COMP318: Ontologies and Semantic Web

Describing Web Resources in RDF

UNIVERSITY OF LIVERPOOL

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Where were we

- Problems with today's web
  - User defined queries
  - Ambiguity
  - Poor support for integration tasks and complex queries
- Need for more semantics

As we read it

What is the page about

When does it take place

Where does it take place

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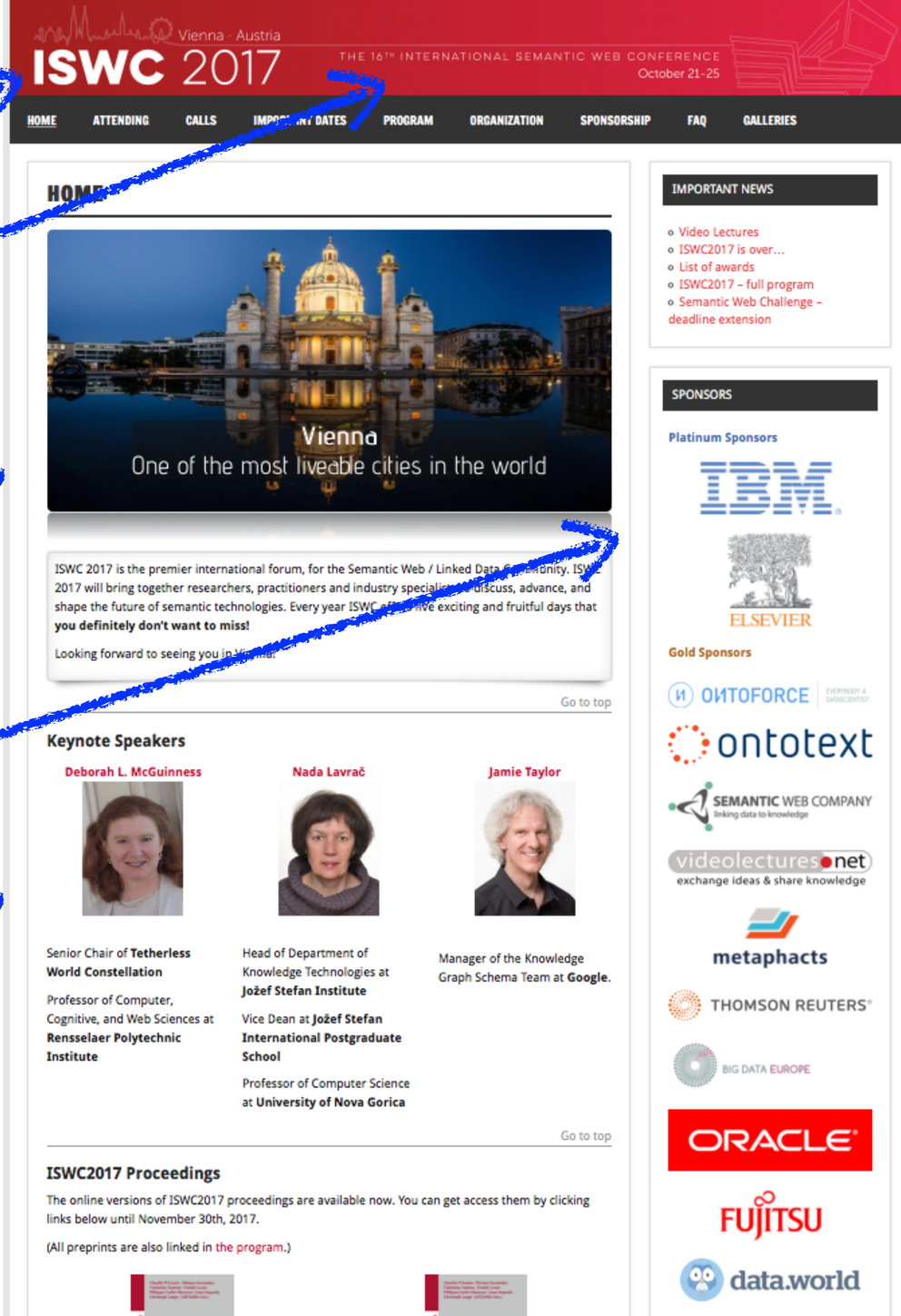

```
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<html lang="en-US">

<head>
<meta charset="UTF-8" />
<meta name="viewport" content="width=device-width, initial-scale=1">
<link rel="profile" href="http://gmpg.org/xfn/11" />
<link rel="pingback" href="https://iswc2017.ai.wu.ac.at/xmlrpc.php" />

<title>ISWC2017 The 16th International Semantic Web Conference &#8211; ISWC2017</title>
<link rel='dns-prefetch' href='//iswc2017.ai.wu.ac.at' />
<link rel='dns-prefetch' href='//maps.google.com' />
<link rel='dns-prefetch' href='//fonts.googleapis.com' />
<link rel='dns-prefetch' href='//s.w.org' />
<link rel="alternate" type="application/rss+xml" title="ISWC2017 The 16th International Semantic Web Conference &raquo; Feed" href="https:
<link rel="alternate" type="application/rss+xml" title="ISWC2017 The 16th International Semantic Web Conference &raquo; Comments Feed" hre
        <script type="text/javascript">
            window._wpemojiSettings = {"baseUrl":"https:\/\/s.w.org\/images\/core\/emoji\/2\/72x72\/","ext":".png","svgUrl":"https:\/\/s.w
            !function(a,b,c){function d(a){var c,d,e,f,g,h=b.createElement("canvas"),i=h.getContext&&h.getContext("2d"),j=String.fromCharC
        </script>
        <style type="text/css">
img.wp-smiley,
img.emoji {
    display: inline !important;
    border: none !important;
    box-shadow: none !important;
    height: 1em !important;
    width: 1em !important;
    margin: 0 .07em !important;
    vertical-align: -0.1em !important;
    background: none !important;
    padding: 0 !important;
}
</style>
<link rel='stylesheet' id='dropshadowboxes_css-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/plugins/drop-shadow-boxes/css/dropshado
