

Resource Description Framework (RDF)

A basis for knowledge representation on the Web

- ▶ Simple language to capture assertions (as statements)
 - ▶ Captures elements of knowledge about a resource
 - ▶ Facilitates incremental acquisition of knowledge
 - ▶ Supports inferencing to extract and use knowledge
- ▶ Consolidates old KR ideas
 - ▶ Frames
 - ▶ Object-oriented modeling
- ▶ Applies URIs to
 - ▶ Clarify meanings
 - ▶ Handle vocabulary differences
 - ▶ Crucial for heterogeneity

Why RDF?

- ▶ Whereas XML and JSON
 - ▶ Produce a document tree
 - ▶ Don't identify the content represented by a document, i.e.,
 - ▶ Concepts the document is about
 - ▶ Relationships among the concepts
 - ▶ Enable multiple representations for the same content
- ▶ RDF expresses the content itself in a standard form

Resources and Literals

- ▶ RDF captures descriptions of resources
- ▶ A resource is an “addressable” object
 - ▶ Of which a description can be given
 - ▶ Identified via a URI
 - ▶ Worth talking about and possible to talk about
- ▶ A literal is something simpler
 - ▶ A value, e.g., string or integer
 - ▶ Cannot be given a description

Statements or Triples

- ▶ RDF is based on a simple grammar
 - ▶ An RDF document is simply a set of statements also known as triples
- ▶ Each statement consists of
 - ▶ Subject: a resource (starting point)
 - ▶ Object: a resource or a literal (ending point)
 - ▶ Predicate: a resource (connection)
- ▶ Comes with RDFS, a vocabulary to create vocabularies

Rendering RDF

- ▶ RDF is not about the surface syntax but about the underlying content
- ▶ Using the XML serialization of RDF
 - ▶ RDF is not tied to XML
 - ▶ Standard XML namespace syntax
 - ▶ Namespaces defined by the RDF standard
 - ▶ Typically abbreviated `rdf` and `rdfs`

Example of N-Triples Notation

The basic syntax: Subject-Predicate-Object

```
<http://www.wiley.com/SOC>
  <http://purl.org/dc/elements/1.1/title>
    "Service-Oriented Computing" .
<http://www.wiley.com/SOC>
  <http://purl.org/dc/elements/1.1/creator>
    "Munindar" .
<http://www.wiley.com/SOC>
  <http://purl.org/dc/elements/1.1/creator>
    "Michael" .
<http://www.wiley.com/SOC>
  <http://purl.org/dc/elements/1.1/publisher>
    "Wiley" .
```

Example in XML

Using the Dublin Core vocabulary

```
<?xml version='1.0' encoding='UTF-8'?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dc="http://purl.org/dc/elements/1.1/">
  <rdf:Description rdf:about="http://www.wiley.com/SOC">
    <dc:title>Service-Oriented Computing</dc:title>
    <dc:creator>Munindar</dc:creator>
    <dc:creator>Michael</dc:creator>
    <dc:publisher>Wiley</dc:publisher>
  </rdf:Description>
</rdf:RDF>
```

- ▶ `rdf:Description` gathers statements about one subject
- ▶ Distinguish `rdf:ID` from `rdf:about`

Exercise

Reproduce previous example in JSON Linked Data syntax

Exercise

- ▶ Graphs represent binary relationships naturally
 - ▶ A verb plus two nouns (a *transitive* verb)
 - ▶ The vendor ships SKU-99
 - ▶ A verb plus two nouns (including an adjective on one of the nouns)
 - ▶ The big vendor ships the green product
- ▶ Express a three-party relationship
 - ▶ A verb plus two nouns plus an adverb
 - ▶ The vendor ships SKU-99 quickly
 - ▶ Hint: think of gerunds from natural language grammar
 - ▶ A verb plus three nouns (a *ditransitive* verb)
 - ▶ The vendor sells Alice SKU-99

Multiparty Relationships

- ▶ An edge has two terminals, so limited to binary relationships
- ▶ To represent a multiparty relationship, introduce a resource corresponding to the relationship itself
 - ▶ That's what a gerund does in NL
 - ▶ Analogous to an association entity
 - ▶ Include edges originating or targeting this resource

