

Chapter 6

RDF/XML: XML Syntax of RDF Data

- An XML representation of RDF data for providing RDF data on the Web
- ⇒ could be done straightforwardly as a “holds” relation mapped according to SQLX (see next slide).
- would be highly redundant and very different from an XML representation of the same data
- search for a more similar way: leads to “striped RDF/XML”
 - data feels like XML: can be queried by XPath/Query and transformed by XSLT
 - can be parsed into an RDF graph.
- usually: provide RDF/XML data to an agreed RDFS/OWL ontology.

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A STRAIGHTFORWARD XML REPRESENTATION OF RDF DATA

Note: this is not RDF/XML, but just some possible representation.

- RDF data are triples,
- their components are either URIs or literals (of XML Schema datatypes),
- straightforward XML markup in SQLX style,
- since Turtle has a term structure, it is easy to find an XML markup.

```
<my-n3:rdg-graph xmlns:my-n3="http://simple-silly-rdf-xml.de#">
  <my-n3:triple>
    <my-n3:subject type="uri">foo://bar/persons/john</my-n3:subject>
    <my-n3:predicate type="uri">foo://bar/meta#name</my-n3:predicate>
    <my-n3:object type="http://www.w3.org/2001/XMLSchema#string">John</my-n3:object>
  </my-n3 triple>
  <my-n3:triple> ... </my-n3 triple>
  :
</my-n3:rdg-graph>
```

- The problem is not to have *any* XML markup, but to have a useful one that covers the *semantics* of the RDF data model.

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6.1 RDF/XML: RDF as an XML Application

- root element type: `<rdf:RDF>`
(namespace URL: `<http://www.w3.org/1999/02/22-rdf-syntax-ns#>`)
- not just “some markup”
- but covers the semantics of “resource description”

Markup

- “Striped RDF/XML” syntax as an abbreviated form (similar to the well-known XML structure)

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RDF/XML DESCRIPTIONS OF RESOURCES

`<rdf:Description>` elements collect a (partial) description of a *resource*:

- which resource is described: `@rdf:about="uri"`
- subelements describe its properties (amongst them, its type as a special property),
 - **element name**: name of the property
Note that this name is actually an URI.
(this is where XML namespaces come into play)
 - value of the property:
 - * **element contents**:
text content or one or more nested `<rdf:Description>` elements
 - * attribute `@rdf:resource="uri"`: property points to another resource that has an RDF description of its own elsewhere
- can contain nested `<rdf:Description>` elements similar to blank nodes in nested Turtle data.
- there can be multiple descriptions of the same resource (as in Turtle).
- later: different URI definition mechanisms

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Example

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xml:base="foo://bla/"
  xmlns="foo://bla/meta#">
  <rdf:Description rdf:about="persons/john">
    <rdf:type rdf:resource="meta#Person"/>
    <name>John</name>
    <age>35</age>
    <hasChild>
      <rdf:Description rdf:about="persons/alice">
        <rdf:type rdf:resource="meta#Person"/>
        <name>Alice</name>
        <age>10</age>
      </rdf:Description>
    </hasChild>
    <hasChild rdf:resource="persons/bob"/>
  </rdf:Description>
  <rdf:Description rdf:about="persons/bob">
    <rdf:type rdf:resource="meta#Person"/>
    <name>Bob</name>
    <age>8</age>
  </rdf:Description>
</rdf:RDF>
```

[Filename: RDF/john-rdfxml.rdf]

- xml:base determines the URI prefix, either flat (ending with a "#", or hierarchical, ending with a "/")
- in 2nd case: local parts can be hierarchical expressions
- default namespace set to <foo://bla/meta#>
- element names are the property names

```
prefix : <foo://bla/meta#>
select ?X ?Y ?A
from <file:john-rdfxml.rdf>
where {?X :hasChild ?Y . ?Y :age ?A}
```

[Filename: RDF/john-rdfxml.sparql]

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ABBREVIATED FORM: STRIPED RDF/XML

- Full syntax:

```
<rdf:Description rdf:about="uri">
  <rdf:type rdf:resource="classname">
    resource description
  </rdf:Description>
```

- Abbreviated syntax:

```
<classname rdf:about="uri">
  resource description
</classname>
```

- Striped RDF/XML: alternatingly *classname* – *propertyname* – *classname*
- domain terminology URIs = element names
- all attribute names are in the RDF namespace
- all object URIs are in attribute values
- all attribute values are object URIs
(next: an even shorter form where this will not hold!)

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Example: Striped

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xml:base="foo://bla/persons/"
  xmlns="foo://bla/meta#">
  <Person rdf:about="john">
    <name>John</name>
    <age>35</age>
    <hasChild>
      <Person rdf:about="alice">
        <name>Alice</name>
        <age>10</age>
      </Person>
    </hasChild>
    <hasChild rdf:resource="bob"/>
  </Person>
  <Person rdf:about="bob">
    <name>Bob</name>
    <age>8</age>
  </Person>
</rdf:RDF>
```

- looks very much like well-known XML
- xml:base applies now only to objects' URIs
e.g. <foo://bla/persons/alice>
- terminology URIs reside all in the namespaces
- same query as before:

```
# jena -q -qf john-striped.sparql
prefix : <foo://bla/meta#>
select ?X ?Y
from <file:john-striped.rdf>
where {?X :hasChild ?Y}
```

[Filename: RDF/john-striped.sparql]

[Filename: RDF/john-striped.rdf]

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ABBREVIATED FORM: STRIPED RDF/XML WITH VALUE ATTRIBUTES

- Full syntax:

```
<rdf:Description rdf:about="uri">
  <rdf:type rdf:resource="classname"
  <property1>value</property1>
  <property2 rdf:resource="uri"/>
</rdf:Description>
```

where property₁ has a single, scalar value (string or number)

- Abbreviated syntax:

```
<classname rdf:about="uri" prefix:property1="value">
  <property2 rdf:resource="uri"/>
</classname>
```

- Striped RDF/XML: alternatingly *classname* – *propertyname* – *classname*
- domain terminology URIs = element and attribute names
Note: attributes MUST be prefixed by an explicit namespace
- attribute values are object URIs or literal values.

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Example: Striped with Attributes

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:base="foo://bla/persons/"
  xmlns:p="foo://bla/meta#">
  <p:Person rdf:about="john" p:name="John" p:age="35">
    <p:hasChild>
      <p:Person rdf:about="alice" p:name="Alice" p:age="10"/>
    </p:hasChild>
    <p:hasChild rdf:resource="bob"/>
  </p:Person>
  <p:Person rdf:about="bob" p:name="Bob" p:age="8"/>
</rdf:RDF>
```

[Filename: RDF/john-striped-attrs.rdf]

- looks even more like well-known XML

```
# jena -q -qf john-striped-attrs.sparql
prefix : <foo://bla/meta#>
select ?X ?Y ?N
from <file:john-striped-attrs.rdf>
where {?X :hasChild ?Y . ?Y :name ?N}
```

[Filename: RDF/john-striped-attrs.sparql]

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ABBREVIATIONS

- omit “blank” description nodes by
`<property-name rdf:parseType="Resource"> ... </property-name>`
- literal-valued properties can even be added to the surrounding property element.

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:mon="http://www.semwebtech.org/mondial/10/meta#">
  <mon:City rdf:nodeID="hannover" mon:name="Hannover">
    <mon:population rdf:parseType="Resource">
      <mon:year>1995</mon:year> <mon:value>525763</mon:value>
    </mon:population>
    <mon:population mon:year="2002" mon:value="515001"/>
  </mon:City>
</rdf:RDF>
```

[Filename: RDF/parse-type.rdf]

- `rdf:parseType` is not a real RDF citizen:
 - it exists only in the RDF/XML serialization,
 - it is intended as a parsing instruction to the RDF/XML → RDF parser.

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URI REPRESENTATION/CONSTRUCTION MECHANISMS

- describe a remote resource via its full global URI (as above)
 - attribute `@rdf:about="uri"` identifies a remote resource
- use a base URI by `xml:base` that sets the base URI for resolving relative RDF URI references (i.e., `rdf:about`, `rdf:resource`, `rdf:ID` and `rdf:datatype`), otherwise the base URI is that of the document.
 - set `xml:base="uri"` (e.g. in the root element)
 - `@rdf:about="relativepath"`: the resource's global URI is then composed as `xmlbase relativepath` (note that `xmlbase` must end with "/" or "#")
 - `@rdf:ID="local-id"`: the resource's global URI is then composed as `xmlbase#local-id`. `local-id` must be a simple QName (no path!)
 - then, use `@rdf:resource="#localpart"` in the object position for referencing it.
- only locally known IDs:
 - attribute `@rdf:nodeID="name"`: defines and describes a *local* resource that can be referenced only inside the same RDF instance by its ID
 - then, use `@rdf:nodeID="id"` in the object position of a property instead of `@rdf:resource="uri"`