<link rel='stylesheet' id='ce_responsive-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/plugins/simple-embed-code/css/video-container
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<link rel='stylesheet' id='faqwd_front_end_default_style-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/plugins/faq-wd/css/default.cs
<link rel='stylesheet' id='dynamicnewslite-stylesheet-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/themes/dynamic-news-lite/style.c
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<link rel='stylesheet' id='dynamicnewslite-default-fonts-css'  href='//fonts.googleapis.com/css?family=Droid+Sans%3A400%2C700%7CFrancois+O
<link rel='stylesheet' id='wps_gfw-widget-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/plugins/easy-customizable-text-widget/css/fr
<link rel='stylesheet' id='wpgmp-frontend-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/plugins/wp-google-map-plugin//assets/css/fro
<link rel='stylesheet' id='ms-main-css'  href='https://iswc2017.ai.wu.ac.at/wp-content/plugins/masterslider/public/assets/css/masterslider
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<!-- This site uses the Google Analytics by MonsterInsights plugin v5.5.3 - Universal enabled - https://www.monsterinsights.com/ -->
<script type="text/javascript">
    (function(i,s,o,g,r,a,m){i['GoogleAnalyticsObject']=r;i[r]=i[r]||function(){
        (i[r].q=i[r].q||[]).push(arguments)},i[r].l=1*new Date();a=s.createElement(o),
        m=s.getElementsByTagName(o)[0];a.async=1;a.src=g;m.parentNode.insertBefore(a,m)
    })(window,document,'script','//www.google-analytics.com/analytics.js','__gaTracker');

    __gaTracker('create', 'UA-85705863-1', 'auto');
    __gaTracker('set', 'forceSSL', true);
    __gaTracker('send','pageview');

</script>
<!-- / Google Analytics by MonsterInsights -->
<script type='text/javascript' src='https://iswc2017.ai.wu.ac.at/wp-includes/js/jquery/jquery.js?ver=1.12.4'></script>
<script type='text/javascript' src='https://iswc2017.ai.wu.ac.at/wp-includes/js/jquery/jquery-migrate.min.js?ver=1.4.1'></script>
<!--[if lt IE 9]>
<script type='text/javascript' src='https://iswc2017.ai.wu.ac.at/wp-content/themes/dynamic-news-lite/js/html5shiv.min.js?ver=3.7.3'></scri
<![endif]-->
<script type='text/javascript'>
/* <![CDATA[ */
```

