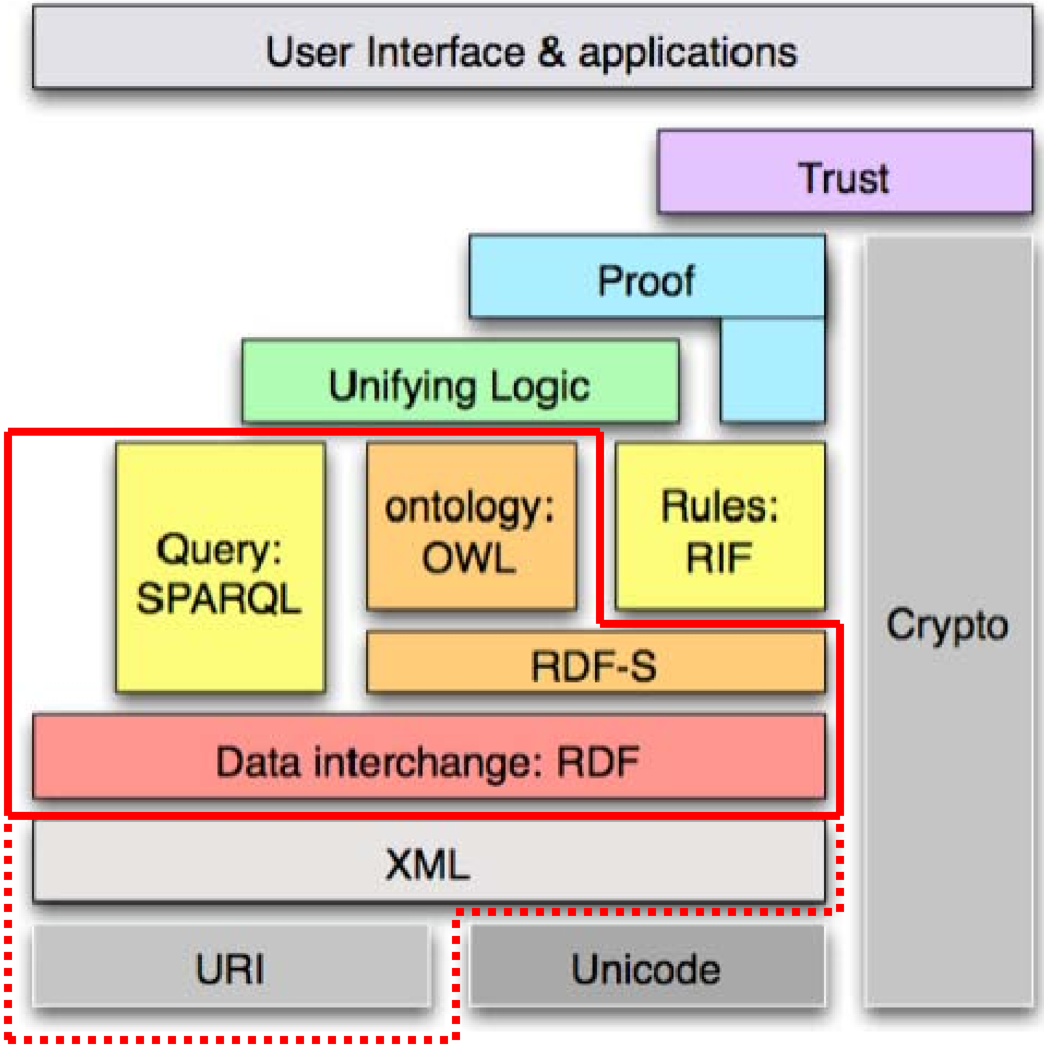
**Horrocks, Parsia, Patel-Schneider, Hendler, Semantic Web Architecture: Stack or Two Towers? LNCS 3703, 37-41, 2005.**

