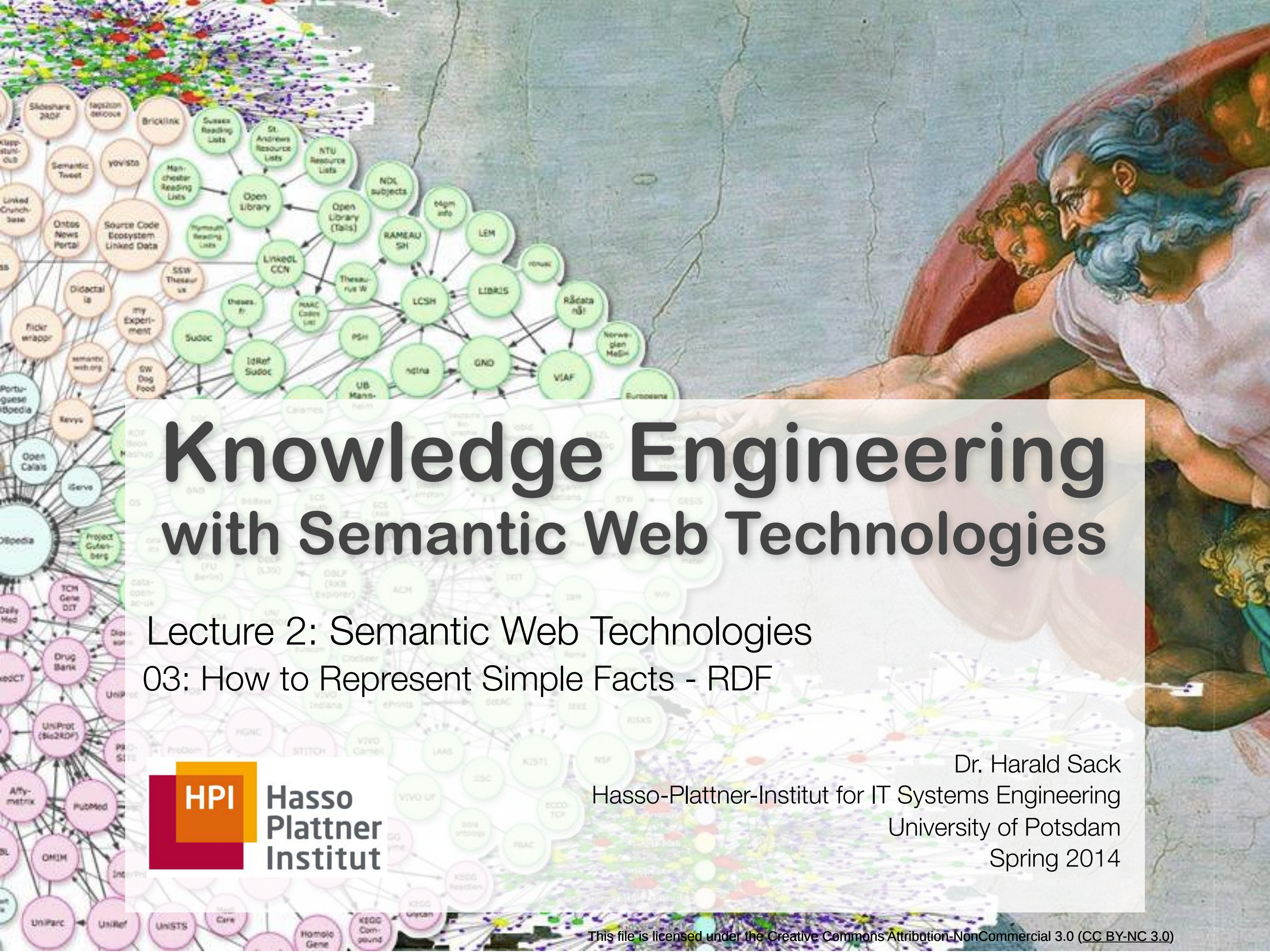




Knowledge Engineering with Semantic Web Technologies

Lecture 2: Semantic Web Technologies
03: How to Represent Simple Facts - RDF

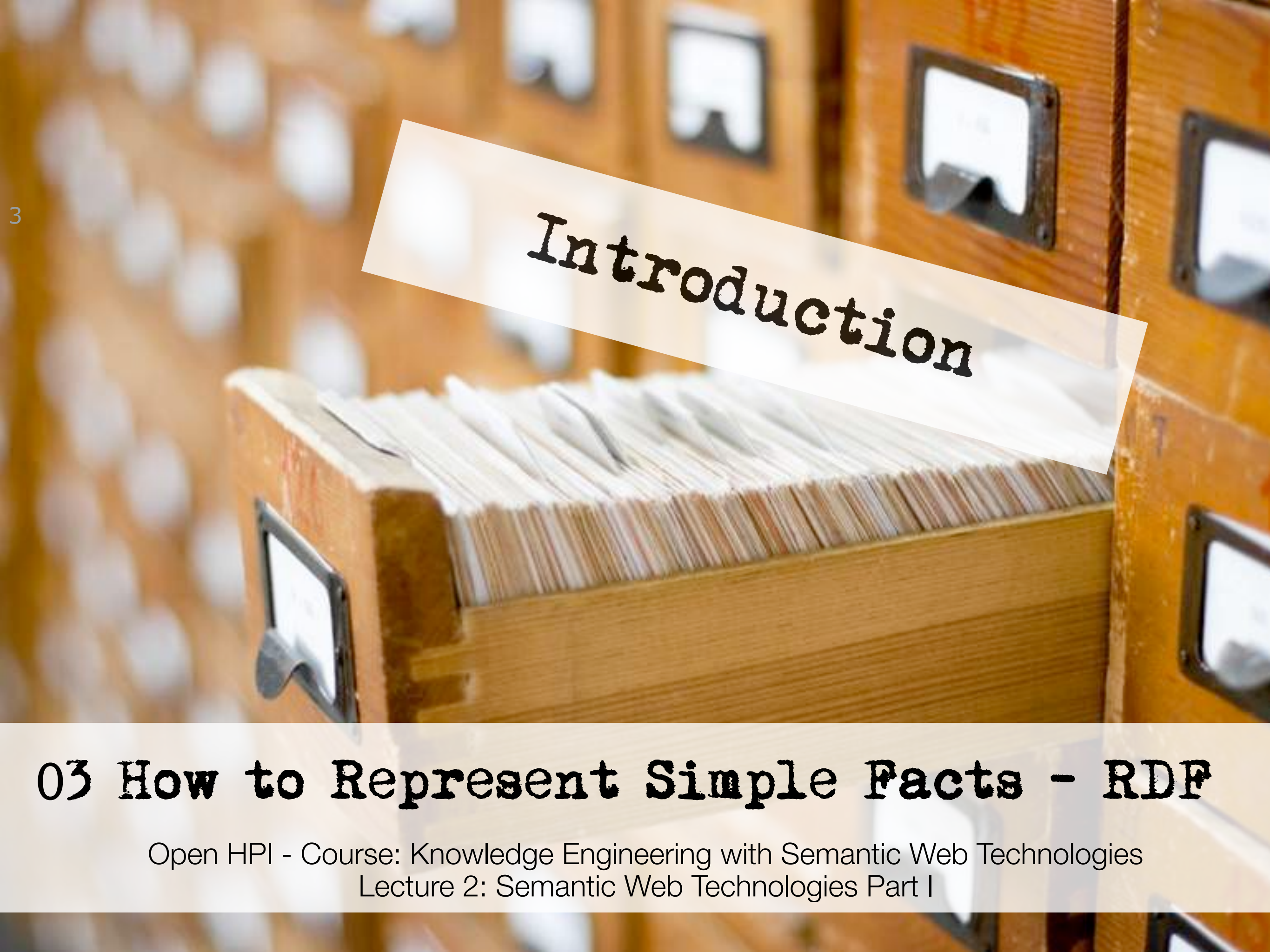


Dr. Harald Sack
Hasso-Plattner-Institut for IT Systems Engineering
University of Potsdam
Spring 2014



Lecture 2: Semantic Web Technologies - Part 1

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies



Introduction

03 How to Represent Simple Facts - RDF

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies
Lecture 2: Semantic Web Technologies Part I

2. Semantic Web Technologies

Part 1

The Semantic Web Technology Stack (not a piece of cake...)