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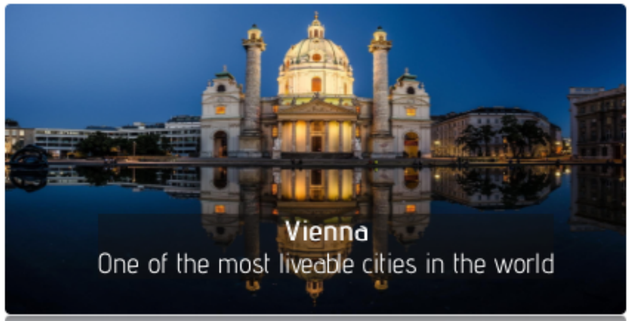

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Looking forward to seeing you in Vienna!

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Keynote Speakers

Deborah L. McGuinness

Senior Chair of **Tetherless World Constellation**

Professor of Computer, Cognitive, and Web Sciences at **Rensselaer Polytechnic Institute**

Nada Lavrač

Head of Department of Knowledge Technologies at **Jožef Stefan Institute**

Vice Dean at **Jožef Stefan International Postgraduate School**

Professor of Computer Science at **University of Nova Gorica**

Jamie Taylor

Manager of the Knowledge Graph Schema Team at **Google**.

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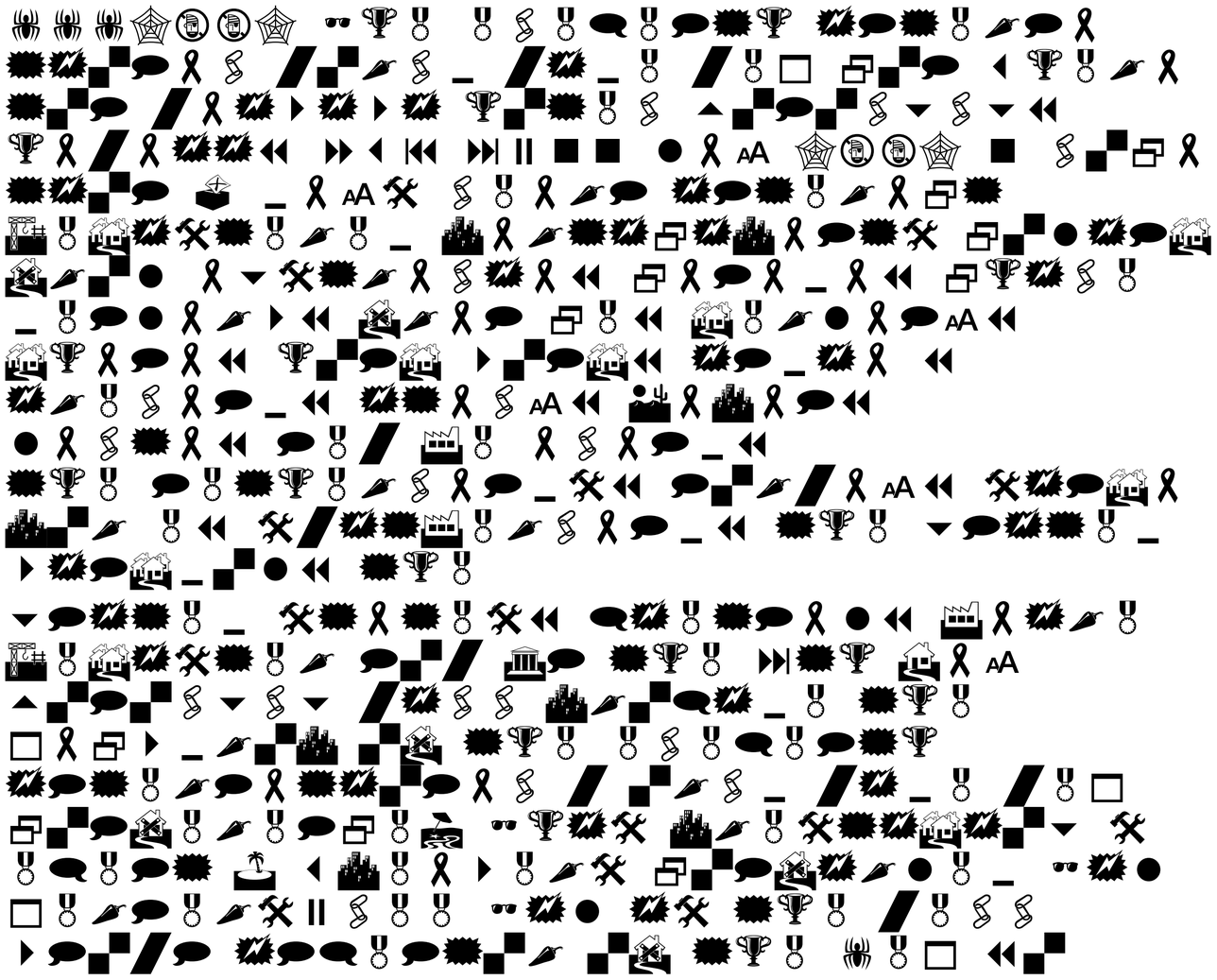