# Tim Berners-Lee version, 2006

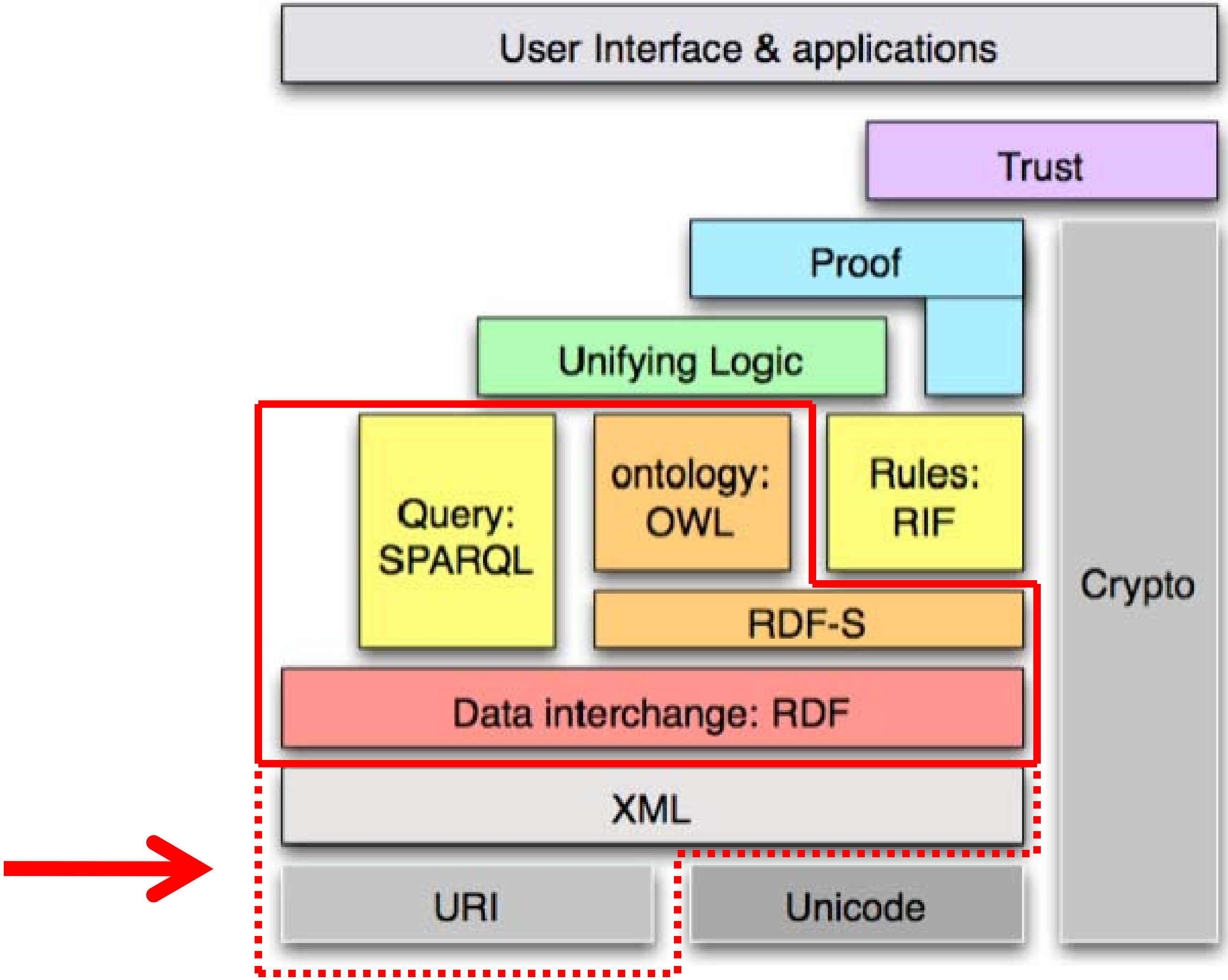


**http://www.w3.org/2006/Talks/0718-aaai-tbl/**

# Planned coverage in this lecture



# Planned coverage in this lecture



# Today's Session

1. The Semantic Web Layer Cake

2. Essentials of the eXtensible Markup Language XML

   Appendix A in the textbook, plus some material on namespaces and URIs taken from Chapter 2

3. Class project – status

4. Class presentations – first topics

# XML contents

- **Motivation**
- **Syntax**
- **URIs**
- **Namespaces**
- **XML Schema**

# Markup-languages

- Basic idea: adding additional information or structure to (unstructured) text

- to *annotate* text
  Webster’s: annotation –
  a note added by way of comment or explanation

- text = data
  additional info = metadata (data about data)

- usually done by way of *tags*:
  <tag-name> ... Text ... </tag-name>
  [opening tag] [closing tag]

# Markup-languages

- **Most prominent example: HTML**
  **Annotations used for encoding display information**

- **<i>This book</i> has the title <b>FOST</b>.**
  **Browser shows:**

  *This book* has the title **FOST**.

