Learning Objects Metadata and Tools in the Area of Operations Research

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Abstract: Information technology and the Internet are making inroads into almost all areas of our society. The requirements of students and professionals are fast changing, the information society requires lifelong learning in practically all areas, especially those related to information technologies. The educational sector can profit in particular from the benefits IT adds to the ways of learning. The core techniques exists, still the integration into the curricula and the integration of learning environments and traditional knowledge management systems and libraries cannot keep up with the pace of technology development. This article focuses on the use of so called 'learning objects' in the field of Operations Research and Management Science (OR/MS). Learning objects refer to pieces of information of different granularity which can be combined, linked and reused. We will demonstrate some of the concepts mentioned above by the LOM editor of the Technical University of Darmstadt and prototype systems developed in the project OR-World of the University of Paderborn and give an outlook on the future development.

1 Introduction

The idea of learning objects follows a constructivistic view of learning where students actively construct knowledge rather than are being taught by a teacher. Web environments can be considered as an ideal platform for persons holding this frame of mind. Though a traditional web based approach (HTML) is a first step into the right direction, it is not optimal in terms of structure, consistency and manageability. If we consider large scale systems with a very large amount of documents, authors need tools to assist them while creating and maintaining educational material. On the other hand readers often get lost when retrieving documents, the amount of hits often turns out to be irrelevant. The flat description model which HTML offers is not precise enough to allow an efficient search and retrieval process. Due to the lack of support for efficient structuring, retrieval, and linking among very large amounts of documents by standard Web technologies, namely HTML, new technologies which allow a more sophisticated retrieval method, such as a structured Metadata approach, are emerging. In the context of learning objects the Learning Object Metadata standard (LOM) is widely accepted and becomes more and more important (see section 3 for further details, other examples for Metadata classifications are Dublin Core or IMS).

HTML is not consequently separating content, structure and representation of a document. Furthermore HTML is not extensible by additional tags. If we think of learning objects, other tags than “heading” or “bold” for example are desirable. The tagging of learning objects with specialized tags is simply not possible in HTML. Links among documents can only be defined as untyped, unidirectional links. In order to minimize maintenance efforts and costs it would be desirable to use single source documents (e.g. in the form of XML documents) published on demand in a format of one's choice (e.g. HTML, paper, e-book, WAP, etc.). A dedicated markup language stores structured document information besides the content and enables the rendering of different representations of the source document. This way the maintenance costs for material can be decreased and the material can be made available to different people with adaptive views. Open technologies standards such as XML and dedicated markup languages for documents offer the chance of constructing content which can be (re)used by people independent of their location.

The standardization of metadata descriptions has the effect that tools dealing with metadata descriptions become universally applicable. LOM and IMS are excellent examples that a widely used specification which is accepted as a standard can promote immensely to the exchange of data.

2 OR-World

After being developed since about 40 years, contents of OR/MS have reached a high level of maturity. The basic algorithmic and modeling techniques form a stable core of the discipline, whereas implementation issues develop rapidly with new perspectives offered by information technology. This justifies the high amount of developing effort necessary to create such systems. The core contents are well-suited for hypermedia learning because they essentially consist of processes and algorithms, thus implying a dynamic nature. While the dynamics cannot be fully represented in paper-based books, it can very well be illustrated interactively by animations on a computer screen.

The knowledge domain OR/MS is highly interrelated, basic algorithms and methods can be applied to practical problems in varying contexts. Thus, in a graphical representation of the knowledge domain, a graph instead of a strict hierarchy would be drawn. A previous structuring of a content area is helpful for building the links among objects in a hypermedia network. Because OR/MS is already well-structured, it is very suitable for the representation within OR-World.

OR-World is funded within the Fifth Framework Programme of the European Community. The goal of the project is to develop a hypermedia network of learning objects where:

- Each object is well described by a Metadata description.
- Object granularity from media elements to thematic metastructures can be stored.
- Objects can be reused in the sense of combining objects of lower granularity to objects of higher complexity.
- Dedicated Document Type Definitions for different types of objects are available.
- Renderings in varying target formats can be generated by the system (see [OR-World 2000] for further details.