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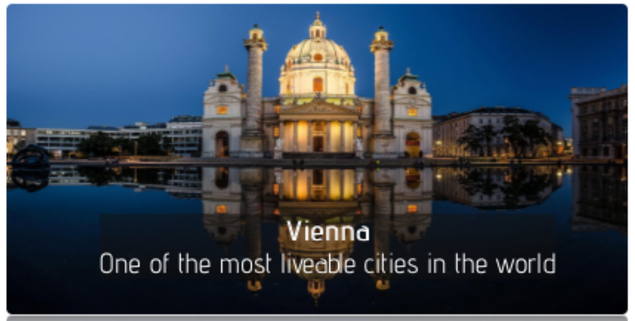

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A richer data model

- Semantic Web: beyond machine readable to machine understandable.
  - data model:
    - data model that can be used by multiple applications
      - not only for describing documents
      - for people to describe application-specific information
    - data model that is domain independent
      - any application can use it to describe information
  - semantics:
    - mechanism to interpret the data model
    - describes the interpretations of the data items wrt the domain
  - syntax:
    - standardised exchange mechanism

Let’s encode meaning in XML

- XML = eXtensible Markup Language
  - set of rules for encoding documents in machine processable form.
  - It was designed to transport and store data
    - the focus is what data is
  - XML complements HTML:
    - HTML was designed to display data
      - the focus is how data looks
  - XML is not meant to do anything!
    - it was created to structure, store and transport information.
  - XML is now the most common tool for data transmissions between all sorts of applications

XML is not the answer

- Meaning of XML documents is intuitively clear
  - “semantic” markup tags are domain terms
  - no unique way to express the same information
- But computers do not have intuition
  - Tag names per se do not provide semantics
  - The semantics are encoded outside the XML specification
- XML makes no commitment on:
  - Domain specific ontological vocabulary
  - Ontological modelling primitives
    - requires pre-arranged agreement on 1. & 2.
- Feasible for closed collaboration
  - agents in a small & stable community
  - pages on a small & stable intranet

Nesting of Tags in XML

- John Smith is a lecturer of SemWeb Technologies

```
<course name=”SemWeb Technologies">
      <lecturer>John Smith</lecturer>
</course>
```

- Opposite nesting, same information!

```
<lecturer name=”John Smith">
      <course>SemWeb Technologies</course>
</lecturer>
```

RDF: Resource Description Framework

- Semantic Web: beyond machine readable to machine understandable.
  - Resource Description Framework (RDF)is the W3C language for describing metadata on the Web.

- Models Meta-Data about resources on the Web using subject-predicate-object triples
  - Triples define the relationship or predicate between two entities (the subject and object)

RDF Building Blocks

Statements

Statements are subject-predicate-object triples.
They assert the properties of a resource the resource, a property, and a value
Objects can be resources or literals (atomic values - strings)

Resources are similar to entities in ER models
- –"something" we want to describe
  - E.g. *authors*, *books*, *publishers*, *places*, *people*, *hotels*

Every resource has a URI
- –a URL (Web address) or
- –some other kind of unique identifier: URNs

Advantages of using URIs:
- –a global, worldwide, unique naming scheme
- –reduces the homonym problem in distributed data

Properties

Properties are special types of resources
- –they describe semantic relations between resources
  - E.g. *written by, age, smaller than, etc*
- –they are also identified by a URI