- **Same idea can be used for content description:**

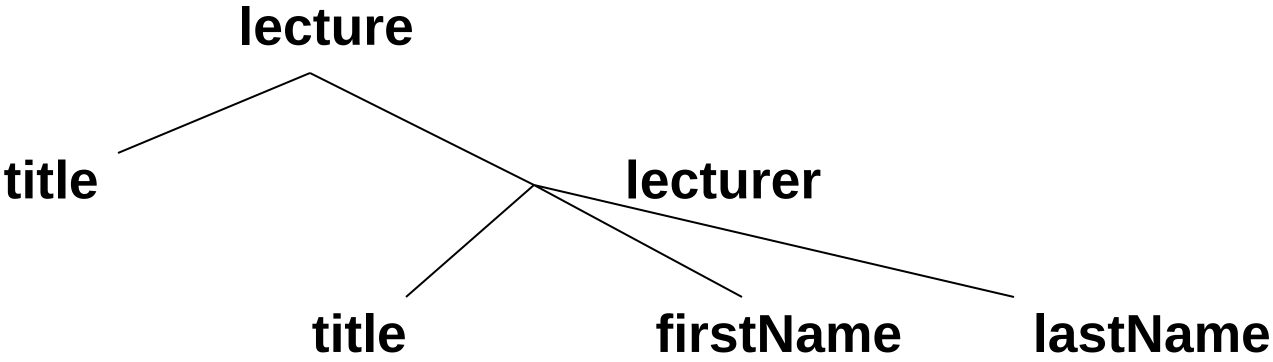
  **<book>This book</book> has the title <title>FOST</title>.**

# Tags may be nested

```
<lecture>
   <title>        KR4SW        </title>
   <lecturer>
        <title>        Prof. Dr.     </title>
        <firstName>    Pascal        </firstName>
        <lastName>     Hitzler       </lastName>
   </lecturer>
</lecture>
```

# Tree structure

```
<lecture>
    <title>        KR4SW        </title>
    <lecturer>
        <title>        Prof. Dr.    </title>
        <firstName>    Pascal       </firstName>
        <lastName>     Hitzler      </lastName>
    </lecturer>
</lecture>
```



lecture

title

lecturer

title

firstName

lastName

# XML contents

- Motivation
- Syntax
- URIs
- Namespaces
- XML Schema

# XML

- eXtensible Markup Language

- origin: structured text
- W3C standard for data exchange
  [see www.w3.org for W3C]
  - input and output data of applications can be described using XML
  - additionally only needed: a standardized description / vocabulary
- complementary to HTML
  - HTML is for display/presentation
  - XML is for describing content
- database view: XML as data model for semi-structured data

# XML-Syntax: prolog

- every XML document is a text document

- every XML document begins with a declaration containing
  - the version number of the used standard
  - and optionally, the character encoding.

- example:

<?xml version=“1.0” encoding=“utf-8”?>

# XML-Syntax: XML Elements

- XML elements
  - describe objects which are enclosed in matching tag-pairs.
  - can contain text and/or further XML elements, arbitrarily nested.
  - empty elements can be abbreviated,
    e.g. <year></year> can be written as <year/>.
  - the outermost element is called *root* element (there is only one)

| | |
|---|---|
| opening tag: | <author> |
| subelements: | <firstName>Sebastian</firstName> |
| | <lastName>Rudolph</lastName> |
| | <email>rudolph@kit.edu</email> |
| text: | This is some text inside an XML element. |
| closing tag: | </author> |

# XML-Syntax: XML Attributes

- XML attributes
  - are name-string-pairs in opening tags (or self-closing tags).
  - are associated with the corresponding XML element.
  - are an alternative means to sub-elements for describing data.

attribute

```
<author email=“rudolph@kit.edu”>
<firstName>Sebastian</firstName>
<lastName>Rudolph</lastName>
This is some text inside an XML element.
</author>
```

# XML-Syntax, XML vs. HTML

- XML Documents which are syntactically correct, are said to be *well-formed*.