Most apps use only a subset of the stack

Querying allows fine-grained data access

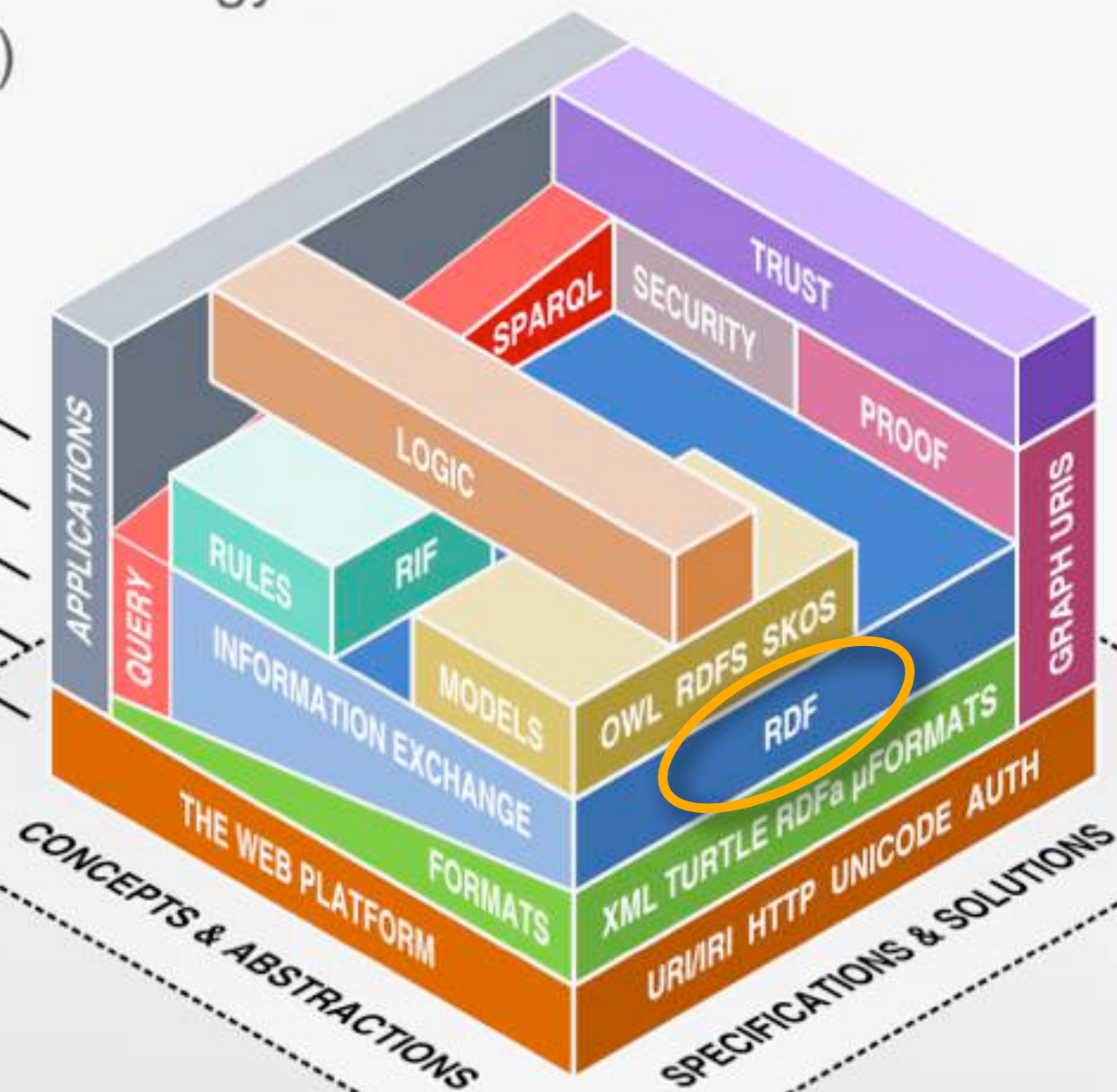
Standardized information exchange is key

Formats are necessary, but not too important

The Semantic Web is based on the Web

Linked Data uses a small
selection of technologies

LINKED DATA



Knowledge Representation

... a simple example



■ How do I represent

„Harald Sack has the phone number ++49 (331) 5509-927“ in XML?