Three Views of a Statement

- A statement can be seen as:
  - A triple
  - A piece of a graph
  - A XML code fragment
- Thus an RDF document can be viewed as:
  - A set of triples
  - A graph (semantic net)
  - An XML document

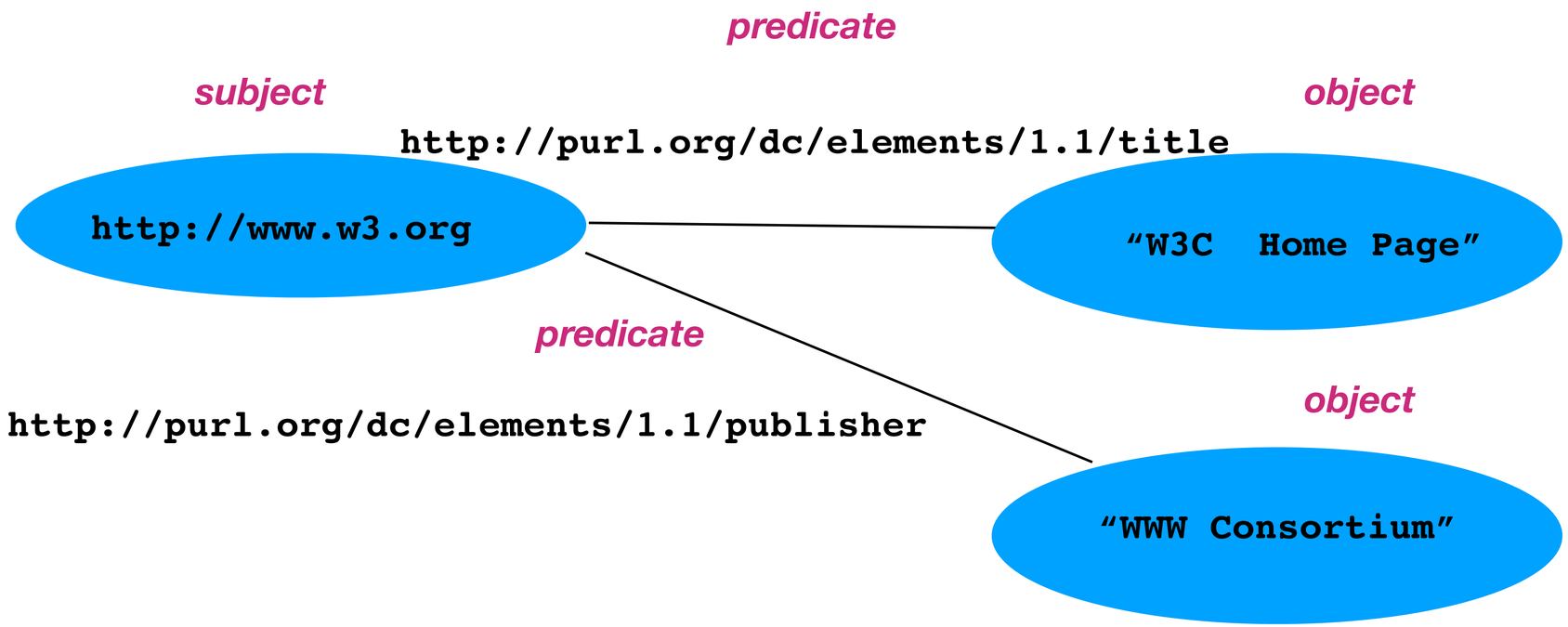
Statements as Triples

```
(John Smith,
 http://www.jsdomain.org/site-owner,
 http://www.liv.ac.uk/SemWeb)
```

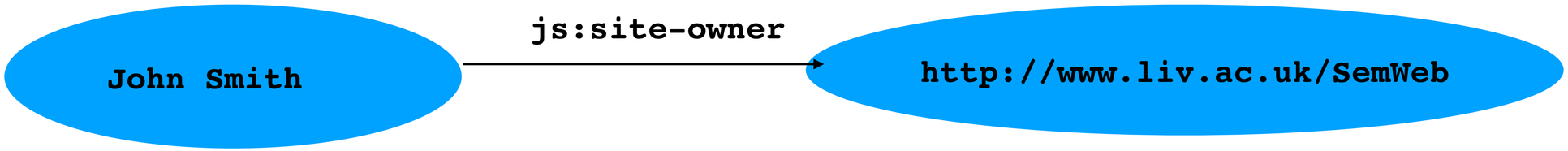
- The triple (x,P,y) can be considered as a logical formula P(x,y)
  - Binary predicate P relates object x to object y
  - RDF offers only binary predicates (properties)
    - mydomain:site-owner(John Smith,liv:SemWeb)