- XML vs HTML:
  - HTML uses a fixed vocabulary (set of tags) with a fixed meaning (for display of text)
  - XML allows free choice of tag names, whose meaning is not fixed.

```
<h1> Bib </h1>
  <p>
    <i>FOST</i>
    <b>2010</b>
  <p>
```

```
<Bib id=“o1”>
        <title>FOST</title>
        <author>...</author>
        <year>2010</year>
</Bib>
```

# XML contents

- Motivation
- Syntax
- URIs
- Namespaces
- XML Schema

# URIs

- URI = Uniform Resource Identifier
  URL = Uniform Resource Locator (has a location on the WWW)
  IRI = Internationalized Resource Identifier (uses Unicode)
  $\text{URLs} \subseteq \text{URIs} \subseteq \text{IRIs}$
- used for identifying Web resources
- resources can be anything that has an identity in the context of an application (books, locations, humans, abstract concepts, etc.)
- analogous to, e.g., ISBN for books

# URIs – format

**scheme:[//authority]path[?query][#fragment]**

- **scheme: type of URI, e.g. http, ftp, mailto, file, irc**
- **authority: typically a domain name**
- **path: e.g. /etc/passwd/**
- **query: optional; provides non-hierarchical information. Usually for parameters, e.g. for a web service**
- **fragment: optional; often used to address part of a retrieved resource, e.g. section of a HTML file.**

- **not all characters are allowed in URIs.**

# URIs

- where do they come from?
- what URIs to use?
- what does a URI stand for?

  http://www.pascal-hitzler.de – is this a URI for a web page or for the person “Pascal Hitzler”?
- What about URIs which do not dereference?

# XML contents

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# Namespaces

```
<lecture>
    <title>        KR4SW          </title>
    <lecturer>
          <title>        Prof. Dr.      </title>
          <firstName>    Pascal         </firstName>
          <lastName>     Hitzler        </lastName>
    </lecturer>
</lecture>
```

- same tag name – probably better to disambiguate

# Namespaces

```
<lecture          xmlns:lec=“http://example.org/lecture/”
                  xmlns:person=“http://example.org/person/>
   <lec:title>    KR4SW           </lec:title>
   <lec:lecturer>
        <person:title>            Prof. Dr.       </person:title>
        <person:firstName>        Pascal          </person:firstName>
        <person:lastName>         Hitzler         </person:lastName>
   </lec:lecturer>
</lec:lecture>
```

- disambiguate using namespaces
- same mechanism can be used for indicating different sources for data

# Namespaces – declaration mechanisms

- **Namespace declaration**
  **Usage: namespace:name in XML element names**
  **Declaration: xmlns:namespace=“<uri>” in XML opening tags or empty-element tags. Affects XML subtree, multiple declarations possible.**
- **Base namespace (only RDF)**
  **Usage: non-URI name as value for some RDF/XML elements.**
  **Declaration: xml:base=“<uri>” in XML opening tags or empty-element tags. Affects XML subtree, multiple declarations possible.**
- **Entity declaration**
  **This is part of so-called *Document Type Definitions*.**
  **Usage: &entity; in XML attribute values or RDF literal values.**
  **Declaration: <!ENTITY entity ‘text’> in initial DOCTYPE declaration. Affects whole document, only one declaration possible.**

# Namespaces – entity declarations

```
<?xml version=“1.0”?>
<!DOCTYPE rdf:RDF
      [   <!ENTITY owl "http://www.w3.org/2002/07/owl#" >
          <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
          <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
          <!ENTITY otherOnt "http://example.org/otherOntology/" >
      ]>
```

Usage examples follow below.

We will not discuss Document Type Declarations (DTDs) in more detail – they are a weaker mechanism than XML schema. Just use the above as a form of “macro”.