Knowledge Representation

... a simple example

■ How do I represent

„Harald Sack has the phone number ++49 (331) 5509-927“ in XML?

```
<phonenr>  
  <owner>Harald Sack</owner>  
  <number>++49 (331) 5509-927</number>  
</phonenr>
```

Knowledge Representation

... a simple example

■ How do I represent

„Harald Sack has the phone number ++49 (331) 5509-927“ in XML?

```
<phonenr>  
  <owner>Harald Sack</owner>  
  <number>++49 (331) 5509-927</number>  
</phonenr>
```

```
<person name="Harald Sack">  
  <phonenr>49 (331) 5509-927</phonenr>  
</person>
```

Knowledge Representation

... a simple example

■ How do I represent

„Harald Sack has the phone number ++49 (331) 5509-927“ in XML?

```
<phonenr>  
  <owner>Harald Sack</owner>  
  <number>++49 (331) 5509-927</number>  
</phonenr>
```

```
<person name="Harald Sack">  
  <phonenr>49 (331) 5509-927</phonenr>  
</person>
```

```
<person name="Harald Sack" phone="49 (331) 5509-927" />
```

Knowledge Representation

... a simple example

■ How do I represent

„Harald Sack has the phone number ++49 (331) 5509-927“ in XML?

```
<phonenr>  
  <owner>Harald Sack</owner>  
  <number>++49 (331) 5509-927</number>  
</phonenr>
```

```
<person name="Harald Sack">  
  <phonenr>49 (331) 5509-927</phonenr>  
</person>
```

```
<person name="Harald Sack" phone="49 (331) 5509-927" />
```

is there a unique (intuitive) way to model knowledge (in XML)?

Knowledge Representation

... with XML?

- Successful communication requires translation from one XML serialization (Schema A) to another XML serialization (Schema B)

```
<phonenr>  
  <owner>Harald Sack</owner>  
  <number>++49 (331) 5509-927</number>  
</phonenr>
```

XML Schema A

XML Schema B

```
<person name="Harald Sack">  
  <phonenr>49 (331) 5509-927</phonenr>  
</person>
```

XSLT Transformation

```
<xsl:stylesheet version="1.0"  
  xmlns:xsl="http://...Transform"  
  <xsl:template match="/">  
    ....  
  </xsl:template>  
</xsl:stylesheet>
```

Knowledge Representation

... a simple example

■ How do I represent:

„Harald Sack has the phone number ++49 (331) 5509-927“

Harald Sack

Knowledge Representation

... a simple example

■ How do I represent:

„Harald Sack has the phone number ++49 (331) 5509-927“

Harald Sack

has the phone number

Knowledge Representation

... a simple example

■ How do I represent:

„Harald Sack has the phone number ++49 (331) 5509-927“

Harald Sack

has the phone number

++49 (331) 5509-927

Knowledge Representation

... a simple example

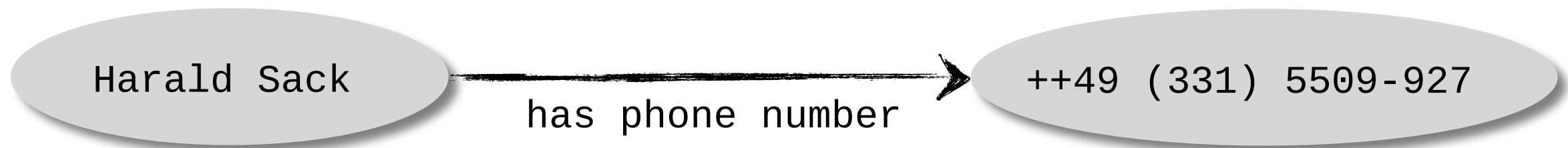


- How do I represent:
„Harald Sack has the phone number ++49 (331) 5509-927“
- Intuitive knowledge representation with **directed graphs**

Knowledge Representation

... a simple example

- How do I represent:
„Harald Sack has the phone number ++49 (331) 5509-927“
- Intuitive knowledge representation with **directed graphs**







