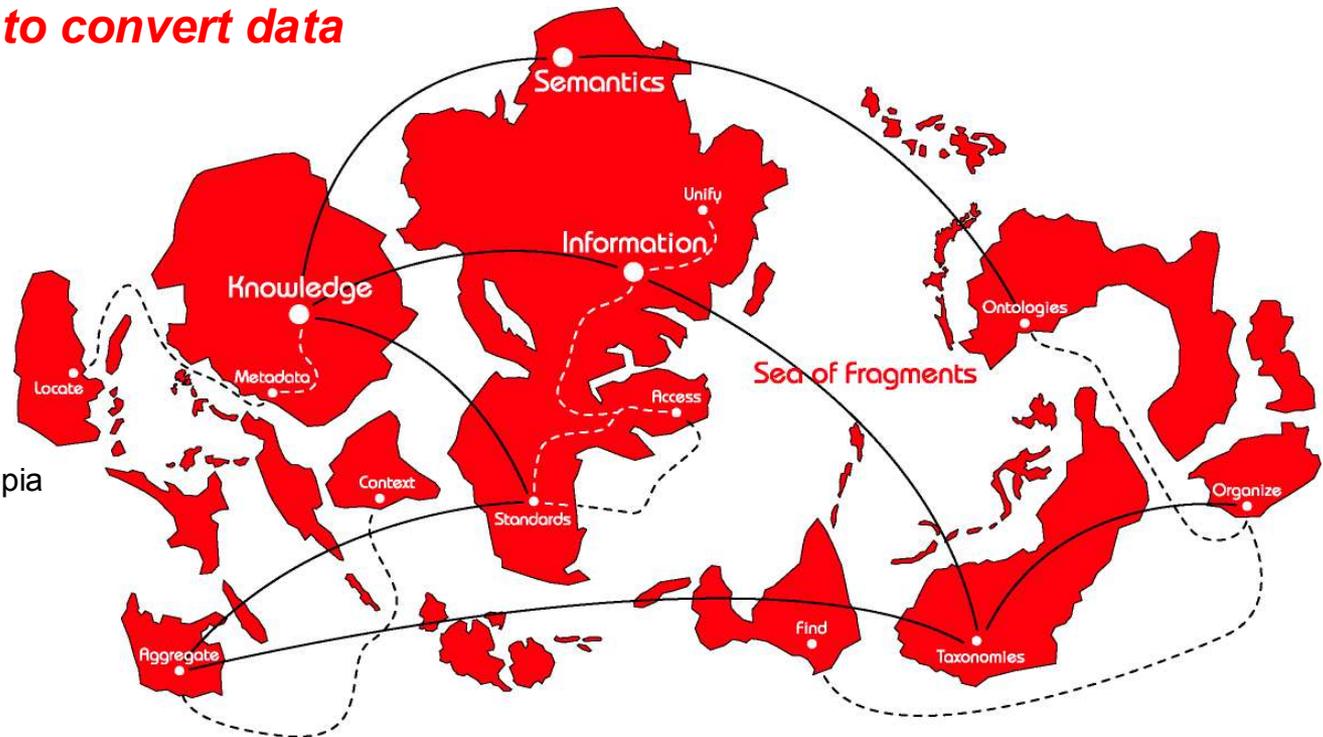


TM/RDF Interoperability in Practice

A Tutorial

GOALS:

Understand topic maps, relation to RDF, and be able to convert data



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Presented at ISWC 2004
 2004-11-07

Who is talking?

- **Lars Marius Garshol**

- Development manager at and co-founder of Ontopia
- Co-author of the new ISO 13250 Topic Maps, parts 2 and 3
- Co-editor of ISO 18048 Topic Map Query Language (TMQL)
- Responsible for the Unicode support in the Opera web browser
- Active open source developer in the XML community
- Wrote *“Definitive XML Application Development”*, published by Prentice-Hall in 2002

- **Ontopia**

- the leading topic map software vendor
- Norwegian company headquartered in Oslo
- main product: Ontopia Knowledge Suite (OKS)

Background for this tutorial

- **Have been working full-time on Topic Maps since April 2000**
 - standardization, software, applications, evangelization, ...
- ***RDF, Topic Maps, DAML, OIL*, paper, December 2001**
 - XML-based RDF-to-topic map mapping
- **Topic Maps conversion toolkit based on RDF (2002-2003)**
- ***Living with Topic Maps and RDF*, paper, May 2003**
 - RDF-based RDF-to-Topic maps mapping
 - TM-based TM-to-RDF mapping
- **Implemented mappings in OKS and Omnigator (2003)**
- **User interface for creating mappings in Omnigator (2004)**

Today's agenda

- **Background**
- **Introduction to Topic Maps**
- **Comparing the models**
- **Approaches to conversions**
- **Understanding Topic Maps**
- **Converting topic maps to RDF**
- **Schema languages**
- **Query languages**
- **Future work**

Preparations for the exercises

- **Install Java, if you haven't already**
 - JDK or JRE, version 1.3 or higher
- **Install the Omnigator**
- **Put the example.rdf file in**
 - OMNIGATOR/jakarta-tomcat/webapps/omnigator/WEB-INF/topicmaps

Background

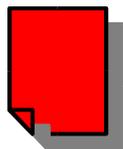
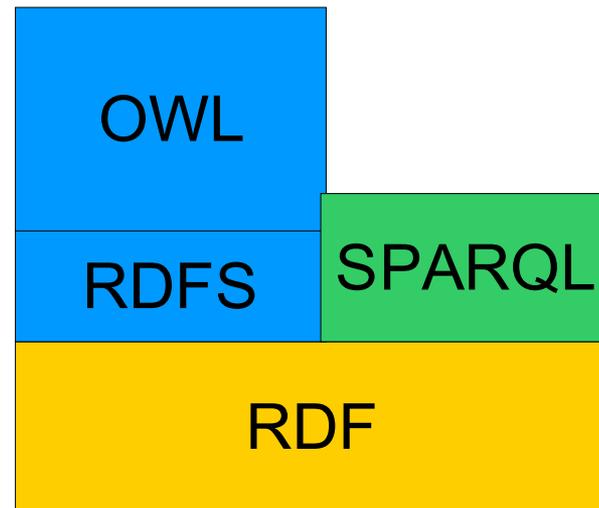
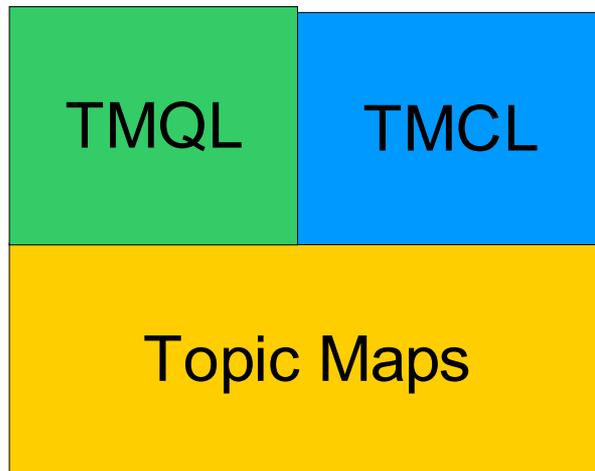


*Two technologies, one problem?
Some history*

Why this tutorial?

- **Topic Maps and RDF are considered by many to compete for the same space**
 - Yet there is little understanding of how the two match up
 - There is also little communication between the two communities
- **This is an attempt to**
 - Explain how the two compare,
 - Position them relative to one another,
 - Build bridges between the communities, and
 - Teach a practical approach to interoperability

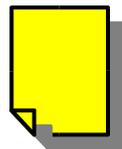
The big picture



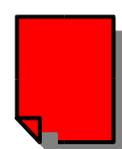
XTM



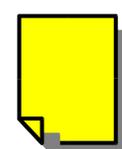
HyTM



LTM



RDF/XML



n3

Technical comparison

- **Topic Maps and RDF**
 - are graph-based data models,
 - have well-defined identity tests and merging operators,
 - have XML-based interchange syntaxes (as well as human-friendly ones),
 - are standards, and
 - have (or will have) standardized schema and query languages
- **Differences**
 - RDF is lower-level than Topic Maps,
 - topic maps support reification, qualification/provenance/context, and n-ary relationships, and
 - Topic Maps distinguish different kinds of URI references

Comparison of goals and use

- **Topic Maps goals**

- make information findable
- make indexes mergeable
- enable collocation of information
- support “seamless knowledge”

- **Topic Maps uses**

- portal infrastructure
- classification/indexing
- application integration
- business process modelling
- product data management
- e-learning

- **RDF goals**

- represent metadata on the web (RDF MS, Lassila & Swick)
- unify metadata and data (MCF, Guha)
- support data integration (Miller)
- enable the Semantic Web (Berners-Lee, Miller, ...)

- **RDF uses**

- portal infrastructure
- application integration
- document metadata
- web agent applications
- ???

Summing up the comparisons

- **The technologies are similar, yet different**
- **The goals and visions are similar, yet different**
- **It is clear that the two are very close, yet significantly different**
- **In practice, they perform well at different things**
- **We will return to this**

Where we stand today

- **Topic Maps have been standardized and deployed**
 - the standard is written and published, and the second edition nearly done
 - a number of commercial projects have been developed and deployed based on this standard
 - commercial and open source tools are available
 - a whole community has developed around the standard
 - work has begun on supporting standards
- **RDF has been standardized and deployed**
 - the situation is much the same as for topic maps
- **In short, neither topic maps nor RDF will be going away soon**

