Agenda

- Introduction of Lecturer
- Organizational Matters
- What is the “Semantic Web”? 
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- What is the “Semantic Web”? 
Introduction of Lecturer

Prof. Dr. Sebastian Rudolph

Since Apr 13  Full Professor for Computational Logic at the Computer Science Department, TU Dresden

2006 – Feb 13  Research Assistant → Project Leader → Privatdozent at the Chair of Knowledge Management, Institute AIFB, University of Karlsruhe → Karlsruhe Institute of Technology

2003 – 2006  Research Assistant at the Chair of Psychology of Teaching and Learning, TU Dresden

2000 – 2003  PhD Scholarship Holder Graduate School, TU Dresden

1995 – 2000  Studies for high-school teaching (Math, Physics, CS), TU Dresden
Introduction of Lecturer

scientific interests

- logic-based knowledge representation and reasoning
- semantic technologies
- complexity and decidability problems
- computational linguistics
- theory of databases
- (and much more)
Agenda

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- What is the “Semantic Web”?
Organizational Matters: Time and Place

- **Wednesday**, 13:00 – 14:30 (4.DS)
- **Friday**, 09:20 – 10:50 (2.DS) and 11:10 – 12:40 (3.DS)
- exact schedule see below
- INF E005
Literature

Hitzler, Krötzsch, Rudolph, Sure “Semantic Web Grundlagen” Springer-Verlag

Hitzler, Krötzsch, Rudolph, Sure “Foundations of Semantic Web Technologies” CRC Press
Agenda

- Introduction of Lecturer
- Organizational Matters
- What is the “Semantic Web”?
The Web

The Web is at the heart of the transition from industrial to information society, providing the infrastructure for a novel quality of handling information in terms of retrieval and provision

- high availability
- high up-to-date-ness
- low cost
The Web

Commercialization on all levels
The Web

Commercialization on all levels
Further aspects of daily life are being “webized”:

- authorities, administration (eGovernment)
- education (eLearning, eEducation)
- social contacts (social networking platforms, dating sites)
- everyday life?
Why Semantic Web?

Syntax vs. Semantik

Syntax (from greek συνταξις composition, sentential structure) denotes the (normative) structure of data, i.e., it characterizes what makes data “well-formed”

Semantik (greek σηµαυτικσ belonging to the sign) denotes the meaning of data, i.e., it characterizes what conclusions can be drawn from it.

\[
\begin{align*}
4 + 3 &= 12 & 3 + 4 &= 7 \\
\text{syntactically wrong} & \quad \text{syntactically correct} & \quad \text{semantically wrong} & \quad \text{semantically correct}
\end{align*}
\]
Problems of the Web

- plethora of information
- targeted at human end user
Problems of the Web

- plethora of information
- targeted at human end user
Problems of the Web

- plethora of information
- targeted at human end user
Problems of the Web

- plethora of information
- targeted at human end user

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Curriculum Vitae (PDF)

**Brief Introduction:**

Dr. Guilin Qi is a professor working at Southeast University in China. His research topics include knowledge representation and reasoning, semantic Web, uncertainty reasoning. His current research interests include the areas of

- **Knowledge representation:** belief merging, belief revision, inconsistency handling, nonmonotonic reasoning, information fusion, argumentation, paraconsistent logic
<h1>Ian Horrocks</h1>
<table>
<tr>
<td class="personImg">
<img src="IH005-1.jpg" alt="Photo Ian Horrocks"/>
</td>
<td>
<div class="personinfo">
<div>Professor Ian Horrocks FRS</div>
<div>Professor of Computer Science</div>
<div>Fellow, <a href="http://www.oriel.ox.ac.uk">Oriel College</a></div>
<div>ian.horrocks@cs.ox.ac.uk</div>
<div>+44 1865 273939</div>
<div>+44 1865 273839 (fax)</div>
</div>
<p>Wolfson Building, Parks Road, Oxford OX1 3QD</p>
</td>
</tr>
</table>
Problems of the Web

- localizing information problematic
- today’s search engines good but mostly keyword-based
- desirable: search for content → semantic search
Problems of the Web