RDF Graphs

- The subject/predicate/object triples found in an RDF document form a graph:



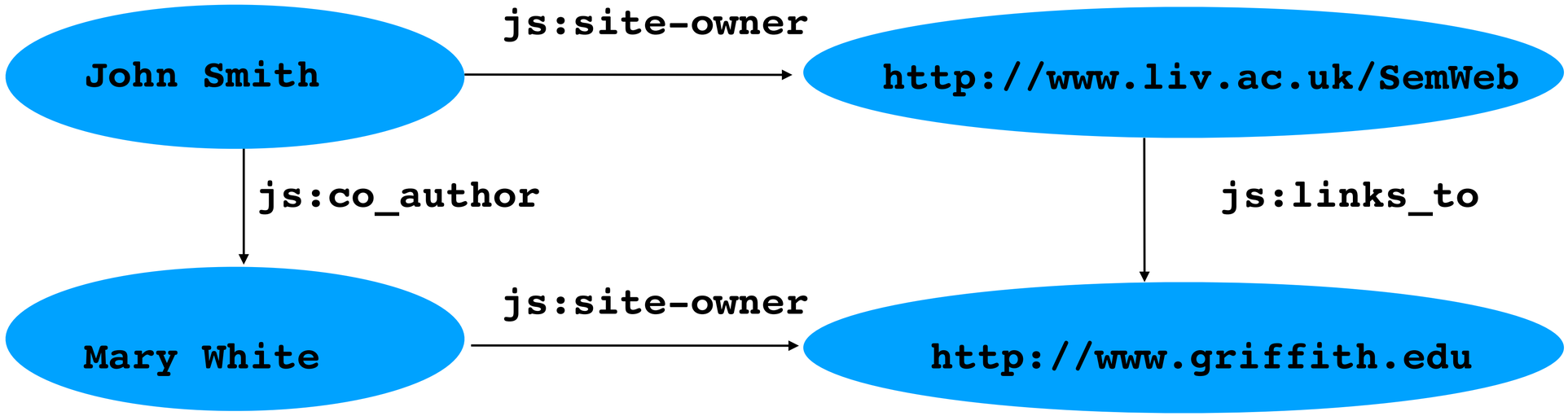
RDF Graph



- A directed graph with labeled nodes and arcs
  - **from** the resource (the **subject** of the statement)
  - **to** the value (the **object** of the statement)

- The value of a statement may be a resource
  - It may be linked to other resources

A Set of Triples as a graph (Semantic Net)



Same Statements in XML syntax

```
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:js="http://www.jsdomain.org/my-rdf-ns">

  <rdf:Description
   rdf:about="http://www.liv.ac.uk/SemWeb">
   <js:site-owner
    rdf:resource=John Smith/>
  </rdf:Description>
</rdf:RDF>
```

Statements in XML

- An RDF document is represented by an XML element with the tag `rdf:RDF`
- The content of this element is a number of **descriptions**, which use `rdf:Description` tags.
- Every description makes a statement about a resource, identified in 3 ways:
  - an **about** attribute, referencing an existing resource
  - an **ID** attribute, creating a new resource
  - without a name, creating an anonymous resource

Node and Edge labels in RDF graphs

- Node and edge labels can be:
  - URI
  - Literal (string)
  - Bnode (anonymous label)