Resource Description Framework

Resource

- can be everything (in principle)...
- must be uniquely identified and be referencable
- ...simply via URI



Resource Description Framework

Description

- = Descriptions of resources
- ...via representing properties and relationships among resources
- ...relationships can be represented as graphs



Resource Description Framework

Framework

- = Combination of web based protocols (URI, HTTP, XML,...)
- based on formal model (semantics)
- defines all allowed relationships among resources



Resource Description Framework

Harald Sack

has phone number

++49 (331) 5509-927

- Knowledge in RDF is expressed as a **list of statements**
- all RDF statements follow the same simple schema



Resource Description Framework

Harald Sack **Subject**

has phone number **Property**

++49 (331) 5509-927 **Object**



Resource Description Framework

Harald Sack **Subject**

→ **URI**

has phone number **Property** → **URI**

++49 (331) 5509-927 **Object** → **URI/Literal**



Resource Description Framework

- **Statements (RDF-Triple):**

Subject + Property + Object / Value

URI

URI

URI / Literal



Resource Description Framework

Constituents of the RDF-Graph

- **URI:**
 - to reference **resources** uniquely

<http://harald.sack.de/foaf.rdf#harald>

Subject

<http://harald.blogspot.com/>

Object

<http://xmlns.com/foaf/0.1/weblog>
Property



Resource Description Framework

Constituents of the RDF-Graph

- **Literals:**

- describe **data values** that do not have a separate existence
- strings, interpretation via datatype

`http://harald.sack.de/foaf.rdf#harald`

S

`++49-331-5509-927`

O

`http://xmlns.com/foaf/0.1/phone`

P



Resource Description Framework

Constituents of the RDF-Graph

- **Literals:**

- typed literals can be expressed via **XML Schema datatypes**
- Namespace for typed literals: `http://www.w3.org/2001/XMLSchema#`
 - Example: `"Semantics"^^<http://www.w3.org/2001/XMLSchema#string>`
- Language Tags denote the (natural) language of the text:
 - Example: `"Semantik"@de` , `"Semantics"@en`

Core types	<u>xsd:string</u>	Character strings
	<u>xsd:boolean</u>	true, false
	<u>xsd:decimal</u>	Arbitrary-precision decimal numbers
	<u>xsd:integer</u>	Arbitrary-size integer numbers
IEEE floating-point numbers	<u>xsd:double</u>	64-bit floating point numbers incl. $\pm\text{Inf}$, ± 0 , NaN
	<u>xsd:float</u>	32-bit floating point numbers incl. $\pm\text{Inf}$, ± 0 , NaN
Time and date	<u>xsd:date</u>	Dates (yyyy-mm-dd) with or without timezone
	<u>xsd:time</u>	Times (hh:mm:ss.sss...) with or without timezone
	<u>xsd:dateTime</u>	Date and time with or without timezone
	<u>xsd:dateTimeStamp</u>	Date and time with required timezone
Recurring and partial dates	<u>xsd:gYear</u>	Gregorian calendar year
	<u>xsd:gMonth</u>	Gregorian calendar month
	<u>xsd:gDay</u>	Gregorian calendar day of the month
	<u>xsd:gYearMonth</u>	Gregorian calendar year and month
	<u>xsd:gMonthDay</u>	Gregorian calendar month and day
	<u>xsd:duration</u>	Duration of time
	<u>xsd:yearMonthDuration</u>	Duration of time (months and years only)
	<u>xsd:dayTimeDuration</u>	Duration of time (days, hours, minutes, seconds only)
Limited-range	<u>xsd:byte</u>	-128...+127 (8 bit)
	<u>xsd:short</u>	-32768...+32767 (16 bit)
	<u>xsd:int</u>	-2147483648...+2147483647 (32 bit)
	<u>xsd:long</u>	-9223372036854775808...+9223372036854775807 (64 bit)
	<u>xsd:unsignedByte</u>	0...255 (8 bit)
	<u>xsd:unsignedShort</u>	0...65535 (16 bit)