LOM is highly accepted and will be used for the Metadata description of our learning objects in the project. The advantage of a data centered, standardized approach is obvious: An externally developed editor such as the LOM editor of TU Darmstadt can be integrated in OR-World without many hassles. The interfaces to the files/databases where the descriptions are stored may have to be adjusted but the basic data structure is fixed. This way the efforts in

software development can be focused on building stable software components which can be reused just like the documents created in the standardized format.

Core technologies such as XML and XSL lay the foundations on which applications can be built. Metadata description is not the only application which can be imagined. One of the main drawbacks of HTML is that one kind of general document template serves to represent the whole variety of imaginable documents from small fragments to articles, books, etc. On a micro level, documents differ significantly in their structure. Within the project dedicated document type definitions for the varying granularities of learning objects will be developed. Currently document type definitions for large documents such as books or technical documentations are available. One example is the docbook DTD which stems from SGML but is also available for XML [Docbook 2000]. Media elements differ significantly in their structure from case studies, tests etc. and for optimal use this has to be reflected in the applied document structure. XML and XSL in this sense are just a means to specify the desired behavior. The structure of documents in the learning context still has to be defined. When a set of document type definitions will be available, the documents built consistently on these definitions can be rendered in different visual representations. Most obvious examples are renderings in the HTML or Acrobat PDF format. We use standard technologies from the XML Apache project [Apache XML 2000], see Figure 1 for a visualization of the process.