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Example: using global protocol://path#IDs

- **does only work with #-namespaces, otherwise constructs `foo://bla/persons/#john`**

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xml:base="foo://bla/flatpersons#"
  xmlns="foo://bla/meta#">
  <Person rdf:ID="john">
    <name>John</name>
    <age>35</age>
    <hasChild>
      <Person rdf:ID="alice">
        <name>Alice</name>
        <age>10</age>
      </Person>
    </hasChild>
    <hasChild rdf:resource="#bob"/>
  </Person>
  <Person rdf:ID="bob">
    <name>Bob</name>
    <age>8</age>
  </Person>
</rdf:RDF>
```

[Filename: RDF/john-ids.rdf]

- `xml:base = "foo://bla/flatpersons#"` determines the URI prefix. IDs must then be QNames (e.g. "john/doe" not allowed)
- default namespace set to `<foo://bla/meta#>`
- element names are the property names

```
# jena -q -qf john-ids-rdf.sparql
prefix : <foo://bla/meta#>
select ?X ?Y
from <file:john-ids.rdf>
where {?X :hasChild ?Y}
```

[Filename: RDF/john-ids-rdf.sparql]

- URIs are then `<foo://bla/flatpersons#john>` and `<foo://bla/meta#name>`

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Example: using local IDs

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns="foo://bla/meta#">
  <Person rdf:nodeID="john">
    <name>John</name>
    <age>35</age>
    <hasChild>
      <Person rdf:nodeID="alice">
        <name>Alice</name>
        <age>10</age>
      </Person>
    </hasChild>
    <hasChild rdf:nodeID="bob"/>
  </Person>
  <Person rdf:nodeID="bob">
    <name>Bob</name>
    <age>8</age>
  </Person>
</rdf:RDF>
```

- no xml:base
- all IDs must be qnames and are localized (e.g., _:b1)
- default namespace set to “foo://bla/meta#”
- element names are the property names

```
# jena -q -qf john-local-rdf.sparql
prefix : <foo://bla/meta#>
select ?X ?Y ?N
from <file:john-local.rdf>
where {?X :hasChild ?Y. ?Y :name ?N}
```

[Filename: RDF/john-local-rdf.sparql]

[Filename: RDF/john-local.rdf]

- a result of the query is e.g. ?X/_:b0, ?Y/_:b1, ?N/“Bob”
- these local resources cannot be referenced by other RDF instances.

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Example (with base URI and relative paths)

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:mon="http://www.semwebtech.org/mondial/10/meta#"
  xml:base="http://www.semwebtech.org/mondial/10/">
  <mon:Country rdf:about="countries/D/" mon:name="Germany" mon:code="D">
    <mon:hasProvince>
      <mon:Province rdf:about="countries/D/provinces/Niedersachsen/" mon:name="Niedersachsen">
        <mon:hasCity>
          <mon:City rdf:about="countries/D/provinces/Niedersachsen/cities/Hannover/" mon:name="Hannover">
            <mon:population>
              <rdf:Description>
                <mon:year>1995</mon:year> <mon:value>525763</mon:value>
              </rdf:Description>
            </mon:population>
          </mon:City>
        </mon:hasCity>
        <mon:capital rdf:resource="countries/D/provinces/Niedersachsen/cities/Hannover/">
      </mon:Province>
    </mon:hasProvince>
  </mon:Country>
</rdf:RDF>
```

[Filename: RDF/a-bit-mondial.rdf]

- global URIs are e.g. <http://www.semwebtech.org/mondial/10/meta#name> and <http://www.semwebtech.org/mondial/10/countries/D/provinces/Niedersachsen/cities/Hannover>
- rdf:Description used for a blank node (population) – this will even be shorter later

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NAMES VS. URIs – XMLNS VS. XML:BASE

- element and attribute **names** are subject to **namespace expansion**,
- URIs in **rdf:about**, **rdf:resource**, **rdf:ID** and **rdf:datatype** are subject to expansion with **xml:base**.
- What if URIs from different areas are used?
 - inside a document, different (even hierarchically nested!) **xml:base** values can be used,
 - entities can be used inside URIs.

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LOCAL XML:BASE VALUES

- here, it pays that with the XML level, there is an intermediate semantical level (in contrast to the pure Turtle syntax)

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:mon="http://www.semwebtech.org/mondial/10/meta#"
  xml:base="http://www.semwebtech.org/mondial/10/">
<mon:Country xml:base="countries/D/" rdf:about="." mon:name="Germany" mon:code="D">
  <mon:has_city>
    <mon:City rdf:about="cities/Berlin" mon:name="Berlin"/>
  </mon:has_city>
</mon:Country>
<mon:Country xml:base="foo://bla/countries/F/" rdf:about="." mon:name="France" mon:code="F">
  <mon:has_city>
    <mon:City rdf:about="cities/Paris" mon:name="Paris"/>
  </mon:has_city>
</mon:Country>
</rdf:RDF>
```