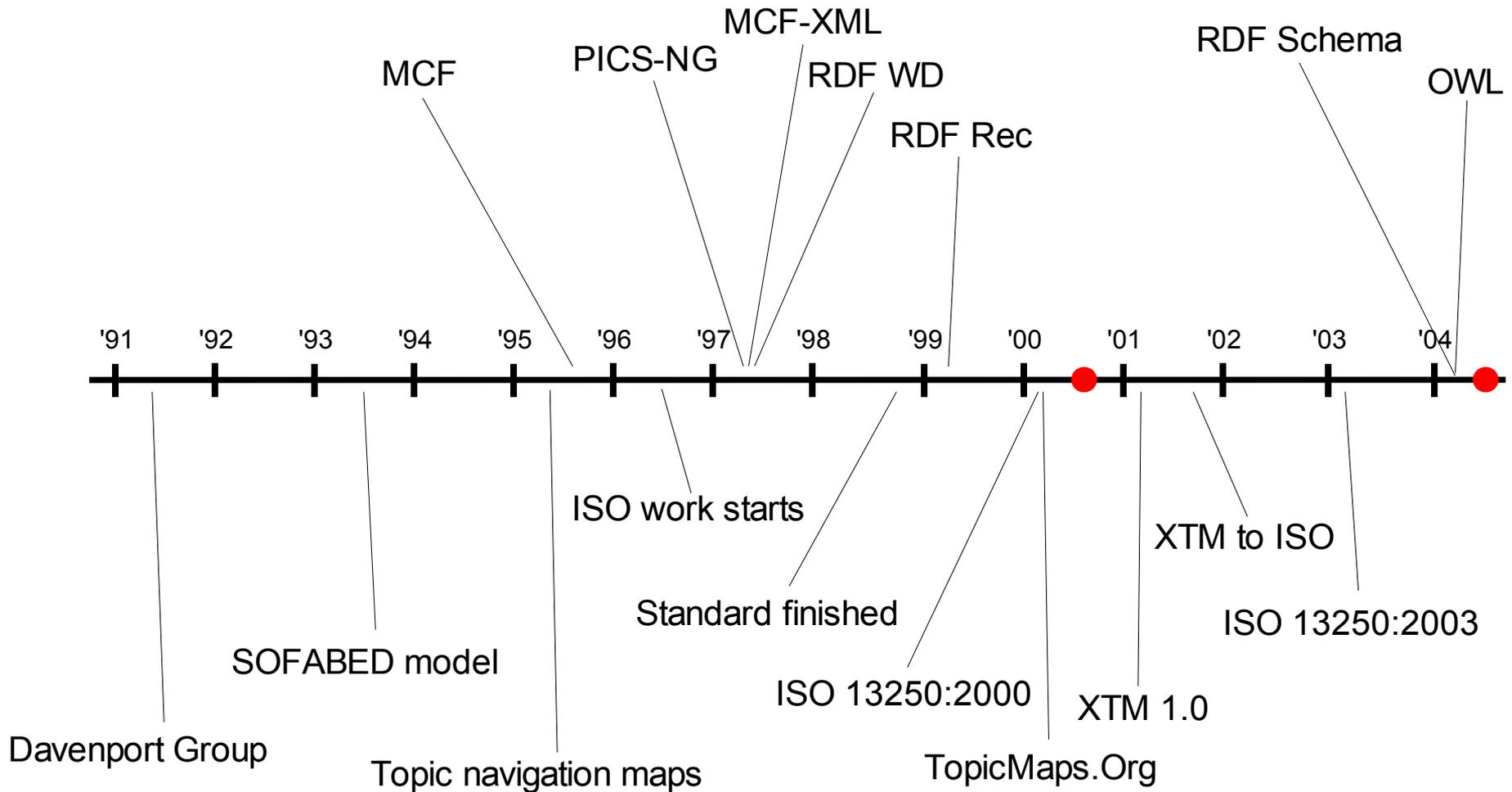
A brief history of topic maps

- **Roots go back to early 1990's**
 - O'Reilly/DEC indexing project
 - Davenport Group → CAPH
- **Adopted as an ISO work item in 1996**
 - Original editors: Steve Newcomb, Michel Biezunski, and Martin Bryan
- **International Standard (ISO/IEC 13250:2000)**
 - Syntax based on SGML, model based on HyTime
- **Web Standard (XML Topic Maps 1.0, 2001)**
 - XML version for use on the Web
 - Adopted by ISO, October 2001
- **Second Edition**
 - ISO 13250: 2003 (includes XTM)
- **Revised Edition**
 - Multipart standard including data model, query language and constraint language (2004-2005)

A brief history of RDF

- **Ramanathan V. Guha**
 - created MCF (Meta Content Framework) at Apple '95-'96
 - common representation for metadata and data; used for HotSauce
 - model and text-based syntax submitted to IETF in '96
- **World Wide Web Consortium**
 - Guha and Bray created an XML syntax for MCF in June '97
 - work was already ongoing on PICS-NG, a general metadata standard
 - RDF = PICS-NG + XML-MCF
 - first working draft August '97, final recommendation February '99
 - second edition of core specifications early 2004

Timeline



Introduction to topic maps



The TAO of Topic Maps

The Findability Problem

- **Ask yourself:**
 - Is this problem really “new”? Didn’t it exist before the advent of computers?
 - How would you go about locating a specific piece of information in a book – short of reading it from cover to cover?
- **Isn’t that what (back-of-book) indexes are for?**
 - An index is an information retrieval device
 - Publishers have traditionally set great store by indexes:
 - “There is no book ... so good that it is not made better by an index, and no book so bad that it may not by this adjunct escape the worst condemnation” (*Sir Edward Cook*)
- **Indexes and maps**
 - The task of the indexer is to chart the topics of the document and to present a concise and accurate map for the readers
 - “A book without an index is like a country without a map”

What is an Index, Really?

Madama Butterfly, 70-71, 234-236, 326

Puccini, Giacomo, 69-71

soprano, 41-42, 337

Tosca, 26, 70, 274-276, 326

topics (in fact, *names of Topics*)

page numbers (locators for *Occurrences*)

A More Complex Index

Cavalleria Rusticana, 71, 203-204

Mascagni, Pietro (composer)

→ *Cavalleria Rusticana*, 71, 203-204

~~*Rustic Chivalry*~~, see *Cavalleria Rusticana*

singers, 39-52

See also individual names

baritone, 46

bass, 46-47 **n**

soprano, 41-42, 337

tenor, 44-45

+ multiple indexes

+ other conventions

- Index of names
- Index of places
- Index of subjects

Additional

concepts:
topic types

occurrence types

topics with multiple names

associations between topics

The Key Features Are



Topics

- named “subjects of discourse”
- may have multiple names
- may be typed

Associations

- relationships between topics

Occurrences

- information relevant to a topic
- may be typed
- pointed to via locators

*These are also
the key constructs
in the topic map
model!*

Glossaries

bass: The lowest of the male voice types. Basses usually play priests or fathers in operas, but they occasionally get star turns as the Devil.

diva: Literally, “goddess” – a female opera star. Sometimes refers to a fussy, demanding opera star. See also prima donna.

first lady: See prima donna.

Leitmotif (German, “LIGHT-mo-teef”): A musical theme assigned to a main character or idea of an opera; invented by Richard Wagner.

prima donna (“PREE-mah DOAN-na”): Italian for “first lady”. The singer who plays the heroine, the main female character in an opera; or anyone who believes the world revolves around her.

soprano: The female voice category with the highest notes and the highest paycheck.

- Glossaries have a different purpose than indexes:
- The purpose is not to provide pointers to every occurrence of a topic...
- ...but rather to provide one specific occurrence type – **the definition**
- Therefore, instead of using locators (page numbers) to point to the definition...
- ...the definition is simply placed in-line.
- It looks different on paper, but the underlying model *is exactly the same*

Thesauri

soprano	
definition	The highest category of female (or artificial male) voice
broader terms	vocalist, singer
narrower terms	lyric soprano, dramatic soprano, coloratura soprano
related terms	mezzo-soprano, treble

Basic concepts:

topics
 associations
 occurrences

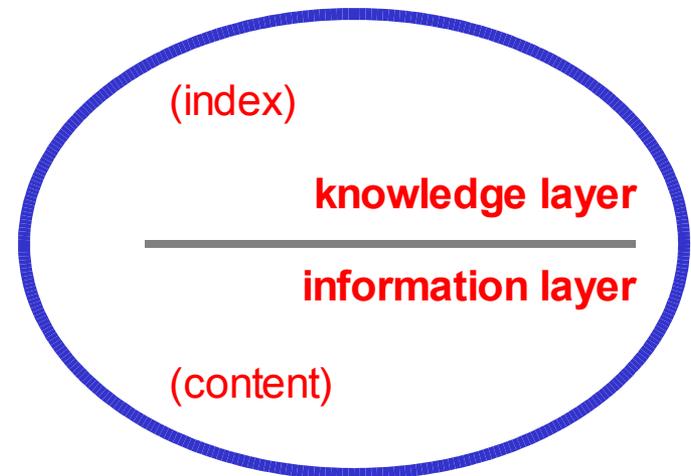
Additional concepts:

topic types
 occurrence types
 association types

Note: The associations are typed!

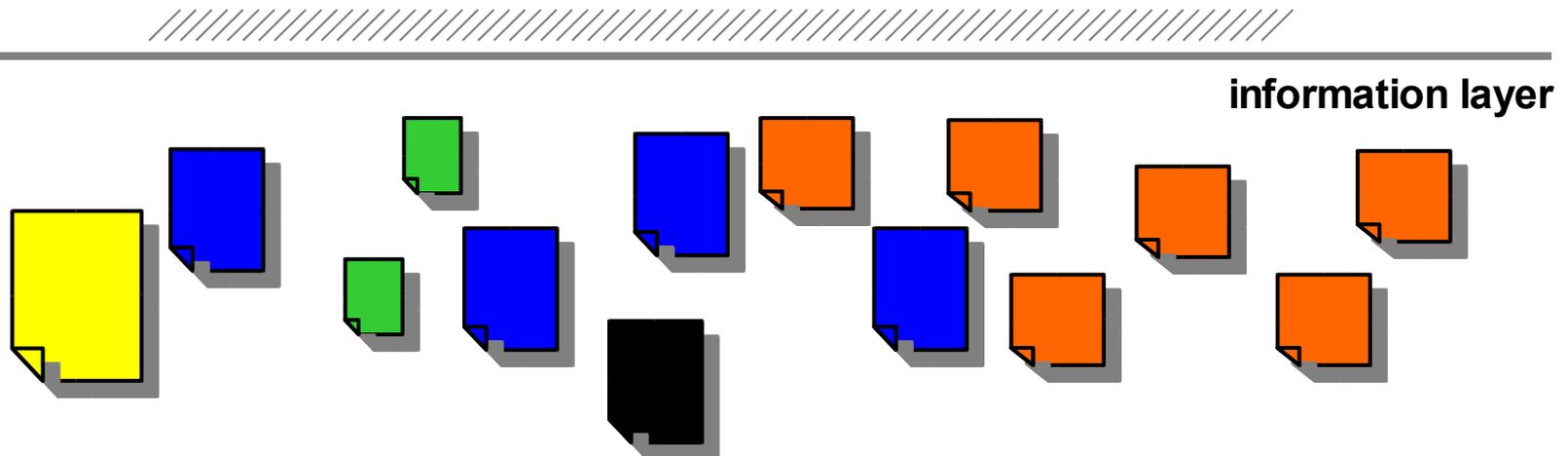
The Two-Layer Model of Topic Maps

- **The core concepts of Topic Maps are based on those of the back-of-book index**
- **The same basic concepts have been extended and generalized for use with digital information**
- **Envisage a 2-layer data model consisting of**
 - a set of information resources (below), and
 - a “knowledge map” (above)
- **This is like the division of a book into content and index**