- Heterogeneity of present information on diverse levels:
  - character encoding (e.g. ASCII vs. Unicode)
  - used natural languages
  - positioning of information on webpages
- desirable: cross-web information integration
Problems of the Web

- **implicit knowledge**, i.e. many pieces of information are not provided explicitly, but follow from the combination of the given data
- requires methods from formal logics
- automated deduction
Problems of the Web

Approaches toward a solution:

1. Ad hoc: Deployment of AI methods (most notably NLP techniques) to evaluate existing unstructured information on the Web

2. A priori: Structure information on the Web at authoring time in a way facilitating later automated deployment
Problems of the Web

Approaches toward a solution:

1. Ad hoc: Deployment of AI methods (most notably NLP techniques) to evaluate existing unstructured information on the Web
2. A priori: Structure information on the Web at authoring time in a way facilitating later automated deployment

⇒ Semantic Web
Problems of the Web

two essential prerequisites for the implementation:

1. open standards for describing information
   - clearly defined
   - flexible
   - extendable

2. methods for eliciting information from such descriptions
1994  First public presentation of the Semantic Web idea
1998  Start of standardization of data model (RDF) and a first ontology languages (RDFS) at W3C
2000  Start of large research projects about ontologies in the US and Europe (DAML & Ontoknowledge)
2002  Start of standardization of a new ontology language (OWL) based on research results
2004  Finalization of the standard for data (RDF) and ontology (OWL)
2008  Standardization of a query language (SPARQL)
2009  Extension of OWL to OWL 2.0
2010  Standard Rule Interchange Format (RIF)
Agenda

- XML – Motivation/Idea
- XML – Syntax
- IRIs
- Name Spaces
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- XML – Motivation/Idea
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- IRIs
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Annotation with Mark-up Languages

- basic idea of mark-up: endow (unstructured) text with additional information (or structure)
- synonym: annotate text

\[
\begin{align*}
\text{text} & = \text{data} \\
\text{additional information} & = \text{metadata}
\end{align*}
\]
Annotation with Mark-up Languages

- common strategy: include to-be-annotated text in so-called tags:

```html
<tag_name> ...Text... </tag_name>
```

- Additional information is read and interpreted by processing software
Annotation with Mark-up Languages

- **most prominent example**: HTML tags encode visual presentation information:
  
  \[
  \text{This book} \text{ has the title } \text{Foundations of Semantic Web Technologies}.
  \]

- **Output of web browser**: 
  This book has the title **Foundations of Semantic Web Technologies**.

- **Strategy also suited for annotation of content**, e.g.:
  
  \[
  \text{Sebastian} \text{ Rudolph works in } \text{Dresden}.
  \]
Annotation with Markup-Languages

```
<lecture>
  <title>
    Deduction Systems
  </title>
  <lecturer>
    <title>
      Prof. Dr.
    </title>
    <firstname>
      Sebastian
    </firstname>
    <lastname>
      Rudolph
    </lastname>
  </lecturer>
</lecture>
```

- nesting of tags is permitted
Annotation with Markup-Languages

• nesting of tags is permitted
• multiple usage of tags is permitted

```
<lecture>
  <title>
    Deduction Systems
  </title>
  <lecturer>
    <title>
      Prof. Dr.
    </title>
    <firstname>
      Sebastian
    </firstname>
    <lastname>
      Rudolph
    </lastname>
  </lecturer>
</lecture>
```
Annotation with Markup-Languages

- nesting of tags is permitted
- multiple usage of tags is permitted
- XML tags constitute a tree structure
Agenda

- XML – Motivation/Idea
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- IRIs
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XML

- eXtensible Markup Language
- Origin: structured text (HTML4.0 ∈ XML ⊂ SGML)
- web standard (W3C) for data exchange:
  - input and output data can be described by means of XML
  - industry only has to agree on standardized tag names (the vocabulary)
- complementary language for HTML:
  - HTML describes presentation
  - XML describes content
- database perspective: XML as a data model for semi-structured data
XML-Syntax – Preamble

- XML document is a text document
- starts with declaration
  - contains version number of the standard used
  - optional: character encoding information

```xml
<?xml version="1.0" encoding="utf-8"?>
```
XML element:
- description of an object enclosed by matching tags
- content of an elements: text and/or further elements (arbitrary nesting possible)
- empty elements: `<year></year>` short: `<year/>
- “outermost” element is called root element (and there can be only one per document)
XML-Syntax – XML attributes