[Filename: RDF/url-expansion.rdf]

- relative **xml:base** expressions are appended:
<http://www.semwebtech.org/mondial/10/countries/D/cities/Berlin>
- absolute **xml:base** expressions overwrite: <foo://bla/countries/F/cities/Paris>.

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XML ENTITIES IN URIS

- if URIs from different bases are mingled in the document:

```
<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
  <!ENTITY mon "http://www.semwebtech.org/mondial/10/">
  <!ENTITY xyz "a:bc"> ] >
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:mon="this://is-actually-not-used"
  xmlns:f="foo://bla#"
  xml:base="foo://bla/">
  <f:Person rdf:about="persons/john" f:name="John" f:age="35">
    <!-- this is not expanded at all: -->
    <f:test rdf:resource="mon:countries/D/cities/Berlin"/>
    <!-- the right way is to use an entity: -->
    <f:lives-in rdf:resource="&mon;countries/D/cities/Berlin"/>
    <f:married-to rdf:resource="&xyz;#mary"/>
  </f:Person>
</rdf:RDF>
```

[Filename: RDF/url-entities.rdf]

```
# jena -q -qf url-entities.sparql
select ?X ?P ?Y
from <file:url-entities.rdf>
where {?X ?P ?Y}
```

[Filename: RDF/url-entities.sparql]

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SPECIFICATION OF DATATYPES IN RDF/XML

- RDF uses XML Schema types
- yields typed literals such as “42”^{^^}<http://www.w3.org/2001/XMLSchema#int>
- In RDF/XML, the type of a literal value is specified by an `rdf:datatype` attribute whose value is recommended to be one of the following: an XSD literal type URI or the URI of the datatype `rdf:XMLLiteral`.
(but then, they cannot be abbreviated into attributes)

```
<mon:Country rdf:resource="http://www.semwebtech.org/mondial/10/countries/D">
  <mon:name
    rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Germany</mon:name>
  <mon:area
    rdf:datatype="http://www.w3.org/2001/XMLSchema#float">356910</mon:area>
</mon:Country>
```

[example next slide]

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DATATYPES: EXAMPLE

note: <http://www.w3.org/2001/XMLSchema#> can be defined as an entity in the local DTD to the RDF/RDFS instance and is then used as `rdf:datatype="&xsd:string"`

```
<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#"> ]>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:mon="http://www.semwebtech.org/mondial/10/meta#"
  xml:base="http://www.semwebtech.org/mondial/10/">
  <mon:Country rdf:about="countries/D">
    <mon:name rdf:datatype="&xsd:string">Germany</mon:name>
    <mon:population rdf:datatype="&xsd:int">83536115</mon:population>
  </mon:Country>
</rdf:RDF>
```

[Filename: RDF/rdf-datatype.rdf]

- `jena -t -pellet -if rdf-datatype.rdf`
- Note: having linebreaks in the data yields unexpected results.

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XMLLITERAL IN RDF/XML: EXAMPLE

- use `rdf:parseType="Literal"`:

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xml:base="foo://bla/persons/"
  xmlns:p="foo://bla/meta#">
  <p:Person rdf:about="john" p:name="John" p:age="35">
    <p:homepage rdf:parseType="Literal">
      <ht:html xmlns:ht="http://www.w3.org/1999/xhtml">
        <ht:body><ht:li>bla</ht:li></ht:body>
      </ht:html>
    </p:homepage>
    <p:hasChild rdf:resource="alice"/>
  </p:Person>
</rdf:RDF>
```