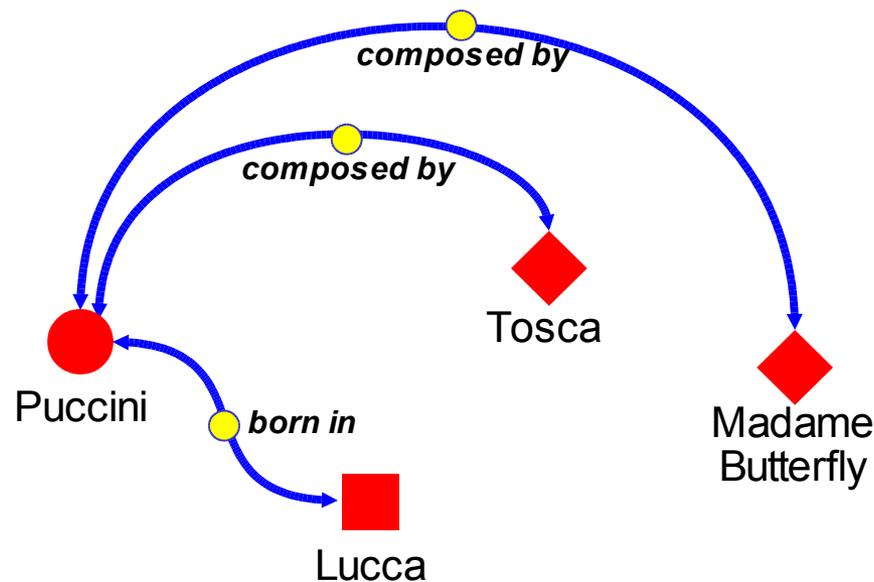
(1) The Information Layer

- **The lower layer contains the content**
 - usually digital, but need not be
 - can be in any format or notation
 - can be text, graphics, video, audio, etc.
- **This is like the content of the book to which the back-of-book index belongs**



(2) The Knowledge Layer

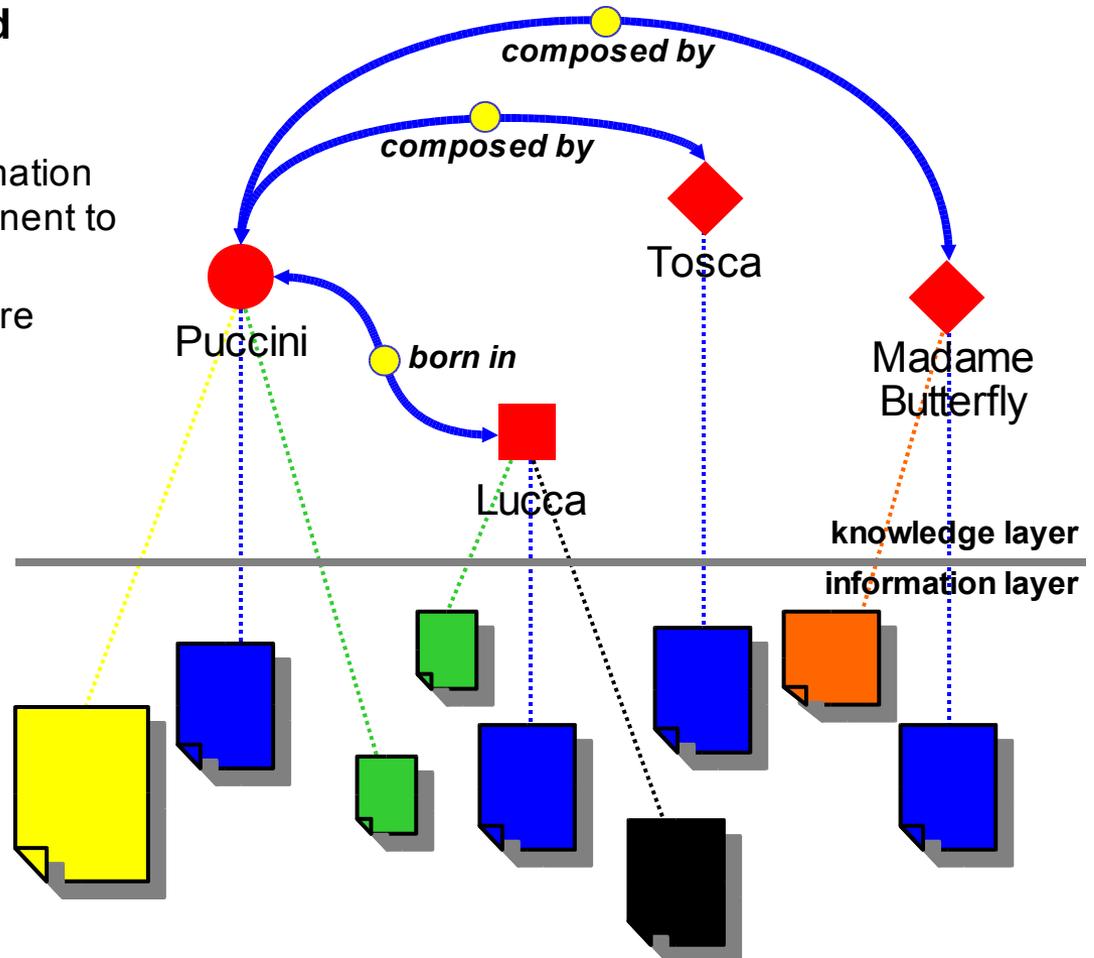
- **The upper layer consists of topics and associations**
 - **Topics** represent the subjects that the information is about
 - Like the list of topics that forms a back-of-book index
 - **Associations** represent relationships between those subjects
 - Like “see also” relationships in a back-of-book index



knowledge layer

(3) Occurrences

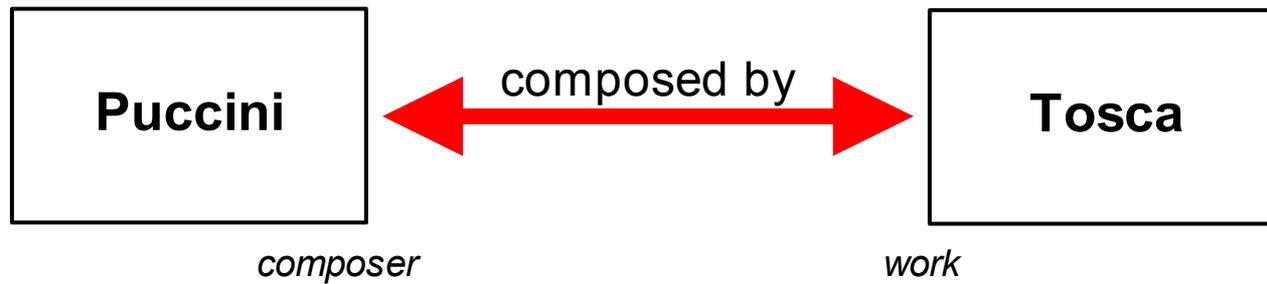
- The two layers are linked together
 - Occurrences are relationships with information resources that are pertinent to a given subject
 - The links (or locators) are like page numbers in a back-of-book index



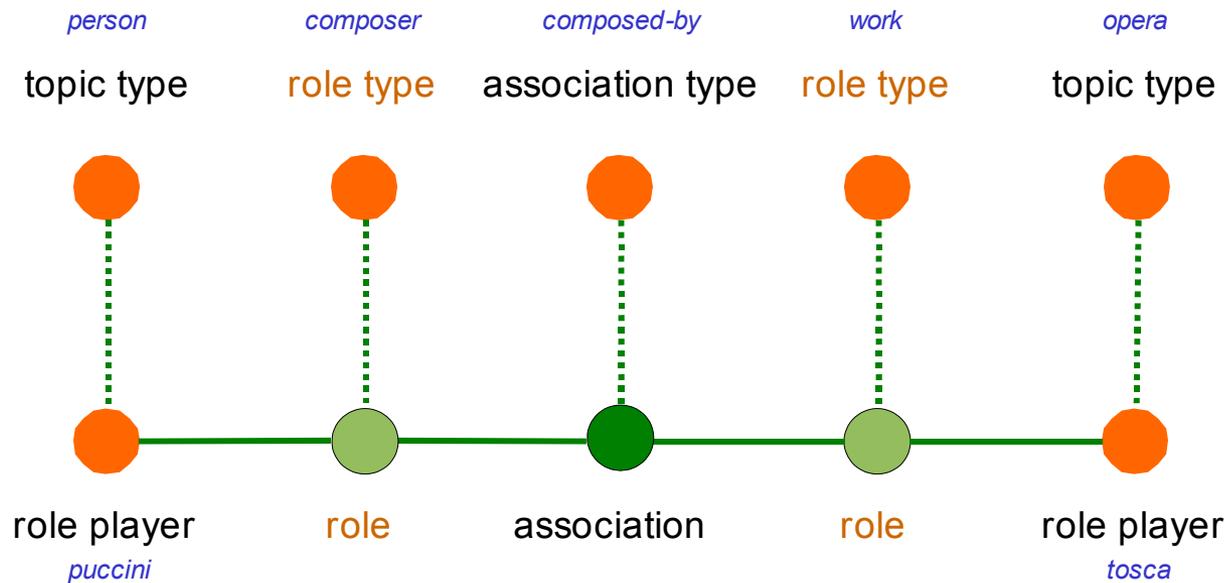
Are associations directional?



