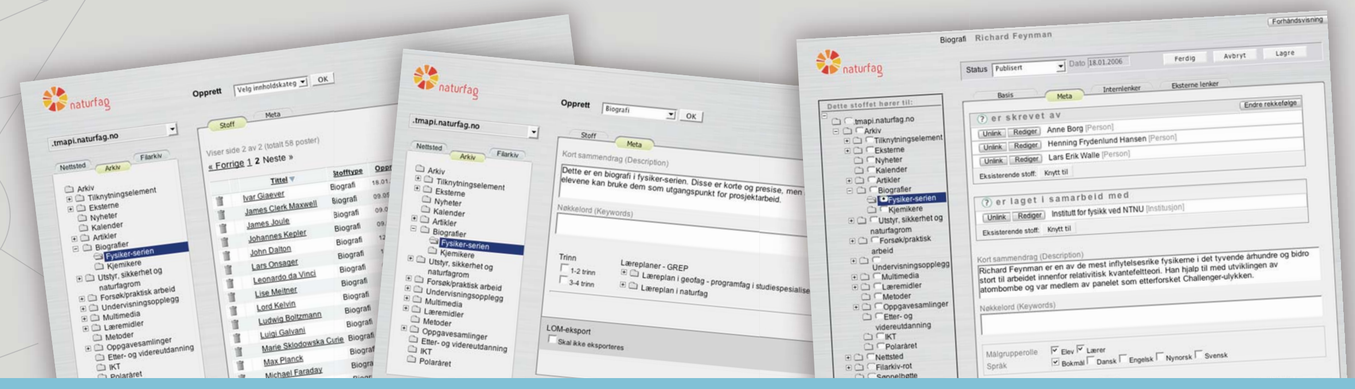


Ontology Driven Strategy for Inference of Learning Object Metadata

We needed to export learning objects metadata in LOM format for a large number of learning resources (topics) maintained in our CMS. The LOM records are used in Learning Management Systems (LMS) and in portals for educational resources.

The learning resources span 200 different e-learning web sites and over 200,000 topics in three different topic maps with different onto-logies, thus requiring some sort of flexible solution.

Why?

Our existing metadata was not modelled with LOM in mind. Manual registration of LOM-specific metadata (or metadata in LOM format) would be prohibitively expensive and time consuming. The relevant data that exists are not necessarily in proper LOM format.

We should be able to infer most of the necessary metadata from our existing ontology.

The rules of inference should be part of the topic map. Should be easy to understand and maintain.

How?

We suggest placing metadata and inference strategies into the topic map to

- provide precise and specialized LOM records based on our existing ontology
- simplify registration and maintenance of metadata
- facilitate flexible models for describing the rules
- allow reuse of inference rules
- provide mapping and inference of metadata in a predictable and understandable fashion
- minimize manual efforts

Our case for implementing this was export of metadata for LOM (NorLOM), but the method is also usable for export of metadata in other forms.

Reuse of data and semantic relationships

Since all learning objects are topics in our CMS and are associated to existing structures in some way, we can make use of these relationships to

- infer facts about learning resources which can be used to generate metadata
- organize the rules of metadata inference for easy maintenance
- provide simple "inheritance" of rules and values in hierarchical relationships

In addition we must allow metadata not only to be assigned to learning objects, but also to more structural elements in the topic map.

Leveraging aspects of the existing ontology

Several types of structures are meaningful in this regard:

- Topic type (instance-of), which is part of a type hierarchy. May imply type of learning object
- Structures related to web publishing: Navigation, by-lines, dates, sizes etc
- Structures from the textbook: Parts, chapters, sub chapters. May imply educational dependencies and will group together similar learning objects.
- Shared ontologies like the Norwegian national curriculum (GREP).
- Organizational structures. E.g. department may imply subject, author, copyright information.
- Domain-based taxonomies and vocabularies.
- Site-specific grouping mechanisms
- Language, contributing organizations, persons, etc.

Other types of existing metadata

Besides associations and type hierarchies, the topic map contains textual data in names and occurrences that may be transformed and used in generation of LOM metadata.

Most metadata available in the CMS are not immediately compatible with the requirements of the LOM standard. The required transformations might be simple formatting operations or complex transformations combining data from several sources (i.e. parts of the topic map).

LOM elements treated separately

To simplify our data model and implementation, we treat each LOM element (e.g. "General/Description") separately. The LOM elements are each represented with a topic in our topic maps, with the structure of the complete LOM record represented by associations (which can be used to assemble a complete LOM record for a learning resource).