```
prefix : <foo://bla/persons/>
select ?X ?P ?Y
from <file:rdf-xmlliteral.rdf>
where { :john ?P ?Y }
```

[Filename: RDF/rdf-xmlliteral.sparql]

[Filename: RDF/rdf-xmlliteral.rdf]

- the resulting literal is
`<ht:html ... > ... </ht:html>^^<http://www.w3.org/1999/02/22-rdf-syntax-ns#XMLLiteral>`
- ... including the newlines (= XML text nodes) inside the XML fragment.

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Using XMLLiterals: Exclusive Canonical XML

- Required by some software (e.g., in the “Jena” Semantic Web Framework)
- XML fragments/subtrees must be processable without their context – thus, namespaces must be present at appropriate levels in the tree.
- Details: <http://www.w3.org/TR/xml-exc-c14n/>
- can be obtained with `xmllint -exc-c14n x.xml > y.xml` (and analogously by other tools)

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RDF/XML vs. “PURE” XML

- striped RDF/XML gives very much the look&feel of common XML documents:
 - nearly no “rdf:...” elements
 - no “rdf:...” elements that are relevant from the XML processing point of view
- can be processed with XPath/XQuery and XSLT as pure XML data
- can also be processed as RDF data in *combination* with RDFS/OWL metadata information (usually from a different source).

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MACHINE-READABILITY

- RDF/XML is usually automatically generated,
- not intended to be read by humans,
- processes as XML serialization of RDF data
 - as a file: → RDF/XML parser → RDF graph
 - as an (XML!) stream: possible preprocessing and then mapping to a graph/DB
 - use generic tools for XML stream processing, like SAX/StAX or the XML Digester (see slides for XML lecture/XML lab course)
 - * generic processing stream → RDF graph
 - * preprocessing stream → filtered/modified graph
(but note that nodes can occur in arbitrary order)

Practical Exercise: Write an XML/RDF Parser in SAX/StAX/Digester.

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6.2 XML Syntax of RDFS/OWL

- RDFS/OWL descriptions are also `<rdf:Description>`s – descriptions of types/rdfs:/owl:Classes or rdf:Properties
- additionally include `rdfs` namespace declaration

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
```

same as above:

- Full syntax:

```
<rdf:Description rdf:about="class-uri">
  <rdf:type rdf:resource="owl:Class">
    resource description
</rdf:Description>
```

- Abbreviated syntax:

```
<owl:Class rdf:about="class-uri">
  resource description
</owl:Class>
```

- Full syntax:

```
<rdf:Description rdf:about="property-uri">
  <rdf:type rdf:resource="rdf:Property">
    resource description
</rdf:Description>
```

- Abbreviated syntax:

```
<rdf:Property rdf:about="property-uri">
  resource description
</rdf:Property>
```

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RDF SCHEMA DOCUMENTS

- description of classes

```
<owl:Class rdf:about="uri">
  <rdfs:subClassOf rdf:resource="class-uri2"/>
</owl:Class>
```

used in RDF/XML data documents by `<rdf:type resource="uri"/>` or `<uri>...</uri>`, also used by `<rdfs:subClassOf rdf:resource="uri"/>` (and by `rdfs:domain` and `rdfs:range`).

- description of properties

```
<rdf:Property rdf:about="uri">
  <rdfs:subPropertyOf rdf:resource="property-uri2"/>
  <rdfs:domain rdf:resource="class-uri1"/>
  <rdfs:range rdf:resource="class-uri2"/>
</rdf:Property>
```

used by names of property elements and of property attributes in RDF/XML data documents, and for `<rdfs:subPropertyOf rdf:resource="uri"/>`.

- instead of `@rdf:about="uri"` the notations `xml:base + local part` or `local-ids` can be used.
- further subelements for class and property descriptions are provided by OWL.

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DEFINING URIS OF RDFS CLASSES AND PROPERTIES

Classes and properties are "usual" resources, identified/defined by

```
<owl:Class rdf:about="class-uri"> ... </owl:Class>
```

(absolute URI or relative URI + base-URI)

reference by `rdf:resource="class-uri"`

```
<owl:Class rdf:ID="classname"> ... </owl:Class> (+ base-URI or extending the file's URL)
```

reference by `rdf:resource="#classname"` (local)

reference by `rdf:resource="base-uri#classname"` (from remote)

```
<owl:Class rdf:nodeID="classname"> ... </owl:Class>
```

reference by `rdf:nodeID="classname"` (only for local definitions)

(analogous for `<rdf:Property>`)