XML attribute:
- pair of name and string-value in start or self-closing tag
- associated with one XML element
- alternative option for describing data

Further possible description of the same data:

```xml
<author email="sab@abc.com">
  <firstname> Serge </firstname>
  <lastname> Abiteboul </lastname>
</author>
```
HTML vs. XML

- HTML: fixed vocabulary (set of tags) and semantics (visual presentation of text)
- XML: free choice of names for describing application-specific syntax and semantics
- XML ⊂ SGML

```xml
<Bib id="o1">
  <paper id="012">
    <title>Foundations of Databases</title>
    <author>
      <firstname>Serge</firstname>
      <lastname>Abiteboul</lastname>
    </author>
    <year>1997</year>
    <publisher>Addison Wesley</publisher>
  </paper>
</Bib>
```

```html
<h1>Bib</h1>
<p>
  <i>Foundations of Databases</i>  
  Serge Abiteboul  
  Addison Wesley, 1997
</p>
...
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- XML – Motivation/Idea
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- Name Spaces
IRIs – Idea

- IRI = Internationalized Resource Identifier
- serve for denoting resources in a world-wide unique way
- a resource can be any object that has (in the context of a given application) a clear identity (e.g. books, cities, persons, publishers, relations between those, abstract concepts etc.)
- in certain domains, something similar already exists: ISBN number for books
IRIs – Syntax

- extension of the notion of URLs; not every IRI relates to a Web document but mostly a Web document is referred to by using its URL as IRI
- starts with the so-called IRI schema, which is separated by a colon (:) from the subsequent part (e.g.: http, ftp, mailto)
- IRIs often hierarchically structured
IRIs – Self-defined IRIs

- necessary, if for a certain resource no IRI exists or is known (yet)
- strategy in order to avoid unintentional double use of an IRI for different things: use http-IRIs of a webpage that you control
- allows for providing a documentation describing the IRI under this address
The Describing vs. the described

- Separation of IRIs for (non-information) resources and their documentation (information resources) by IRI references (appended fragments starting with “#”) or content negotiation

- e.g.: as a IRI for Shakespeare’s “Othello”, http://de.wikipedia.org/wiki/Othello should not be used, but rather http://de.wikipedia.org/wiki/Othello#IRI
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XML Name Spaces: Motivation

- in XML documents, element and attribute names ("markup vocabulary") have universal validity
- in an XML application, these names are interpreted uniformly
- if XML data from several sources is merged, name conflicts / clashes may occur
- name spaces help avoid such conflicts
XML Name Spaces

- XML name spaces are similar to the notion of modules in programming languages
- disambiguation of tag names through usage of different “prefixes”
- a prefix is separated from a local name by a colon (:), thereby \texttt{prefix:name} tags come into being
- name space bindings are ignored by some tools: so-called “shallow name spaces”
Name Space Bindings

- prefixes are associated with name space IRIs by inserting an attribute `xmlns:prefix` into the relevant element or some of its predecessor elements: `prefix:name_1, ..., prefix:name_n`
- the value of the attribute `xmlns:prefix` is an IRI, that may point to a description of the syntax of the name space
- an element can use bindings for several (different) name spaces by using separate attributes `xmlns:prefix_1, ..., xmlns:prefix_m`
Example: Without Name Spaces

```xml
<lecture>
  <title> Deduction Systems </title>
  <lecturer>
    <title> Prof. Dr. </title>
    <firstname> Sebastian </firstname>
    <lastname> Rudolph </lastname>
  </lecturer>
</lecture>
```

*title* is an ambiguous element name
Two Distinct Name Spaces

```xml
<lec:lecture xmlns:lec="http://www.example.org/lectures"
             xmlns:per="http://www.example.org/person">
  <lec:title> Deduction Systems </lec:title>
  <lec:lecturer>
    <per:title> Prof. Dr. </per:title>
    <per:firstname> Sebastian </per:firstname>
    <per:lastname> Rudolph </per:lastname>
  </lec:lecturer>
</lec:lecture>
```

title has been disambiguated by using the prefixes lec and per
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