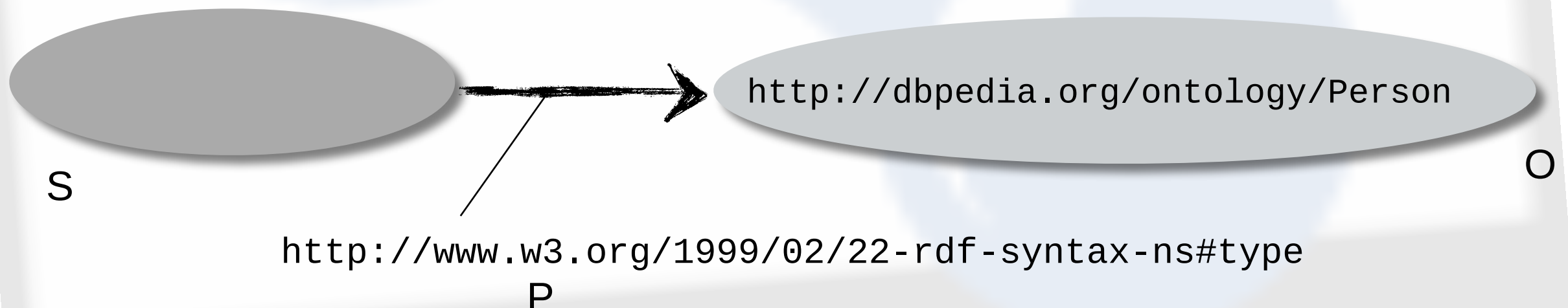
Partial dates	xsd:gMonthDay	Gregorian calendar month and day
	xsd:duration	Duration of time
	xsd:yearMonthDuration	Duration of time (months and years only)
	xsd:dayTimeDuration	Duration of time (days, hours, minutes, seconds only)
Limited-range integer numbers	xsd:byte	-128...+127 (8 bit)
	xsd:short	-32768...+32767 (16 bit)
	xsd:int	-2147483648...+2147483647 (32 bit)
	xsd:long	-9223372036854775808...+9223372036854775807 (64 bit)
	xsd:unsignedByte	0...255 (8 bit)
	xsd:unsignedShort	0...65535 (16 bit)
	xsd:unsignedInt	0...4294967295 (32 bit)
	xsd:unsignedLong	0...18446744073709551615 (64 bit)
	xsd:positiveInteger	Integer numbers >0
	xsd:nonNegativeInteger	Integer numbers ≥0
Encoded binary data	xsd:negativeInteger	Integer numbers <0
	xsd:nonPositiveInteger	Integer numbers ≤0
	xsd:hexBinary	Hex-encoded binary data
	xsd:base64Binary	Base64-encoded binary data
Miscellaneous XSD types	xsd:anyURI	Absolute or relative URIs and IRIs
	xsd:language	Language tags per [BCP47]
	xsd:normalizedString	Whitespace-normalized strings
	xsd:token	Tokenized strings
	xsd:NMTOKEN	XML NMTOKENs
	xsd:Name	XML Names
	xsd:NCName	XML NCNames



Resource Description Framework

Constituents of the RDF-Graph

- **Blank Nodes:**
 - denote **existence of an individual** with specific attributes, but **without providing an identification or reference**