RDF Schema

In essence, an object-oriented type system built on top of RDF

- ▶ Defines
rdfs:Class, rdfs:subClassOf, rdfs:Resource, rdfs:Literal,
rdfs:Property, rdfs:subPropertyOf, rdfs:range, rdfs:domain,
rdfs:label, rdfs:comment, rdfs:seeAlso
- ▶ Applications of RDF Schema
 - ▶ Defining custom vocabularies
 - ▶ Discussed in conjunction with OWL, which greatly enhances the above

RDF Schema versus XML Schema

Both help define custom vocabularies

- ▶ An XML Schema document gives us syntactic details
- ▶ An RDF Schema document gives us a way to capture part of the meaning through a standard vocabulary (rdfs)
- ▶ An OWL document (next topic) captures richer meaning

Collections

- ▶ Function as containers
 - ▶ `rdf:Bag`
 - ▶ `rdf:Sequence`
 - ▶ `rdf:Alt` (choice)
- ▶ Accompanied by properties to extract elements
 - ▶ Schematically represented as `rdf:_1`, `rdf:_2`, and so on
 - ▶ That is, the properties `_1`, `_2`, ... are defined in the `rdf` namespace
- ▶ Collections are applied within OWL
 - ▶ Not otherwise emphasized in this course

Reification Motivation

- ▶ Express a quotation
 - ▶ Alice says the vendor ships SKU-99
- ▶ Hint(?): In RDF, we can only talk about resources
 - ▶ And literals, but literals are where a graph ends (no out edges)

Reification of Statements

- ▶ *Reify*: to make referenceable, essential for quoting statements to
 - ▶ Agree or disagree with them
 - ▶ Assert modalities: possible, desirable, . . .
- ▶ Make a statement into a resource; then talk about it
 - ▶ `rdf:Statement` is a class
 - ▶ the given statement's `rdf:type` is `rdf:Statement`
 - ▶ `rdf:Statement` defines important properties: `rdf:subject`, `rdf:object`, and `rdf:predicate`

Reification Exercise

Produce a model using RDF and RDF Schema of the following assertions:

- ▶ (a) Statement (b) is false
- ▶ (b) Statement (a) is true

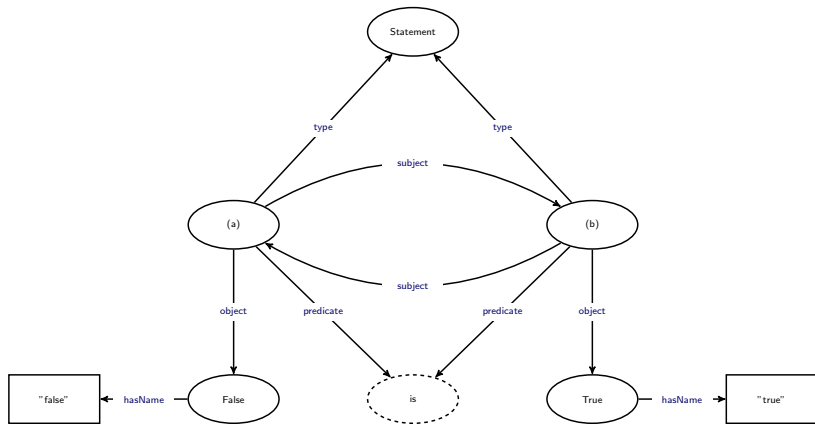
Express your solution as a graph with suitable annotations

- ▶ Notation
 - ▶ Resources: solid ellipses
 - ▶ Properties (hence, also resources): dashed ellipses
 - ▶ Literals: rectangles
- ▶ Definitions
 - ▶ Two resources named `⌈true⌋` and `⌈false⌋`
 - ▶ Property: `⌈is⌋`

Reification Exercise Solution

Problem-specific constructs: (a), (b), True, False, hasName is

Generic: everything else



RDF Summary

- ▶ RDF captures deeper structure than XML
 - ▶ RDF captures graphs in general
 - ▶ Meaning depends on the graph, not the document that represents a graph
- ▶ RDF is based on an simple linguistic representation: subject, predicate, object
 - ▶ But webified via URIs
- ▶ RDF comes prepackaged with RDF Schema
 - ▶ In essence, an object-oriented type system: a vocabulary to create new vocabularies, such as
 - ▶ Friend of a Friend (FOAF)
 - ▶ Dublin Core
 - ▶ Mozilla extensions
 - ▶ Provides a basis for OWL (next topic)