No, They Use *Roles*



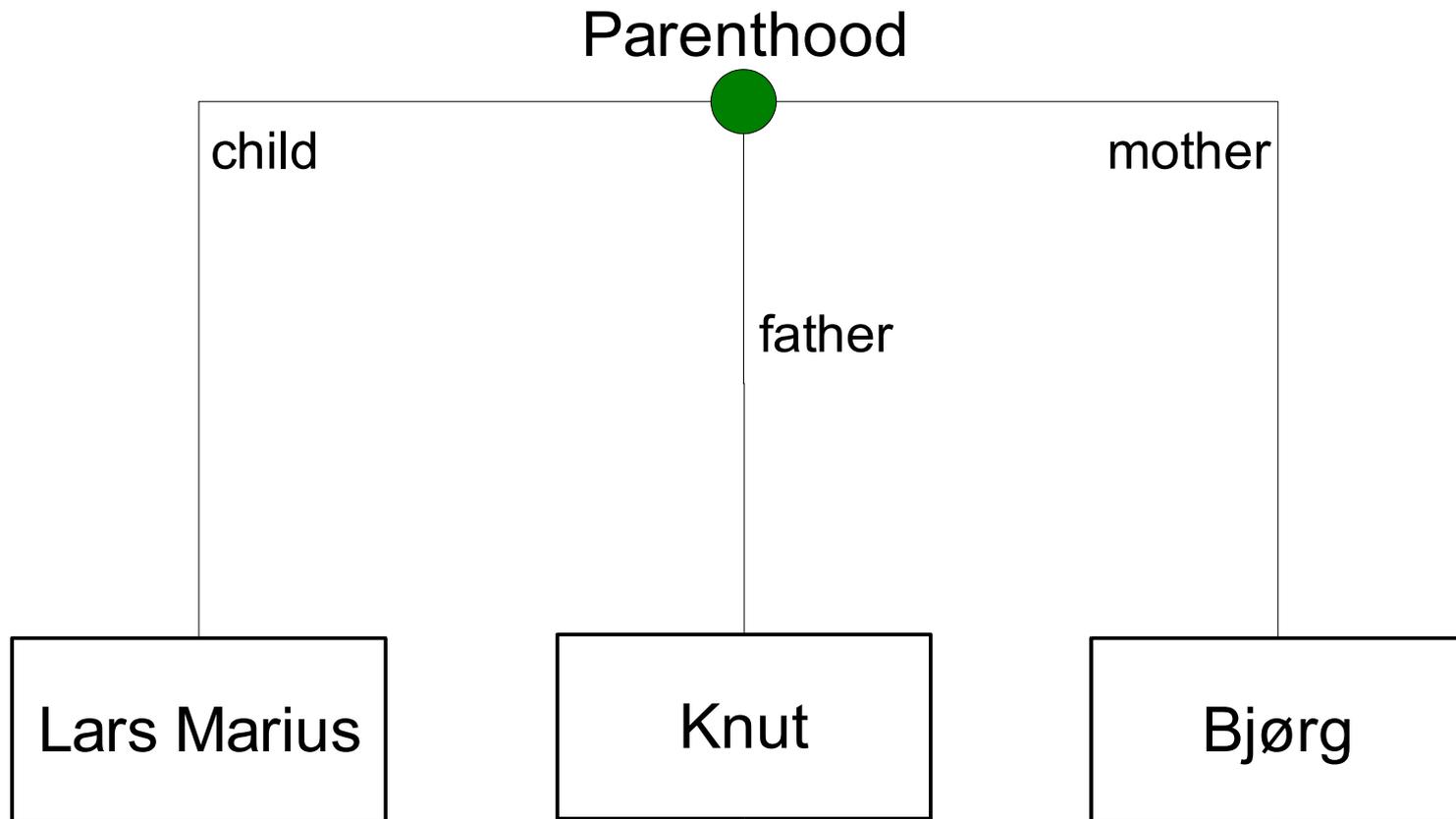
Association Role Types



N.B.

role == *association role* and
 role type == *association role type*

N-ary associations



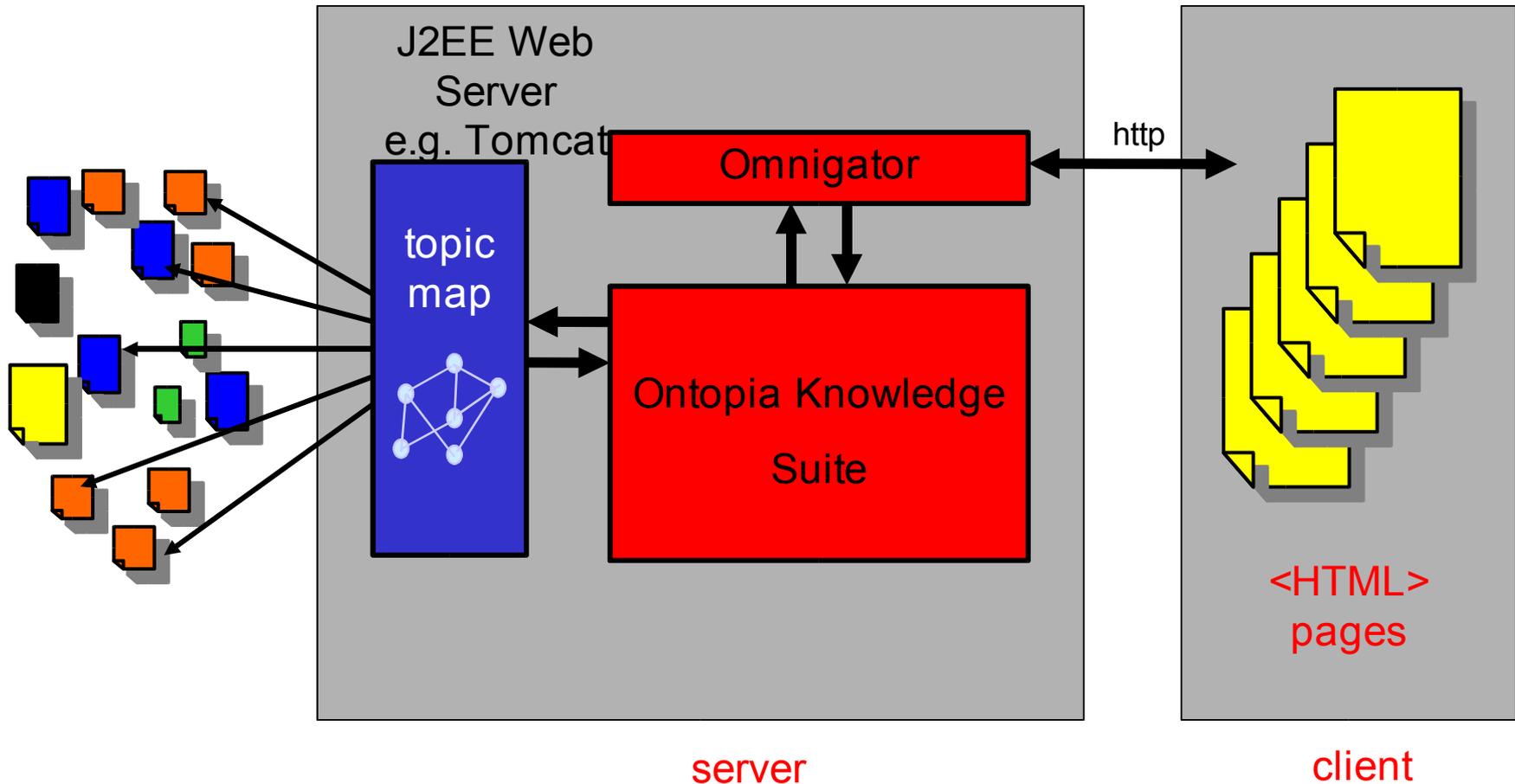
The Omnigator

- **An Omnivorous Topic Map Navigator**
 - The Omnigator will Eat Anything (provided it's a topic map!)
 - Any Ontology: including your own
 - Just drop your own topic map into the Omnigator directory and away you go!
 - The Omnigator makes “reasonable sense” out of any “reasonably sensible” topic map

- **And it's Free!**
 - Download it from the Ontopia web site
 - <http://www.ontopia.net>
 - Or view it online at
 - <http://www.ontopia.net/omnigator>

- **Built using Ontopia's flagship product**
 - The Ontopia Knowledge Suite (OKS)
 - A complete Java toolkit for building topic map applications
 - Academic licenses available from sales@ontopia.net

How the Omnigator Works



The topic map mindset

- **Note how different the topic map outlook is from the RDF one**
- **There is no talk about metadata; focus is entirely on subjects**
 - metadata is often represented in topic maps, but it's not the focus
- **Focus very much on findability**
 - application integration, application data representation, metadata, etc all done and useful, but not in focus
 - the same applies to inferencing etc

Comparing the models



Things and symbols

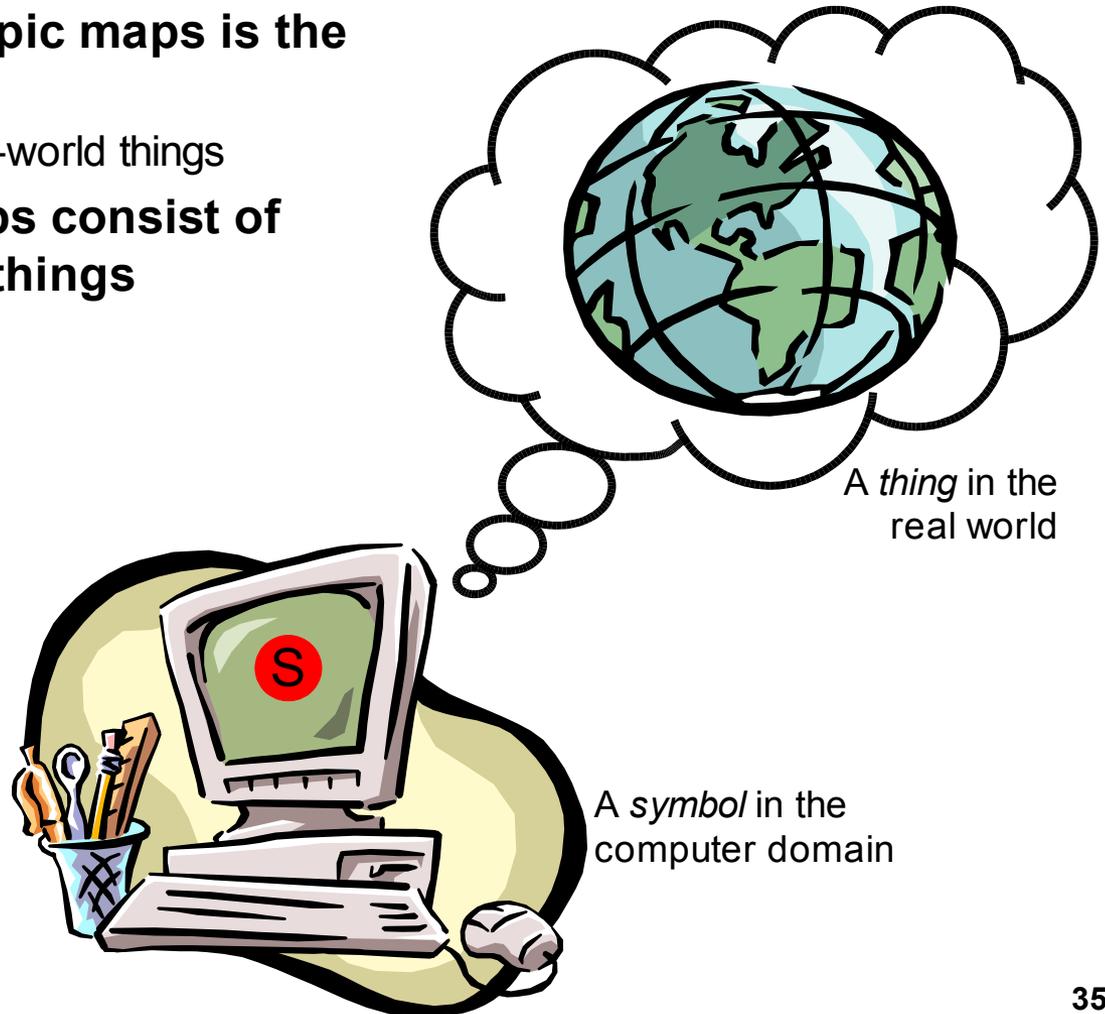
Assertions

Assertions about assertions

Identity

Things

- **The heart of RDF and topic maps is the same:**
 - symbols representing real-world things
- **Both RDF and topic maps consist of statements about these things**