Resource Description Framework

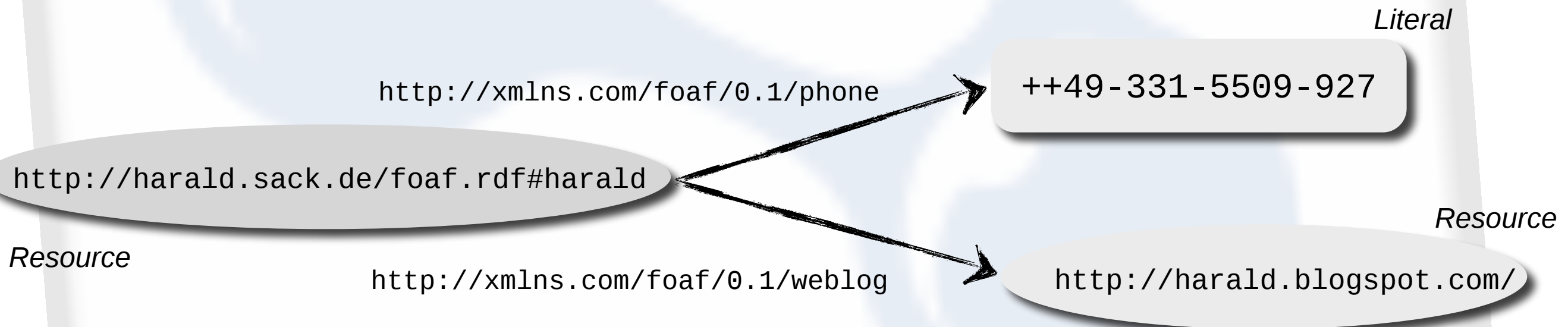
RDF Representations

Resource Description Framework



RDF Representations

- **Node-Edge-Node Triple**





Resource Description Framework

`http://xmlns.com/foaf/0.1/phone`

`++49-331-5509-927`

Literal

`http://harald.sack.de/foaf.rdf#harald`

Resource

`http://xmlns.com/foaf/0.1/weblog`

`http://harald.blogspot.com/`

Resource

- **N-Triples Notation**

- **URIs/IRIs** in angle brackets
- **Literals** in quotation marks
- **Triple** ends with a **period**

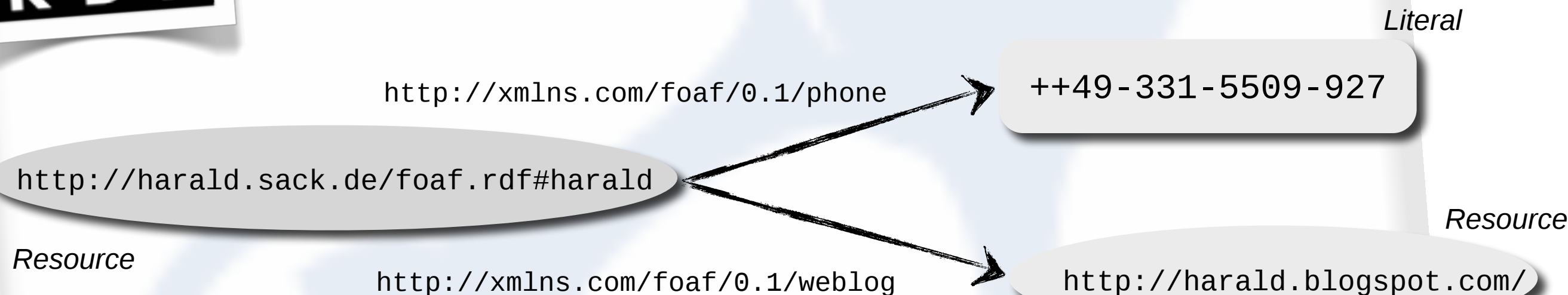
```
<http://harald.sack.de/foaf.rdf#harald> <http://xmlns.com/foaf/0.1/phone> "+49-331-5509-927" .
```

```
<http://harald.sack.de/foaf.rdf#harald> <http://xmlns.com/foaf/0.1/weblog>  
<http://harald.blogspot.com/> .
```



Resource Description Framework

24



- **Turtle (Terse RDF Tripel Language) Notation**

- extension of N-Triples

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@base <http://harald.sack.de/foaf.rdf>

<#harald> foaf:phone "++49-331-5509-927" .
<#harald> foaf:weblog <http://harald.blogspot.com/> .
```



Resource Description Framework

RDF Representations

- **RDF/XML Notation**

```
<xml version="1.0" encoding="utf-8">
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/" >

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:phone>++49-331-5509-927</foaf:phone>
  </rdf:Description>

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:weblog>
      <rdf:Description rdf:about="http://haraldblogspot.com/"></rdf:Description>
    </foaf:weblog>
  </rdf:Description>
</rdf:RDF>
```



Resource Description Framework

RDF Representations

S

- **RDF/XML Notation**

```
<xml version="1.0" encoding="utf-8">
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/" >

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:phone>++49-331-5509-927</foaf:phone>
  </rdf:Description>