Rules describe LOM element assembly

Rules are topics in our topic maps.

Rules are relatively simple descriptions of how to assemble a particular LOM element for learning resources that fulfil certain conditions.

Rules may be expressed in a query language like Tolog, or may contain more elaborate pieces of code, that the underlying system is able to evaluate.

As an example, in a straightforward case a rule may be a simple concatenation of strings from occurrences of the learning resource topic. In a more complex case several queries would have to be made or other code evaluated.

In our implementation, we have preferred simple rules before more complex wherever possible.

Deferring rule evaluation

A rule may defer its work, indicating that it does not have the relevant information for this learning resource – LOM element. I.e. the rule was not appropriate for this case; the query did not return a result. In this way, a rule may contain additional constraints or conditions for its evaluation.

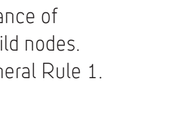
Representing conditions for the rules in the topic map

We have chosen to relate the rules to constructs in our topic map.

The rules, or rather the conditions that must be met for a rule to be valid, are partly defined by their n-ary associations to the existing topic map, using association types and role types to represent the types of conditions and validity of the rules.

If the structures we are traversing at the time of metadata generation are hierarchical, resources can be said to "inherit" policies for metadata inference based on the semantics in the topic map. This makes for a convenient way to organize a multitude of rules using the existing ontology as the organizing principle.

GREP – a topic map of the curriculum



- The Norwegian Education Directorate has created a standardized representation of the national curriculum as a topic map, called "GREP".
- NorLOM in supposed to use the GREP ontology for classification of learning objects
- The content providers in our example use GREP as an important classification vehicle. Like the other tools for meta tagging, this is an integrated part of the CMS.
- Different content distributors (CMS, portals) will use the same standardized classification for retrieval.

Significant rule evaluation order

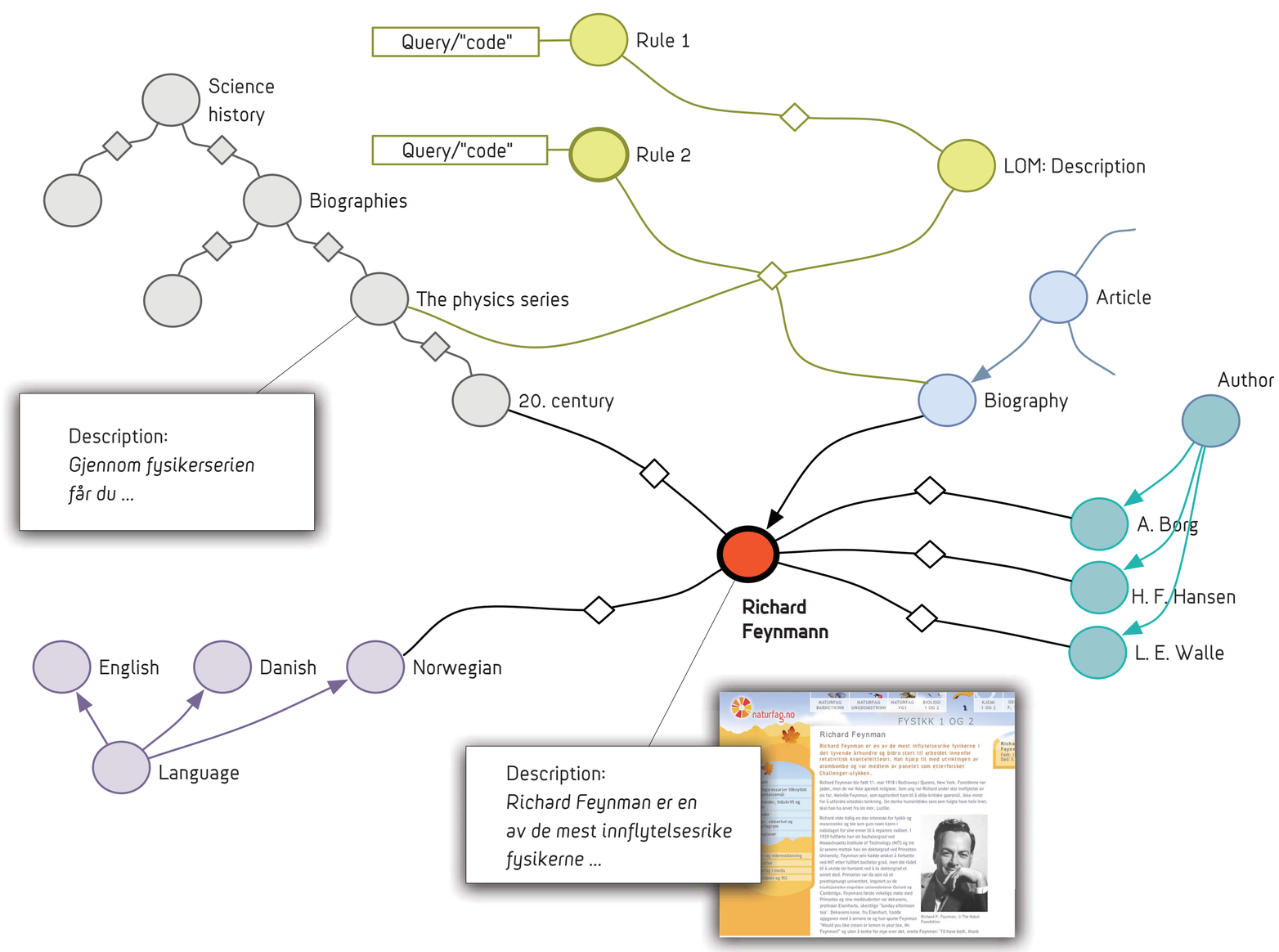
With distributed rules associated to the existing topic maps, the underlying system must do a search for relevant rules when the time for metadata generation comes. This is implemented with system wide knowledge of the priority of the different conditions (association types and role types).