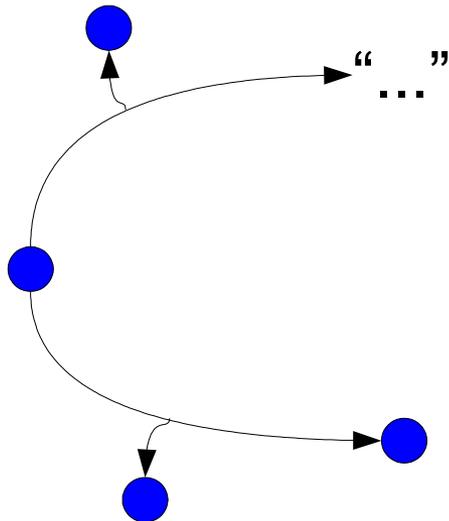
Terminology

- **Topic maps have *topics***
 - all topics are equal (almost)
- **Topics represent *subjects***
 - subjects are explicitly defined as “anything whatsoever, regardless of whether it exists or has any other specific characteristics, about which anything whatsoever may be asserted by any means whatsoever”
- **RDF has *nodes***
 - URI references
 - blank nodes
 - literals
- **Nodes represent *resources***
 - not necessarily documents

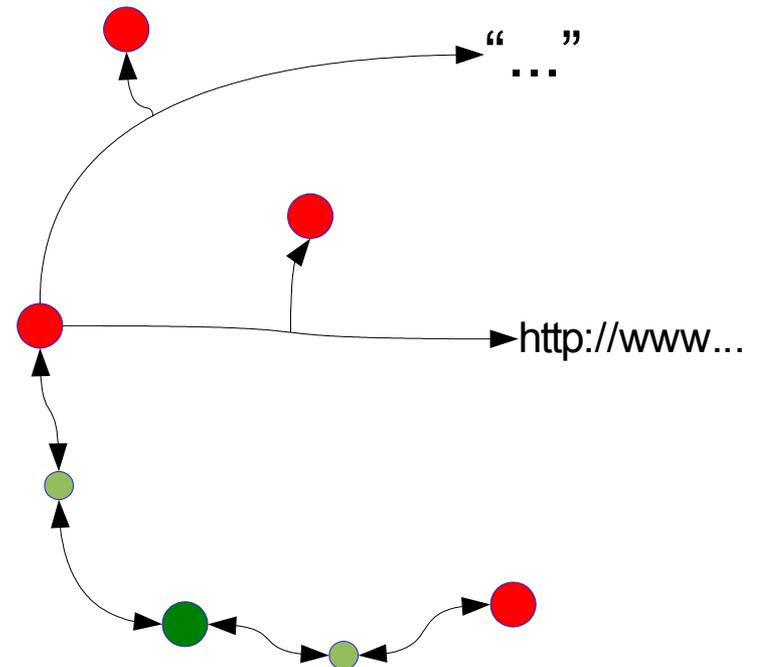
Reference	Topic maps	RDF
Symbol	Topic	Node
Thing	Subject	Resource

Assertions

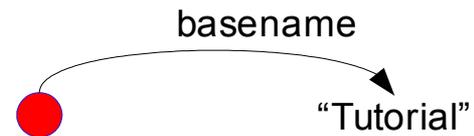
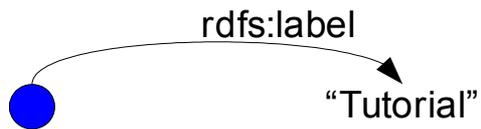
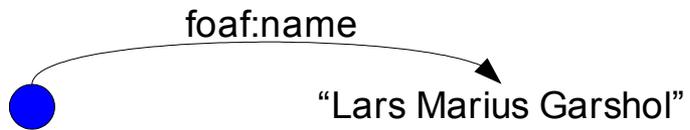
- **RDF has one kind of assertion: the statement**
 - subject, predicate, object
- **Topic maps have three kinds**
 - (1) Names
 - (2) Occurrences
 - (3) Associations



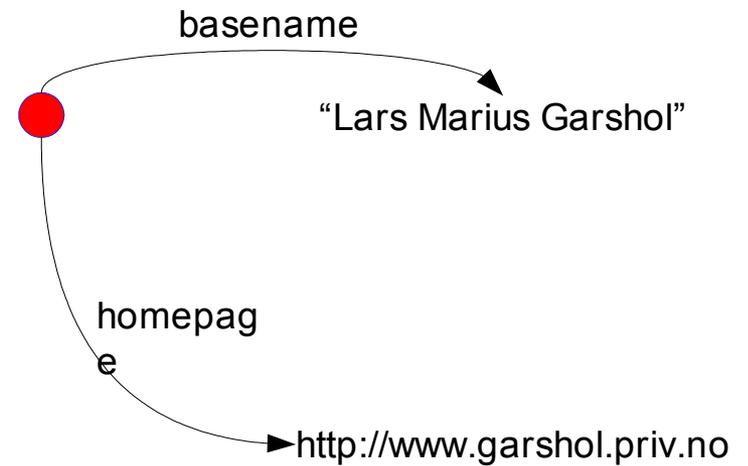
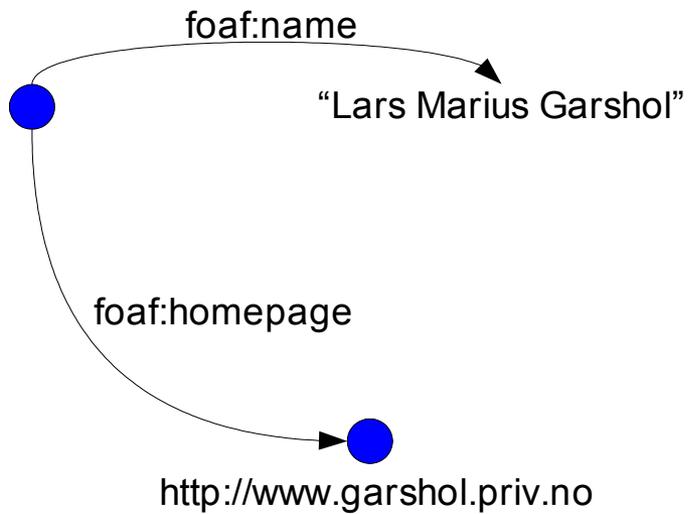
<http://www.ontopia.net>



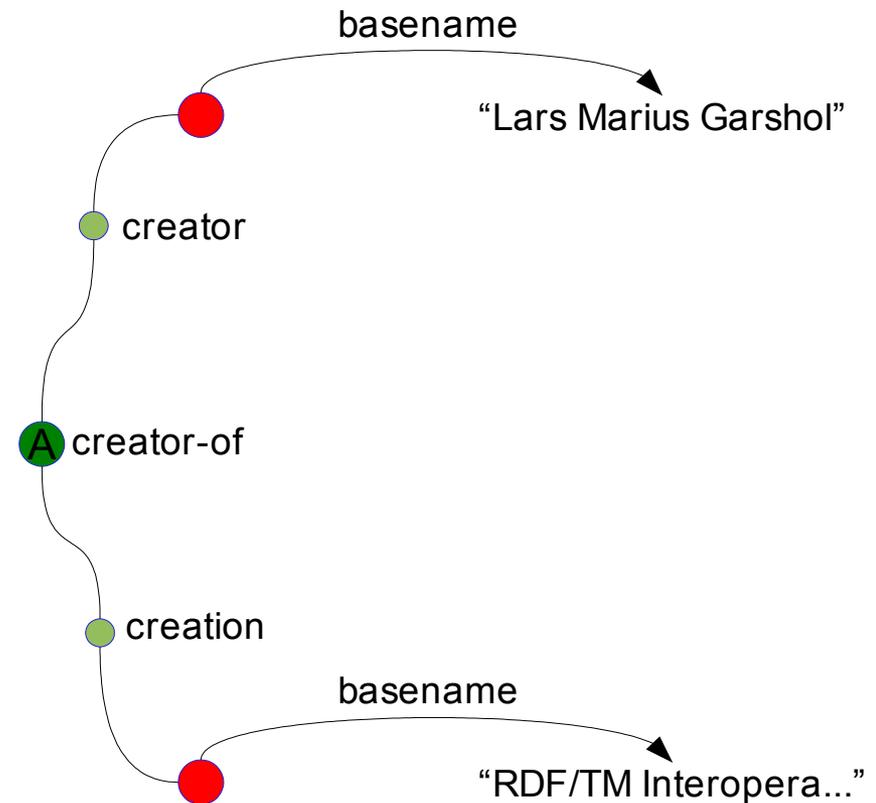
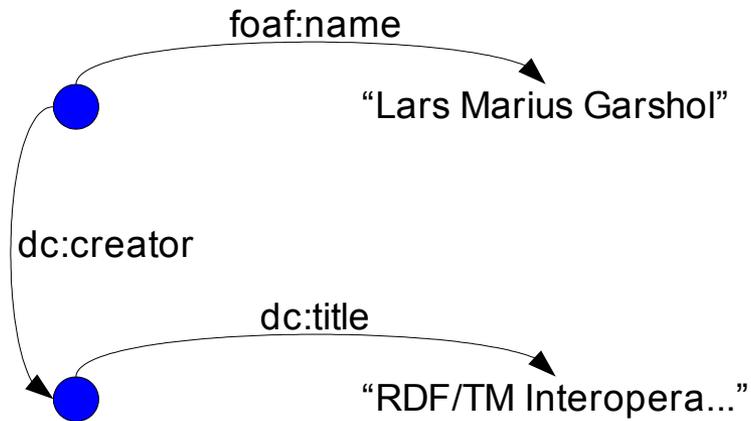
(1) Names



(2) Concept-resource relationships



(3) General relationships



Assertions about assertions

- **This has many uses**
 - record metadata about assertions (created by, last modified, ...)
 - treat assertions as first-class things
- **There are also many common specialized uses**
 - provenance
 - authority
 - context

Assertions about assertions (2)

- **RDF doesn't really do this**
 - reification has no official support
 - it also very cumbersome
- **However, people still use**
 - reification,
 - contexts, and
 - named graphs
- **Many tools have unofficial extensions for this**
 - TriX syntax also does
 - SPARQL, too
- **Topic maps have**
 - reification, and
 - scope
- **Reification is reification as we are used to it**
 - less cumbersome than in RDF
- **Scope is a set of topics**
 - these together define a context
 - this supports provenance, context, and named graphs, plus more