# XML contents

- Motivation
- Syntax
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- XML Schema

# XML Schema

- **XML allows a lot of freedom in encoding information**

```
<author>Sebastian Rudolph</author>

<author name=“Sebastian Rudolph”/>

<author><fullName>Sebastian Rudolph</fullName></author>

<author>        <firstName>Sebastian</firstName>
                <secondName>Rudolph</secondName>   </author>

<author givenName=“Sebastian” surname=“Rudolph”/>
```

# XML Schema

- These degrees of freedom get in the way when exchanging XML documents between applications!

- It is necessary to come up with agreements about the structure of the information, including the names of tags and attributes, and whether certain subelements are required or not.

- XML Schema is a W3C standard which provides for this.

- XML schemas are themselves written in XML.

- An XML document is said to be *valid* if it adheres to a corresponding XML schema.

# XML Schema

- **An XML Schema document is a well-formed XML document which contains *XML schema definitions*.**
- **An XML schema definition begins with an opening tag like**

  **<xsd:schema xmlns:xsd=”http://www.w3.org/2001/XMLSchema”>**

  **it then contains *element types, which can contain attribute types*, which themselves refer to predefined or user-defined datatypes.**

- **datatypes are, e.g. xsd:integer, xsd:string, xsd:time, xsd:date, xsd:anyURI,**
  **xsd:ID (a specific kind of string used as identifier of XML elements)**

# XML Schema Example

```
<?xml version=“1.1” encoding=“utf-16”?>
<!DOCTYPE xsd:schema
     [   <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
     ]>
   <xsd:schema xmlns:xsd=“http://www.w3.org/2001/XMLSchema”>
        <xsd:element name=“author” type=“&xsd;string”
                        minOccurs=“1” maxOccurs=“unbounded”>
                <xsd:attribute name=“email” type=“&xsd;string”
                        use=“required”>
                <xsd:attribute name=“homepage”
                        type=“&xsd;anyURI” use=“optional”>
        </xsd:element>
   </xsd:schema>
```

# XML Schema Example

```
<xsd:element name=“author” type=“&xsd;string”
                              minOccurs=“1” maxOccurs=“unbounded”>
                    <xsd:attribute name=“email” type=“&xsd;string”
                              use=“required”>
                    <xsd:attribute name=“homepage” type=“&xsd;anyURI”
                              use=“optional”>
          </xsd:element>

<author email=“email1@example.org” homepage=“http://korrekt.org”>
    Markus Kroetzsch
</author>
<author email=“email2@example.org” >
    Sebastian Rudolph
</author>
```

# XML Schema – user-defined types

Simple types: obtained by restricting other types.

```
<xsd:simpleType name=“humanAge”>
    <xsd:restriction base=“&xsd;integer”>
           <xsd:minInclusive value=“0”/>
           <xsd:maxInclusive value=200”/>
    </xsd:restriction>
</xsd:simpleType
```

No use of embedded element or attribute types!

# XML Schema – user-defined types

```
<xsd:complexType name="bookType“>
    <xsd:sequence>
           <xsd:element name="author" type="&xsd;string“
                      minOccurs="1“ maxOccurs="unbounded" />
           <xsd:element name="title" type="&xsd;string”
                      minOccurs="1” maxOccurs="1" />
           <xsd:element name="publisher" type="&xsd;string”
                      minOccurs="1“ maxOccurs="1" />
           <xsd:element name="year" type="&xsd;gYear”
                      minOccurs="1" maxOccurs="1" />
    </xsd:sequence>
    <xsd:attribute name="ISBNnumber" type=“&xsd;nonNegativeInteger“
           use="optional" />
</xsd:complexType>
```

# XML Schema – user-defined types

```
<xsd:complexType name="researchBookType">
    <xsd:extension base="bookType">
    <xsd:sequence>
          <xsd:element name="field" type="&xsd;string" />
    </xsd:sequence>
    <xsd:attribute name="price" type="&xsd;nonNegativeInteger“
                    use="optional" />
</xsd:complexType>
```

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# Class project – status

**Domains:**

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

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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

Topic next Tuesday: RDF Part I

Exercise session planned for Tuesday, 18th of January

Estimated (incomplete) breakdown of sessions:

Intro + XML: 2

RDF: 3

OWL and Logic: 6

SPARQL and Querying: 2

Class Presentations: 3

Exercise sessions: 3