Typically evaluation order will assure that more specific rules are evaluated before more general rules.

Example of general/specific rule

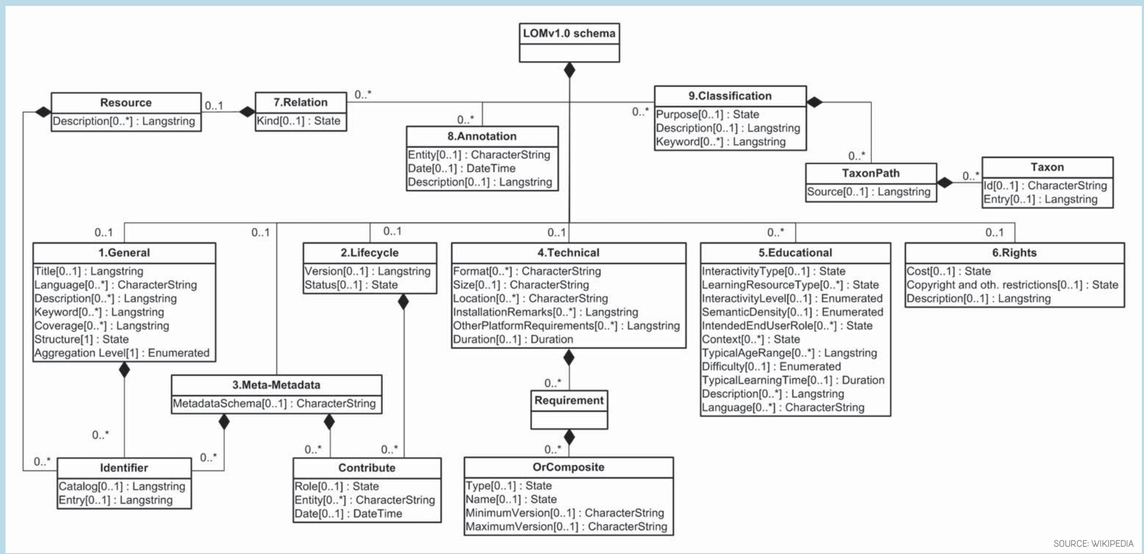
Many of the e-learning web sites in question, use some sort of tree-like structure for web navigation (represented as topics and associations). This allows us to group the relevant rules in a natural way. The figure shows a simple example for the LOM element "General/Description". "Rule 1" represents the general rule.

Our example learning resource is a biography about the physicist Richard Feynman. The Feynman biography is associated with a topic ("20th century") in a tree structure. "Rule 2" applies to the LOM element "General/Description" and to topics that are instance of "Biography" and that are associated with "The physics series" or any of its child nodes. Rule 2 being a specialized rule is evaluated with greater priority than the general Rule 1.



LOM – Learning Object Metadata

- IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata
- Usually encoded in XML (IEEE 1484.12.3), though IEEE 1484.12.4 describes representation in RDF.
- Defines the structure of a metadata instance used to describe learning objects and is defined by data elements, their data type, their value space, and a hierarchy of elements.
- Several application profiles: UK LOM Core, CanCore, NorLOM etc.
- Our LOM-export module generates NorLOM; a Norwegian application profile.



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