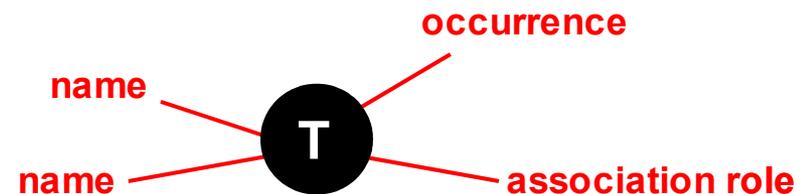
Supporting Context through Scope

- **Topic Maps** are about representing knowledge
- **Knowledge** is not absolute; it has a contextual aspect
- **Context sensitivity** is handled through the concept of **scope**
- **Scope makes it possible to**
 - Cater for the *subjectivity* of knowledge
 - Express *multiple viewpoints* in one knowledge base
 - Provide *personalized views* for different groups of users
 - Track the *source* or provenance of knowledge during merging
 - Record the *usage context* of a name (language, corporate culture, domain, ...)
 - Represent which *authority* claimed that something is true
- **(Scopes are defined as sets of topics)**

How Scope Works

- **Topics have “characteristics”**
 - Its names and occurrences, and the roles it plays in associations with other topics

- **Every characteristic is valid within some context (scope), e.g.**
 - the name “Norge” for the topic Norway in the scope “Norwegian”
 - a certain information occurrence in the scope “technician”
 - a given association is true in the scope (according to) “Authority X”



Filtering by scope

Identity

- **Nodes, in topic maps and RDF, have global identity**
 - that is, there are rules for when nodes *in different graphs* are the same
 - there are also rules for how to merge graphs
- **In RDF there are three cases**
 - blank nodes, which cannot be compared across graphs,
 - URI references, which are identical if the URIs are equal, and
 - literals, which have surprisingly complex rules for identity
- **In topic maps there are also three methods**
 - the rule is: topics are merged if they have the same subject
 - we need more space to discuss how this is determined, however

Identifying information resources

- **Topics representing information resources are easy**
- **Attach a URI to the topic as the *subject locator* of the topic**
- **This means that the topic represents the resource**
- **That is, the resource is the subject of the topic**

```

<topic id="ontopia-hp">
  <subjectIdentity>
    <resourceRef xlink:href="http://www.ontopia.net"/>
  </subjectIdentity>
  ...
</topic>

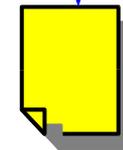
```

Ontopia's homepage



Subject locator

<http://www.ontopia.net>

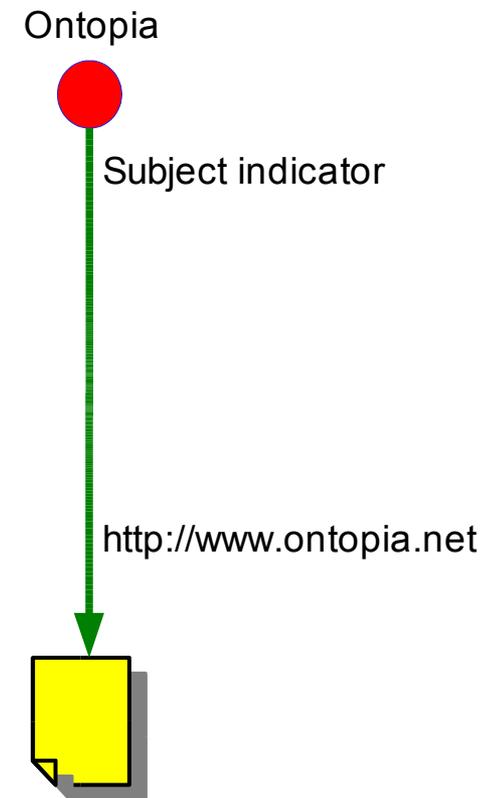


Identifying non-resources

- **Topics representing other things are harder**
 - Concepts do not have URIs
- **Solution:**
 - Create a resource describing the concept
 - Refer to the concept as the description
- **Resource = Subject indicator**

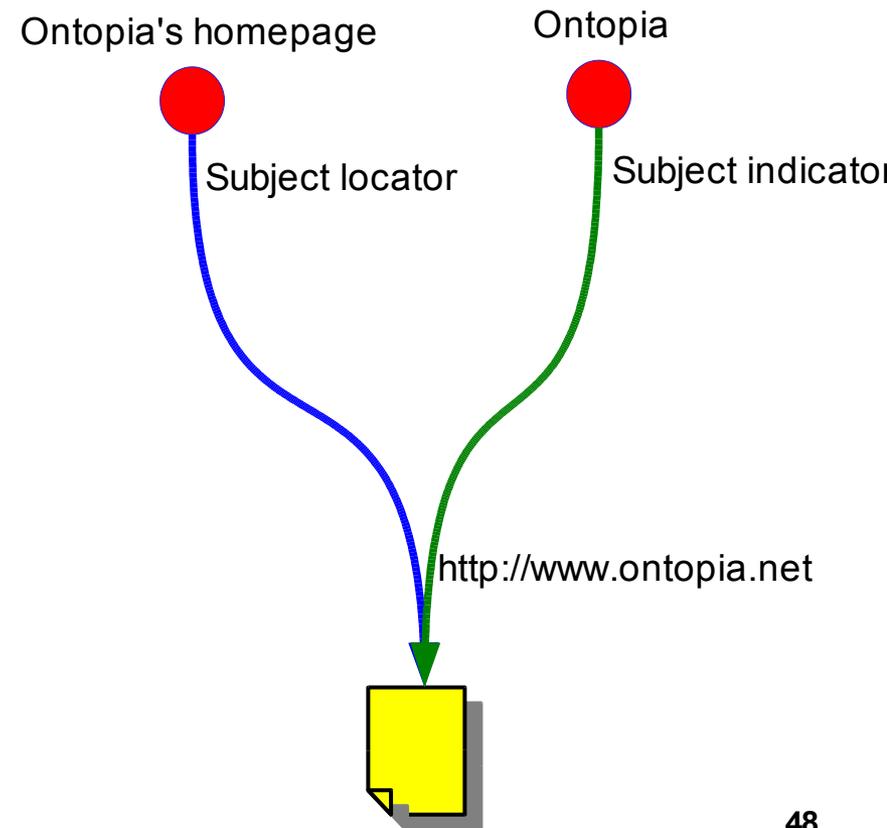
```

<topic id="ontopia-hp">
  <subjectIdentity>
    <subjectIndicatorRef xlink:href="http://www.ontopia.net"/>
  </subjectIdentity>
  ...
</topic>
  
```



Subject locator \neq subject indicator

- **These two topics refer to the same resource, yet remain distinct**
- **This maintains a distinction between**
 - information resources, and
 - everything else
- **In RDF this distinction does not exist**
 - using blank nodes and a `tm:indicator` property it can be approximated
 - however, properties must have URIs
 - this has been the source of much controversy (“identity crisis”, etc)



Merging in topic maps

- **When adding information to a topic map**
 - topics which have the same subject locators or indicators are merged
 - duplicate information is removed
- **Merging two topic maps behaves the same way**
 - effectively the same as adding the information in both into a new map
- **Thus, the same topic can have many identifiers**
 - this expresses the fact that the identifiers identify the same thing
 - different from the RDF approach

Approaches to interoperability



Modelling topic maps in RDF
Model-level mappings
Vocabulary-level mappings

Modelling topic maps in RDF

- **If RDF is lower-level than topic maps, perhaps topic maps can be modelled in RDF?**
- **This means creating an RDF vocabulary for representing topic maps**
- **Many people have tried this approach**
 - *RDF and TopicMaps: An Exercise in Convergence*, Graham Moore, 2001
 - *XML Topic Maps through RDF glasses*, Nikita Ogievetsky, 2001
 - *On the integration of Topic Map data and RDF data*, Martin Lacher and Stefan Decker, 2001
 - *An RDF Schema for topic maps*, Lars Marius Garshol, 2002
- **Basically, it works, but...**

Problems

- **This approach leads to data that**
 - is very heavyweight,
 - is cumbersome to use in RDF,
 - is formulated in terms of the topic map model, rather than the domain vocabulary,
 - interoperates poorly with other RDF data (uses TM vocabulary),
 - is awkward to query with RDQL (uses TM vocabulary),
 - cannot be modelled with RDFS/OWL (uses TM vocabulary)
- **In short, this approach is not the right one**

Finding my creations

SELECT ?c

WHERE (?m, <foaf:name>, “Lars ...”),
 (?c, <dc:creator>, ?m)

SELECT ?c

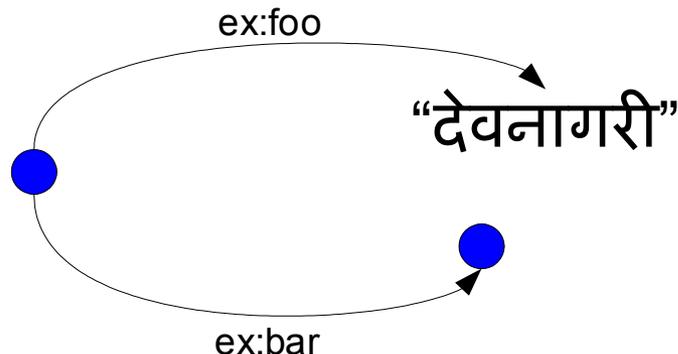
WHERE (?m, <tm:basename>, ?n),
 (?n, <tm:value>, “Lars ...”),
 (?r1, <tm:player>, ?m),
 (?r1, <rdf:type>, <:creator>),
 (?a, <tm:role>, ?r1),
 (?a, <rdf:type>, <:created-by>),
 (?a, <tm:role>, ?r2),
 (?r2, <rdf:type>, <:creation>),
 (?r2, <tm:player>, ?c)

The ideal conversion result

- **Ideally, conversions should produce result data formulated in the same vocabulary as the source data**
- **That is, if the source data is defined in terms of**
 - document, title, creator, person, email address
- **...it would be nice if the result also were, instead of being defined as**
 - topic, base name, association, topic, occurrence
- **Also, tools applicable to the source data should, if similar tools exist for the target technology, be equally applicable to the result data**
- **With that in mind, let's look at a different approach**

Model-level mappings

- **Given how close topic maps and RDF are, it seems it should be possible to create model-level mappings**
 - That is, it should be able to relate RDF model constructs into topic map constructs
 - Converting RDF into topic maps would then be simple, given some basic conventions
- **To some extent this works**
 - RDF nodes and topics are almost the same
- **Reality check:**
 - what does the first statement below map to? base name? occurrence?
 - and the second? association? occurrence?