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Version A: Classes and Properties URLs refer to the same file

- use `rdf:ID` and `rdf:resource="#..."`

Anything that is defined in an RDFS/OWL document - e.g., in

```
<http://foo/bla/metatest.rdf> (or with appropriate setting of xml:base)
```

```
<owl:Class rdf:ID="Country"> <!-- subClassOf-defs etc.--> </owl:Class>
<rdf:Property rdf:ID="capital">
  <rdfs:domain rdf:resource="#Country"/>
  <rdfs:range rdf:resource="#City"/>
</rdf:Property>
```

defines URIs `<http://foo/bla/metatest.rdf#Country>` and `<http://foo/bla/metatest.rdf#capital>` etc. that can be used in another RDF document as (the same applies to the Turtle format)

```
<rdf:RDF xmlns:m="http://foo/bla/metatest.rdf#"
  xml:base="http://www.semwebtech.org/mondial/10/"
  <mon:Country rdf:about="countries/D" mon:name="Germany">
    <mon:capital rdf:resource="countries/D/provinces/Berlin/cities/Berlin"/>
  </mon:Country>
</rdf:RDF>
```

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Example

```
<?xml version="1.0"?>
<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:owl="http://www.w3.org/2002/07/owl#">
  <owl:Class rdf:ID="Country"/>
  <owl:Class rdf:ID="City"/>
  <rdf:Property rdf:ID="capital">
    <rdfs:domain rdf:resource="#Country"/>
    <rdfs:range rdf:resource="#City"/>
  </rdf:Property>
</rdf:RDF>
```

[Filename: RDF/metatest.rdf]

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:m="file:///home/may/teaching/SemWeb/RDF/metatest.rdf#"
  xml:base="bla:dontmatterwhat#">
  <m:Country rdf:ID="Germany"> <!-- bla:dontmatterwhat#Germany -->
    <m:capital rdf:nodeID="Berlin"/> <!-- local blank node _:b0 -->
  </m:Country>
</rdf:RDF>
```

[Filename: RDF/metatest2.rdf]

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Example (cont'd)

```
select ?X ?P ?Y
from <file:metatest.rdf>
from <file:metatest2.rdf>
where {?X ?P ?Y} [Filename: RDF/metatest.sparql]
```

- call `jena -q -qf metatest.sparql`
- illustrates the constructed URLs, like
`<file:///home/may/teaching/SemWeb/RDF/metatest.rdf#capital>`
(using `xml:base` or an `http:` URL makes more sense in reality)
- call `jena -pellet -q -qf metatest.sparql`
- lists lots of “derived” OWL axioms, but also derives that
`_:b0 a <file:///home/may/teaching/SemWeb/RDF/metatest.rdf#City>`

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Version B: Virtual (URI) or remote (URL) Resources

Using `rdf:about` in a class definition specifies anything about a remote resource URL/URI:

- straightforward by `<owl:Class rdf:about="class-uri">` and
`<owl:Property rdf:about="property-uri">`
- write the complete URI, or
- use appropriate `xml:base` or entities (RDF/XML), or base and prefixes (Turtle).

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Comparison

- Version A: class/property resources are represented by XML fragments of the RDFS+OWL instance:
 - when directly extending the file's URL:
 - @rdf:resource similar to an HTML anchor inside the XML document, contains the class/property definition
 - (This matches the original HTML+XML flavor of the late 1990s, but such HTML-style dereferencing is not implemented by default, Linked Open Data turned out to work in a different way based on Web Services)
 - only practical if the RDFS+OWL is non-distributed
 - (although remote RDFS+OWL instances can also add to this resource's description by using rdfs:about)

⇒ centralized ontologies
- Version B: class/property resources are identified by a virtual URI
 - arbitrary RDFS instances can contribute to the resource description
 - users/clients have to know where the resource descriptions can be found

⇒ distributed ontologies (only a common syntax pattern for class/property/instance URIs is required)

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USE CASES FOR CLASS URIS IN RDF/XML DOCUMENTS

- in striped RDF/XML instance data documents by class elements:
 - <[*ns*prefix:]*classname*> ... </[*ns*prefix:]*classname*>
 - non-prefixed: *default-namespace+classname* yields the *class-uri*.
 - prefixed: *nsprefix-namespace+classname* yields the *class-uri*.
- in striped RDF/XML instance data documents by <rdf:type rdf:resource="*class-uri*"/>
 - expanded wrt. xml:base; but usually the xml:base of the instance data document is different from the base of the domain names (=namespace). Use an entity if needed.
- references from RDFS+OWL documents by <rdf:subClassOf rdf:resource="*class-uri*"/>
 - (analogously for rdfs:domain and rdfs:range and OWL properties)
 - expanded wrt. xml:base.
- incremental RDFS/OWL descriptions of the same class in RDFS/OWL documents by <rdf:Description rdf:about="*class-uri*">... </rdf:Description>
 - expanded wrt. xml:base.
- (note that in Turtle, the user can decide to expand wrt. <relURL>+@base or prefix:qname)

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USE CASES FOR PROPERTY URIS IN RDF/XML DOCUMENTS

- in striped RDF/XML instance data documents by property subelements or attributes:

```
<surrounding-element [namespace:]propertyname="...">  
  <[namespace:]propertyname> ... </[namespace:]propertyname>  
  :  
</surrounding-element>
```

 - non-prefixed: *default-namespace+classname* yields the *class-uri*.
 - prefixed: *namespace+elementname* yields the *property-uri*.
- references from RDFS+OWL RDF/XML documents by

```
<rdfs:subPropertyOf rdf:resource="property-uri"/>
```

 - expanded wrt. `xml:base`.
- incremental RDFS+OWL descriptions of the same property in RDF/XML documents by

```
<rdf:Description rdf:about="class-uri">... </rdf:Description>
```

 - expanded wrt. `xml:base`.

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USE CASES FOR XML SCHEMA DATATYPES IN METADATA

- For literal properties, the domain of `<rdf:Property>` can refer to XML Schema types, e.g.

```
<rdf:Property rdf:ID="indepDate">  
  <rdfs:domain rdf:resource="#Country"/>  
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#date"/>  
</rdf:Property>
```

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6.3 Example Sketch: World Wide RDF Web

- many information sources that describe resources
- higher level information management (e.g., portals): use some of these sources for accessing *integrated* information

Example (RDF source see next slide) – the example is not based on real data

- mondial: countries, cities
- <http://www.semwebtech.org/mondial/10/meta#>: the geography ontology
- another resource: cities and their airports
- <http://sw.iata.org/ontology#> (International Air Transport Assoc.): ontology about flight information
- <bla://sw.iata.org/flights/>*flight*: resource associated with a given flight (e.g. LH42).
- <bla://sw.iata.org/airports/>*abbrev*: resource associated with a given airport (e.g., FRA, CDG).
- there will probably be a Lufthansa RDF database that describes the flights in their terminology

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Example (Cont'd) [Filename: RDF/flightbase.rdf]

```
<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
  <!ENTITY mon "http://www.semwebtech.org/mondial/10/" > ]>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:mon="http://www.semwebtech.org/mondial/10/meta#"
  xmlns:travel="http://www.semwebtech.org/domains/2006/travel#"
  <rdf:Description rdf:about="&mon;countries/D/provinces/Berlin/cities/Berlin">
    <travel:has_airport rdf:resource="bla://sw.iata.org/airports/BLN"/>
  </rdf:Description>
  <rdf:Description rdf:about="&mon;countries/F/provinces/IledeFrance/cities/Paris">
    <travel:has_airport rdf:resource="bla://sw.iata.org/airports/CDG"/>
  </rdf:Description>
  <rdf:Description rdf:about="bla://sw.iata.org/flights/LH42"
    xmlns:iata="http://sw.iata.org/ontology#">
    <rdf:type rdf:resource="http://sw.iata.org/ontology#Flight"/>
    <iata:from rdf:resource="bla://sw.iata.org/airports/BLN"/>
    <iata:to rdf:resource="bla://sw.iata.org/airports/CDG"/>
  </rdf:Description>
</rdf:RDF>
```

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RDF vs. XML

Everything that can be expressed by XML can also be expressed by RDF

- + RDF can also be used to *describe* resources
(pictures, movies, ..., programs, Web services, ...)
- + RDF can be represented as a graph, independent from the structure of the (distributed) RDF instances
- + RDF data can be distributed over different files that describe the same resources
- + RDF has a connection to global schema description mechanisms
- o RDF/XML can be queried in the same way by XPath/XQuery ...
 - but: which RDF and RDFS/OWL instances?
 - if local resources are used: relatively easy
 - if global resources are used: appropriate RDFs must be searched for.