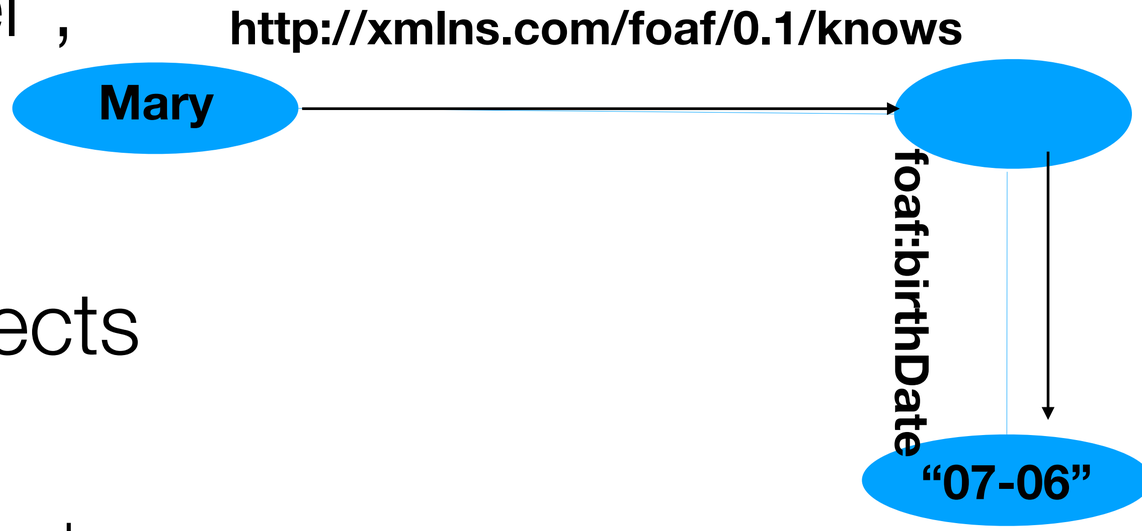
- However:
  - Only URIs and Bnodes can be the **subject** of a triple
  - Only URIs can be the predicate of a triple
  - Only URIs, Bnodes and literals can be the **object** of a triple

Complex values

- Values of properties do not need to be simple strings
- The value of a property can also be a graph node (corresponding to a resource)
  - arbitrarily complex tree and graph structures are possible
  - Values can be syntactically embedded (i.e., lexically in-line) or referenced (linked)

Blank Nodes

- Blank nodes (bnode) denote an RDF graph node with “anonymous label”,
  - the node is not associated with a URI