Vocabulary-level mappings

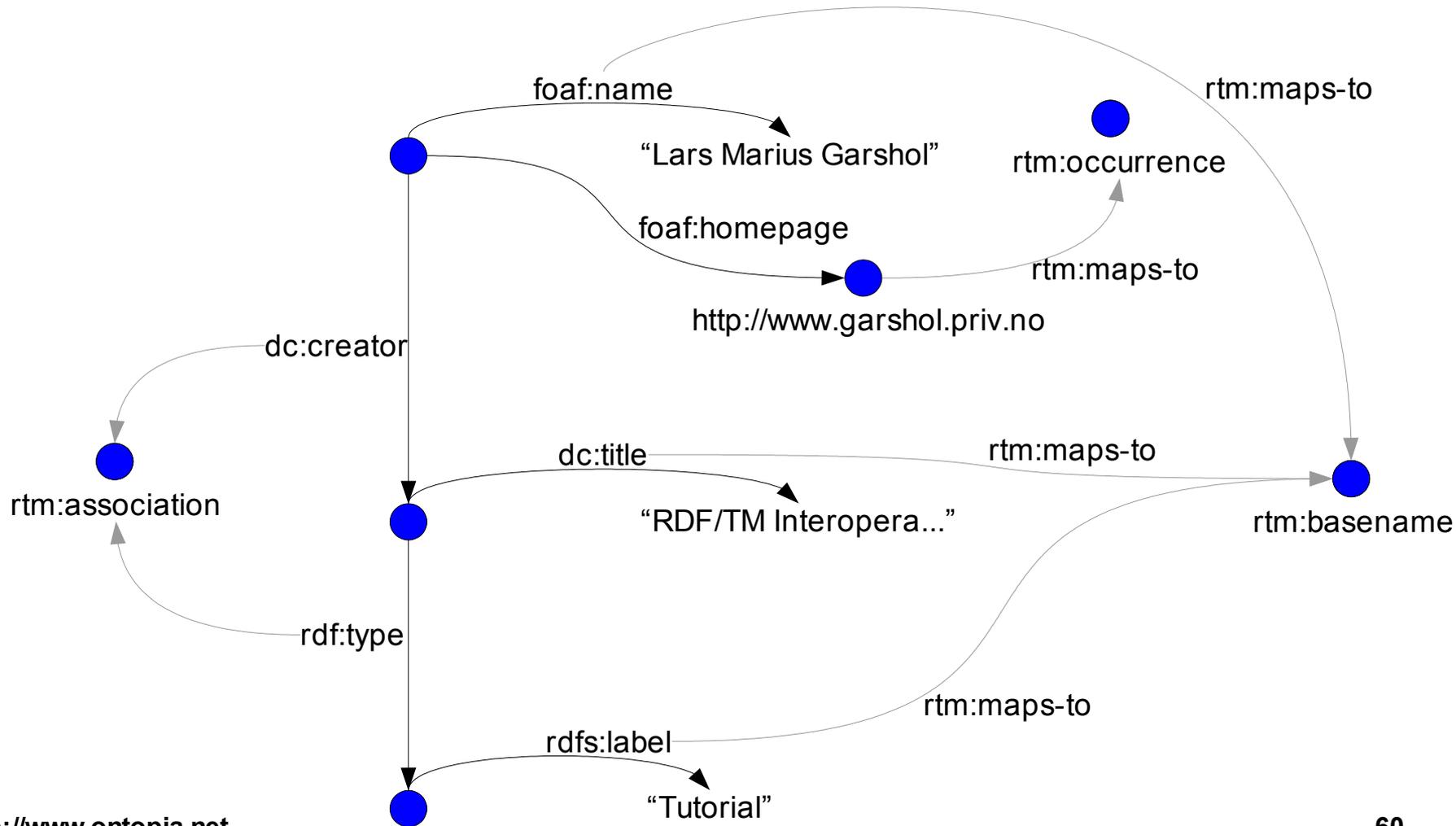
- **However, if we knew the meaning of ex:foo and ex:bar we would be able to do the mapping**
 - We would know whether ex:foo is a name or an occurrence
 - Similarly, whether ex:bar is an occurrence or an association
- **So, what if we created vocabulary mappings?**
 - for each property we could declare what it mapped to
 - the declarations could be RDF statements
- **This is what the RTM (RDF-to-TM) vocabulary does**

How the mapping works

- **For each statement, create a topic for the subject**
- **If the subject has a URI, set that as the subject indicator**
- **Look at the <rtm:maps-to> property on the predicate to see what to map it to**
- **Other properties supply more information, as shown on right**

Mapping to	Information needed	Legal node types
Name	Scope	Literal
Occurrence	Scope, type	Literal, URI
Association	Scope, type, roles	URI, blank
Subject locator		URI
Subject indicator		URI

Example



The RTM vocabulary

- **The namespace is `http://psi.ontopia.net/rdf2tm/#`**
- **Core property: `rtm:maps-to`**
 - domain: `rdf:Property`, range: `rtm:Construct`
 - values
 - `rtm:basename`
 - `rtm:occurrence`
 - `rtm:association`
 - `rtm:instance-of`
 - `rtm:subject-identifier`
 - `rtm:subject-locator`
 - `rtm:source-locator`
- **Additional property: `rtm:type`**
 - domain: `rdf:Property`, range: `rdfs:Resource`
 - type of created topic characteristic defaults to topic representing property
 - this property can be used to override the default

The RTM vocabulary (2)

- **The rtm:in-scope property**
 - domain: rdf:Property, range: rdfs:Resource
 - repeatable; used to attach fixed scoping topics to the created characteristic
 - mainly used to attach scope to base names
- **The rtm:subject-role property**
 - domain: rdf:Property, range: rdfs:Resource
 - required for properties mapped to associations
 - sets the role played by the topic that is the subject of the RDF statement
- **The rtm:object-role property**
 - domain: rdf:Property, range: rdfs:Resource
 - required for properties mapped to associations
 - sets the role played by the topic that is the value of the RDF statement

Exercise #1

- **Start the Omnigator**
- **Go to <http://localhost:8080/omnigator/>**
 - then click on `example.rdf`
- **Use the RDF2TM plug-in to configure the mapping**
 - it must be turned on: go to Manage, then Plug-ins
- **Then reload the file to see the results of your mapping**
- **Keep tuning the mapping until you get it right**
- **Look at the mapping file to learn how it works**
 - `OMNIGATOR/jakarta-tomcat/webapps/omnigator/WEB-INF/topicmaps/mapping.rdff`

Exercise #2

- **Extend the mapping.rdff file with mappings for the FOAF vocabulary**
 - manually, that is
 - note that for associations you must supply the role types...
- **Key properties**
 - foaf:name
 - foaf:mbox
 - foaf:homepage
 - foaf:knows
- **Copy foaf.rdf to the topicmaps directory**
- **Go to “Manage”, press “Refresh sources”**
- **Then click foaf.rdf to see the result**

Learning topic maps



The XTM and LTM syntaxes

Topic Map Syntaxes

- **HyTM (HyTime Topic Maps)**
 - Topic Maps as originally defined by ISO
 - An architecture expressed in terms of SGML and HyTime
 - *Will be left out of the next version of ISO 13250*
- **XTM (XML Topic Maps)**
 - Defined by TopicMaps.Org in 2001 and later adopted by ISO
 - Uses XML and Xlink
 - Will become ISO 13250-2: Topic Maps – XML Syntax
 - *Easy to understand but very verbose*
- **LTM (Linear Topic Map Notation)**
 - Defined by Ontopia in 2001
 - Also supported by TM4J and Perl::XTM
 - *A simple text syntax for rapid prototyping*

Topic Maps: XTM Syntax

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<topicMap
  xmlns="http://www.topicmaps.org/xtm/1.0/"
  xmlns:xlink="http://www.w3.org/1999/xlink"
>

  <!-- topics, associations, and mergeMap elements go here -->

</topicMap>
```

Topic Maps: LTM Syntax

```
/* topics, associations, and occurrences go here */
```

Exercise #3

- **Create an LTM file in the topicmaps directory**
 - choose whatever name for it you like, but make the extension .ltm
 - write a nice comment at the top
- **Go to the Manage page, press Refresh Sources**
- **Enter the topic map and see that it is empty**

Topics: XTM Syntax

```
<topic id="italy">
```

```
...
```

```
</topic>
```

```
<topic id="puccini">
```

```
...
```

```
</topic>
```

Topics: LTM Syntax

[italy]

[puccini]

Exercise #4

- **Create two topics in the topic map**
 - one for yourself
 - one for the class 'person'
- **Use the reload plug-in in the Omnigator to see the result**

Topic Names: XTM Syntax

```

<topic id="la-scala">
  <baseName>
    <baseNameString>Teatro alla Scala</baseNameString>
    <variant>
      <parameters>
        <subjectIndicatorRef
          xlink:href="http://www.topicmaps.org/xtm/1.0/core.xtm#display"/>
        </parameters>
        <variantName>
          <resourceData>La Scala</resourceData>
        </variantName>
      </variant>
      <variant>
        <parameters>
          <subjectIndicatorRef
            xlink:href="http://www.topicmaps.org/xtm/1.0/core.xtm#sort"/>
          </parameters>
          <variantName>
            <resourceData>scala, teatro alla</resourceData>
          </variantName>
        </variant>
      </baseName>
    </topic>

```

Topic Names: LTM Syntax

[topic-id = basename; sortname?; dispname?]

`[la-scala = "Teatro alla Scala"; "scala, teatro alla"; "La Scala"]`

Exercise #5

- **Add a name for yourself, with a sort name if you like**
- **Also add a name for the 'person' class**
- **Reload and view**

Topic Types: XTM Syntax

```
<topic id="opera">
```

```
  ...
```

```
</topic>
```

```
<topic id="tosca">
```

```
  <instanceOf>
```

```
    <topicRef xlink:href="#opera"/>
```

```
  </instanceOf>
```

```
</topic>
```

```
<topic id="boito">
```

```
  <instanceOf>
```

```
    <topicRef xlink:href="#composer"/>
```

```
  </instanceOf>
```

```
  <instanceOf>
```

```
    <topicRef xlink:href="#librettist"/>
```

```
  </instanceOf>
```

```
</topic>
```

Topic Types: LTM Syntax

[topic-id : topic-type = basename; sortname?; dispname?]

[tosca : opera]

[boito : composer librettist]

Exercise #6

- **Make yourself an instance of the 'person' class**
- **Reload and view**

Subject identity: XTM Syntax

```
<!-- Refer to a resource as subject: -->
```

```
<topic id="foo">  
  <subjectIdentity>  
    <resourceRef xlink:href="http://www.ontopia.net"/>  
  </subjectIdentity>  
  <baseName>  
    <baseNameString>The Ontopia Website</baseNameString>  
  </baseName>  
</topic>
```

```
<!-- Refer to a subject indicator: -->
```

```
<topic id="bar">  
  <subjectIdentity>  
    <subjectIndicatorRef xlink:href="http://www.ontopia.net/about.html"/>  
  </subjectIdentity>  
  <baseName>  
    <baseNameString>Ontopia</baseNameString>  
  </baseName>  
</topic>
```

Subject identity: LTM Syntax

```
[topic-id = names %subject-locator-URL]
```

```
[topic-id = names @subject-indicator-URL]
```

```
/* Refer to a resource as subject: */
```

```
[foo = "The Ontopia Website" %"http://www.ontopia.net" ]
```

```
/* Refer to a subject indicator: */
```

```
[bar = "Ontopia" @"http://www.ontopia.net/"]
```

Exercise #7

- **Add a subject indicator for the person topic**
 - `http://xmlns.com/foaf/0.1/Person`
- **Reload the topic map to see the result**

Occurrences: XTM Syntax