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:weblog>
      <rdf:Description rdf:about="http://haraldblogspot.com/"></rdf:Description>
    </foaf:weblog>
  </rdf:Description>
</rdf:RDF>
```



Resource Description Framework

RDF Representations

S

P

- **RDF/XML Notation**

```
<xml version="1.0" encoding="utf-8">
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/" >

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:phone>++49-331-5509-927</foaf:phone>
  </rdf:Description>

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:weblog>
      <rdf:Description rdf:about="http://haraldblogspot.com/"></rdf:Description>
    </foaf:weblog>
  </rdf:Description>
</rdf:RDF>
```



Resource Description Framework

RDF Representations

S

P

O

- **RDF/XML Notation**

```
<xml version="1.0" encoding="utf-8">
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:foaf="http://xmlns.com/foaf/0.1/" >

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:phone>++49-331-5509-927</foaf:phone>
  </rdf:Description>

  <rdf:Description rdf:about="http://harald.sack.de/foaf.rdf#harald">
    <foaf:weblog>
      <rdf:Description rdf:about="http://haraldblogspot.com/"></rdf:Description>
    </foaf:weblog>
  </rdf:Description>
</rdf:RDF>
```



Resource Description Framework

RDF Representations

- **JSON-LD Notation** (*RDF 1.1*)

```
{
  "http://harald.sack.de/foaf.rdf#harald" : {
    "http://xmlns.com/foaf/0.1/phone" : [ { "value" : "++49-331-5509-927",
                                             "type" : "literal" } ]
  }
  {
    "http://xmlns.com/foaf/0.1/weblog" : [ { "value" : "http://harald.blogspot.com/",
                                              "type" : "uri" } ]
  }
}
```



Resource Description Framework

RDF Representations

S

P

O

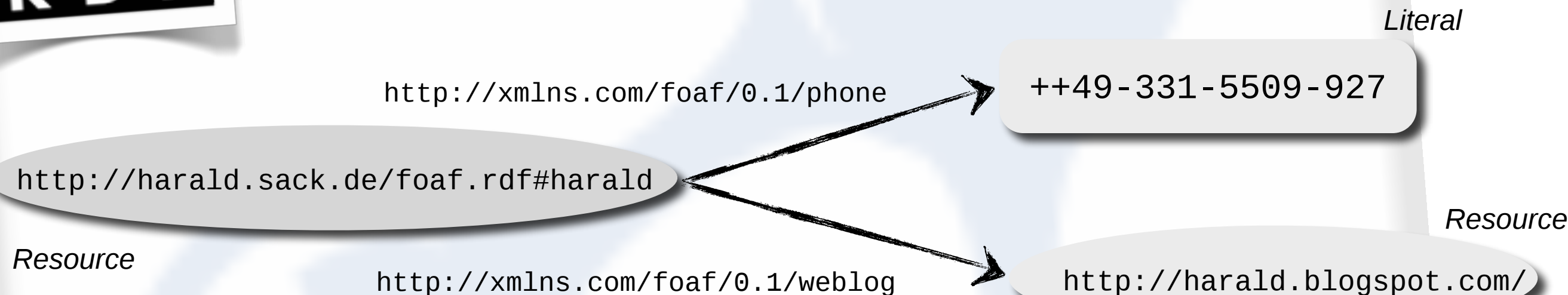
- **JSON-LD Notation** (*RDF 1.1*)

```
{
  "http://harald.sack.de/foaf.rdf#harald" : {
    "http://xmlns.com/foaf/0.1/phone" : [ { "value" : "++49-331-5509-927",
                                             "type" : "literal" } ]
  }
  {
    "http://xmlns.com/foaf/0.1/weblog" : [ { "value" : "http://harald.blogspot.com/",
                                              "type" : "uri" } ]
  }
}
```



Resource Description Framework

27



• Turtle (Terse RDF Tripel Language) Notation

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@base <http://harald.sack.de/foaf.rdf> .  
  
<#harald> foaf:phone "++49-331-5509-927" .  
<#harald> foaf:weblog <http://harald.blogspot.com/> .
```

Simple Facts in RDF

04 How to Represent Simple Facts - RDF Pt.2

Open HPI - Course: Knowledge Engineering with Semantic Web Technologies
Lecture 2: Semantic Web Technologies Part I