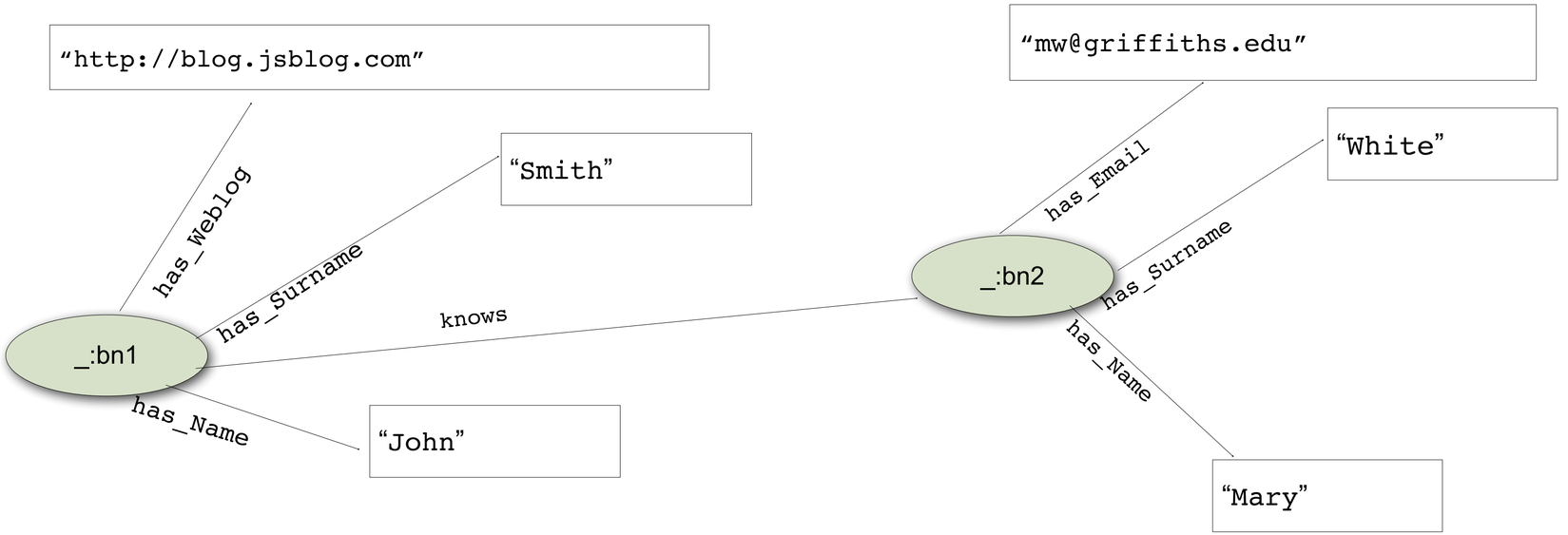


- Bnodes can be used both as subjects and objects
  - For example, the statement “Mary has a friend who is born on June 7th”
    - _:p1 is the blank node (bnode)

```
ex: Mary   foaf:knows       _:p1
_:p1       foaf:birthDate   07-06
```

Digression: blank nodes

- Social networks APIs do not issue URIs for the members of their community, even if they have lots to say about them.
  - a blank node is used to represent a member and and the facts about the member are linked to the blank node



Example

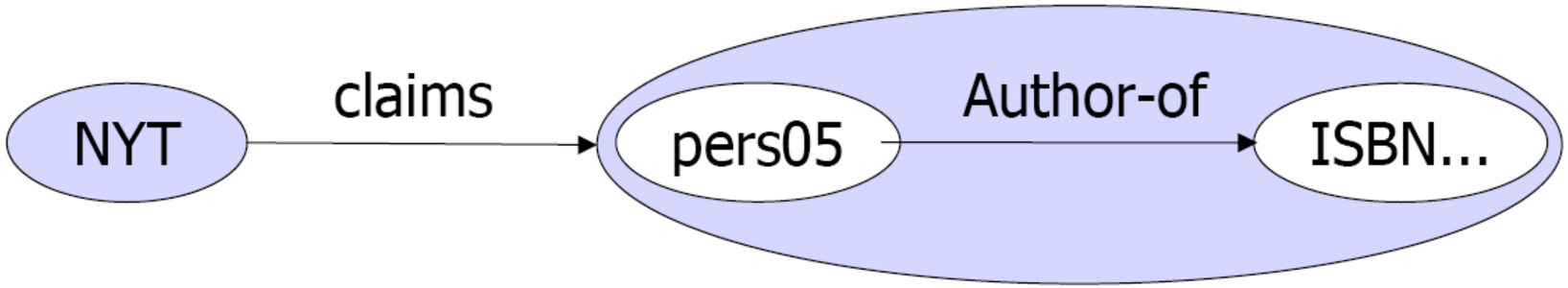
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix : <http://example.org/#> .

<http://www.w3.org/TR/rdf-syntax-grammar>
dc:title "RDF/XML Syntax Specification (Revised)" ;
:editor [
 :fullName "Dave Beckett";
 :homePage <http://purl.org/net/dajobe/>
] .
```

Higher order statements

- RDF allows you to make statements about other RDF statements
  - “Ralph believes that the web contains one billion documents”
- Higher-order statements
  - allow us to express beliefs (and other modalities)
  - are important for trust models, digital signatures,etc.
  - also: metadata about metadata
  - are represented by modelling RDF in RDF itself
- Reification

Reification

- Any RDF statement can be an object
- We must be able to refer to a statement using an identifier
  - allows users to point to a particular statement (and part of a graph)
- RDF allows such reference through a reification mechanism which turns a statement into a resource
  - newer versions of RDF introduce named graphs where an identifier is assigned to a set of statements



Reification Example

```
<rdf:Description rdf:about="#949352">
    <uni:name>John Smith</uni:name>
</rdf:Description>
```

```
<rdf:Statement rdf:ID="StatementAbout949352">
    <rdf:subject rdf:resource="#949352"/>
    <rdf:predicate rdf:resource=
                "http://www.jsmydomain.org/uni-ns#name"/>
    <rdf:object>John Smith</rdf:object>
</rdf:Statement>
```

Recap

- Limitation of XML
- RDF
  - Basic ideas behind RDF
  - Statements about resources
    - triples
    - graphs
    - XML vocabularies
  - Modelling primitives in RDF