```

<topic id="la-boheme">
  <occurrence>
    <instanceOf><topicRef xlink:href="#homepage"/></instanceOf>
    <resourceRef
      xlink:href="http://www.opera.it/Opere/La-Boheme/La-Boheme.html"/>
    </occurrence>
  <occurrence>
    <instanceOf><topicRef xlink:href="#premiere-date"/></instanceOf>
    <resourceData>1896 (1 Feb)</resourceData>
  </occurrence>
</topic>

```

Occurrences: LTM Syntax

```
{topic-id, occurrence-type, (URL | data)}
```

```
{la-boheme, homepage,  
  "http://www.opera.it/Opere/La-Boheme/La-Boheme.html"}  
{la-boheme, premiere-date, [[1896 (1 Feb)]]}
```

Exercise #8

- **Add topics 'phone' and 'mbox'**
- **Give them subject indicators in the FOAF namespace**
- **Then add for yourself**
 - an mbox occurrence with your email address as a mailto: URI
 - a phone occurrence with your phone number in it as a string
- **Reload topic map and view**

Associations: XTM Syntax

```
<association>
  <instanceOf><topicRef xlink:href="#composed-by"/></instanceOf>
  <member>
    <roleSpec><topicRef xlink:href="#composer"/></roleSpec>
    <topicRef xlink:href="#puccini"/>
  </member>
  <member>
    <roleSpec><topicRef xlink:href="#work"/></roleSpec>
    <topicRef xlink:href="#tosca"/>
  </member>
</association>
```

Associations: LTM Syntax

```
assoc-type ( role-player : role-type, role-player : role-type )
```

```
composed-by( puccini : composer, toska : work )
```

```
born-in ( puccini : person, lucca : place )
```

```
composed-by( puccini, toska )
```

```
born-in ( puccini, lucca )
```

Note: When omitted, the role type will be assumed to be identical to the type of the role playing topic. This can be a useful short-hand, but it is not always what you want.

Exercise #9

- **Add a new person, someone you know**
- **Add a new topic 'knows'**
- **Create an association between you and the person you know**
 - you can both play the role 'person'
- **Reload to see the result**

From topic maps to RDF



From house to bricks

Going the other way

- **Given that we must add information to go from RDF to topic maps, one should expect that going the other way would be painless**
- **Not so**
- **There are a few things one needs to know**
 - which properties are used to represent names?
 - what to do with scope?
 - what direction should binary associations take?
- **However, this can be solved in a similar way**
 - attach the necessary information as declarations
 - represent them in the topic map itself

Rough algorithm

- **Each topic becomes an RDF node**
 - if it has a subject locator, that becomes the URI
 - if not, but it has a subject indicator, that becomes the URI
 - if it has neither it becomes a blank node
 - additional subject indicators are handled with owl:sameAs
- **Base names become RDF statements**
 - the property is chosen using the name-property association for the topic type
- **Occurrences become RDF statements**
 - the property is the occurrence type
- **Binary associations become RDF statements**
 - the preferred-role association is used to decide which role player is the subject; if missing one is chosen at random
- **N-ary associations become RDF nodes**
 - type recorded with rdf:type
 - each role becomes a statement; property is role type; player is value

Reification and scope

- **This is the hardest bit to handle**
- **Current solution**
 - reification represented using RDF reification
 - scope represented using RDF reification and a special tm2rdf:scope property
- **The problem with this is that it's horribly verbose**
 - options in Ontopia exporter to enable/disable this
- **Interestingly, various RDF extensions would solve the scope part**
 - however, RDF/XML does not support this...

The TMR vocabulary

- **Namespace:** <http://psi.ontopia.net/tm2rdf/#>
- **name-property**
 - name-property(rdf-Property : type, rdfs-Label : property)
- **preferred-role**
 - preferred-role(subclass-of : association-type, subclass : role-type)?

Exercise #10

- **Add a topic 'name', and create subject indicator for it in the FOAF namespace**
- **Add an association making 'name' the name property for 'person' topics**
- **Export the result as RDF using the 'Export' plug-in, and study the result**

Schema-level interoperability

- **We've now covered data interoperability, which is the most important part**
- **However, schema interoperability is also important**
 - Life becomes much simpler if schemas do not have to be rewritten by hand
- **The topic map standard corresponding to RDFS and OWL is Topic Maps Constraint Language (TMCL)**
 - This standard is not yet finalized, however
- **We will consider how to preserve RDF schema information in topic maps**
 - The opposite will have to wait until TMCL is ready

A quick look at TMCL

- **The TMCL standard is still being worked on**
- **Declarative constraints in a specialized syntax**
 - these are restrictions on what may be said in the topic map
 - violations are returned in a structured form
- **Can be used to**
 - validate a topic map
 - filter a topic map (ie, return only what is valid)
 - learn about the structure of the topic map
- **Only the basic part has been worked on so far**
 - OWL-like features may be added once the core is in place

Converting RDF Schema

- **The classes are easy: we can just let them be converted directly**
- **The properties need to be mapped, however**
 - rdfs:label Maps to base name
 - rdfs:comment Maps to occurrence
 - rdfs:subClassOf Maps to association (should have its type translated)
 - rdfs:domain Maps to association
 - rdfs:range Maps to association
 - rdfs:isDefinedBy Maps to occurrence
 - rdfs:seeAlso Maps to occurrence
 - rdfs:subPropertyOf Maps to association
- **This mapping preserves the RDFS structure in a topic map, but requires validation logic to be implemented on the topic map side**

RDF Schema validation using queries

- **A crude way to implement RDFS validation in TMs is using queries**
- **Queries can be written to find**
 - all topic characteristics belonging to a topic of a type that is not in the domain of the characteristic's type
 - all topic characteristics whose value does not match the range of the characteristic's type
- **This is quite limited, of course, but then RDFS *is* quite limited**

A quick look at OSL

- **Ontopia Schema Language – Ontopia's short-term schema language**
- **Simple constraint language reminiscent of DTDs**
 - constraints on topic classes and association classes
 - cardinality constraints on characteristics and their types and scopes
 - no ordering, no conditionals, no data typing
- **Has proven itself to work, but not seen wide use**

Converting RDF Schema to OSL

- **Possible, and actually quite easy**
- **rdfs:Class becomes a topic class**
 - properties whose domain is that class get class constraints
 - rtm:maps-to is used to work out what type of constraint to create
 - rtm:in-scope could be used to add scope rules
- **Properties that map to rtm:association become association classes**
 - role constraints set using rtm:subject-role and rtm:object-role

Converting OWL

- **OWL consists of many different kinds of statements which must be handled differently**
- **Metadata**
 - this is just instance-level statements, and can be converted easily
- **Restrictions**
 - value, cardinality, and disjointness; these can be converted, too
 - some of it might go into the RDF Schema-to-OSL conversion
- **Semantic annotations**
 - these are more problematic; not all are needed in topic maps

Query languages



RDQL
TMQL
tolog

The state of standardization

- **W3C Data Access WG**
 - working on RDF query language
- **Current draft: SPARQL**
 - based on RDQL
 - very simple graph-matching language
 - inferencing to be done in level below querying
- **ISO 18048: TMQL**
 - to become standard topic map query language
- **No draft yet**
 - to be based on tolog
 - basic outline already known
 - graph-matching with inference
 - also path capabilities
 - also output construction ability a la XQuery

tolog

- **Ontopia's topic map query language**
 - Basically Datalog adapted for use with topic maps
 - Has been in use for ~2 years
 - Drives a number of commercial applications
 - Also implemented in the open source TM4J engine
- **Basic features**
 - Graph matching (Datalog clauses)
 - AND/OR/NOT support in query body (and rule bodies)
 - Inference rules
 - Aggregate functions (a la SQL)
 - Sorting (a la SQL)
- **Coming extensions**
 - String predicates and comparator predicates

Standards family harmonization

- **SPARQL and tolog share a common core**
 - the graph matching part
- **RDF querying can be done in tolog**
- **In theory it is possible to create a common standard**
- **In practice the political will to do so appears to be wholly missing**

Cross-query example

- **A cross TM/RDF query:**
 - using foaf for "http://xmlns.com/foaf/0.1/" as rdf
xc for "http://psi.ontopia.net/xmlconf/#" as indicator
 - select \$B from
 - foaf:mbox(\$A, "mailto:larsga@ontopia.net"),
 - foaf:knows(\$A, \$B),
 - foaf:mbox(\$B, \$BMAIL),
 - xc:email(\$BTM, \$BMAIL),
 - xc:employed-by(\$BTM : xc:employee, \$C : xc:employer),
 - xc:homepage(\$C, "http://www.empolis.com")?
- **Note the use of the email address to do the join across the TM/RDF boundary**

Translating SPARQL queries with RTM

SELECT ?c

WHERE (?m, <foaf:name>, “Lars ...”),
 (?c, <dc:creator>, ?m)

SELECT

\$C
FROM
 name(\$M, “Lars Mar...”),
 dc:creator(\$M : creator, \$C :
 creation) ?

What the future holds



SWBPD
OWL/TMCL
Query languages

SWBPD

- **Within the Semantic Web Best Practices [...] Working Group a Task Force is being set up to work on TM/RDF interoperability**
 - most likely it will build on the RTM approach
 - not clear yet exactly what the scope of the work will be
 - there may be 2-3 TFs, we don't know yet
- **The task force is currently looking for participants**
 - <http://www.w3.org/2001/sw/BestPractices/RDFTM/>
 - to join, you must be a member of W3C and SWBPD WG
 - most likely it will be created during the upcoming November 18 telecon

OWL/TMCL

- **OWL is done, so there's unlikely to be any TM-related changes to it**
- **TMCL is being created, but with a different focus**
 - focus is much more on validation
 - also some on declarative semantics
 - once the core is done we may work on adding OWL-like features
 - mapping to OWL is likely to be known when TMCL is created

Query languages

- **SPARQL and TMQL are being created in parallel at the moment**
- **There is unlikely to be any work on interoperability or harmonization here**
 - Main reason: lack of political will
- **However, it's not clear whether interoperability work really is needed**

Thank you!

- **The slides from this talk**
 - <http://www.ontopia.net/topicmaps/materials/iswc-2004-tutorial.pdf>
- **About topic maps**
 - <http://www.topicmap.com> (English)
 - <http://www.knowledge-synergy.com> (Japanese)
- **Topic maps standardization**
 - <http://www.isotopicmaps.org>
- **About RDF and topic maps (RTM, TMR, +++)**
 - <http://www.ontopia.net/topicmaps/materials/tmrdf.html>
- **The Omnigator**
 - <http://www.ontopia.net/omnigator/>
- **Questions**
 - <larsga@ontopia.net> (English)
 - <motom@green.ocn.ne.jp> (Japanese)