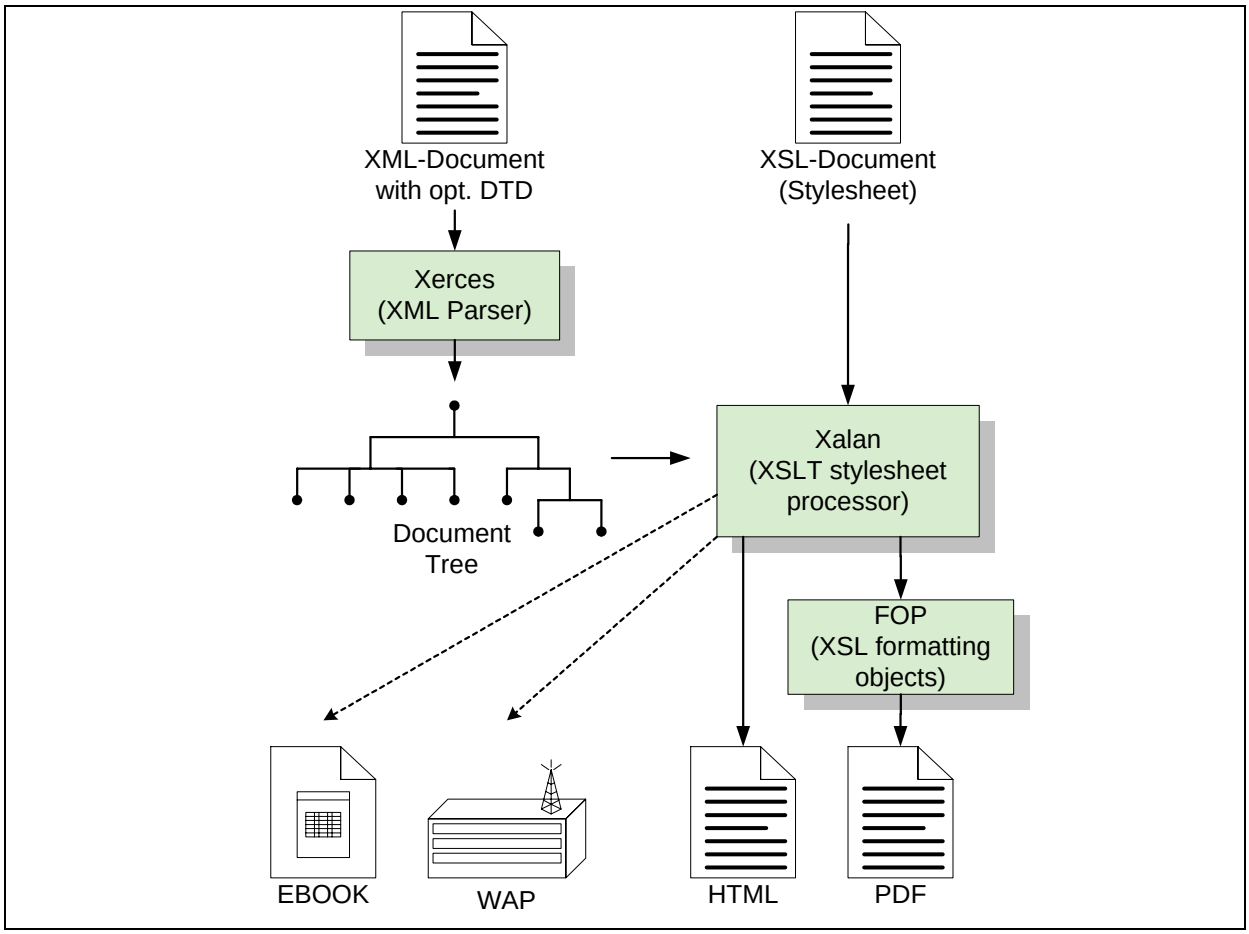

Figure 1: Process of generating varying renderings for XML source documents

The output format can also be varied in terms of extent. A case study for example can reveal more and more details or hints of the case. This allows students to approach a case gradually and helps them to solve the case finally.

Besides the rendering an interesting point is that information to be stored in the metadata description according to LOM is already existing in a structured document. E.g. the title or

author are often stored in the source document. Since the metadata description is physically another entity a mechanism to derive metadata information from the document to be described would be very useful. Most authors in our experience find it annoying to complete the task of setting up the Metadata appropriately. This is correlating to the experiences the TU Darmstadt made and since the appropriateness of the Metadata information determines its value the ease of use is a crucial issue.

3 LOM Editor

In the following we describe the tool that we use to create metadata. The tool can be used to publish metadata records for various resources, e.g. documents, images, audio clips, videos, animations, virtual reality worlds, or multimedia exercises. A metadata record consists of a set of elements, describing a multimedia resource. Examples of these elements are date of creation or publication, type, author, format, or title of a resource.

To access and discover multimedia information resources in a comfortable way, we developed a user-friendly tool, the LOM editor (Figure 2), based on the IEEE-LOM scheme version 4.1. IEEE's specification of Learning Object's Metadata (LOM) defines the following nine categories for metadata of a learning object which will be described in detail because of their importance for our paper. Each of these categories groups appropriate metadata fields of a specific aspect:

- General: General metadata, such as the title, language, structure, or description of a LO
- Life Cycle: Status, version, and role of a LO
- Meta MetaData: Metadata describing the metadata used for a LO
- Technical: All technical information about a LO, such as the format, the length, browser requirements, etc.
- Educational: Information about the educational objective of a LO, such as interactivity, difficulty, end-user type, etc. (details see below).
- Rights: Commercial use and ownership of a LO
- Relation: Implements a concept similar to hypermedia links to be able to refer to other LOs
- Annotation: Used to provide additional, eventually more detailed information about a LO
- Classification: Defines different purposes of a LO, together with its location within a taxonomy of keywords

The LOM editor can be used to create a LOM records and forward it to the persistent layer (middleware) described above, which is responsible for the storage of the metadata record in an appropriate database. It can also be used to change the description of an already tagged resource.

When tagging the source material with the LOM editor, an interesting experience turned out: Most elements of a lesson to be described apply the same basic metadata information, such as the name of the author, the rights of the lesson, or the targeted user group. It would hence be very useful to use a set of templates to tag the material. Templates can avoid the necessity to fill a lot of fields again and again, for example the owner fields, the necessary browser requirements, and many more. In our current implementation, templates are used to store information, which is then only typed in once and can be applied multiple times. To be able to exchange metadata with other applications, we included an XML-based import/export

functionality as part of the LOM editor. This work is based on the LOM object model developed in our research group.

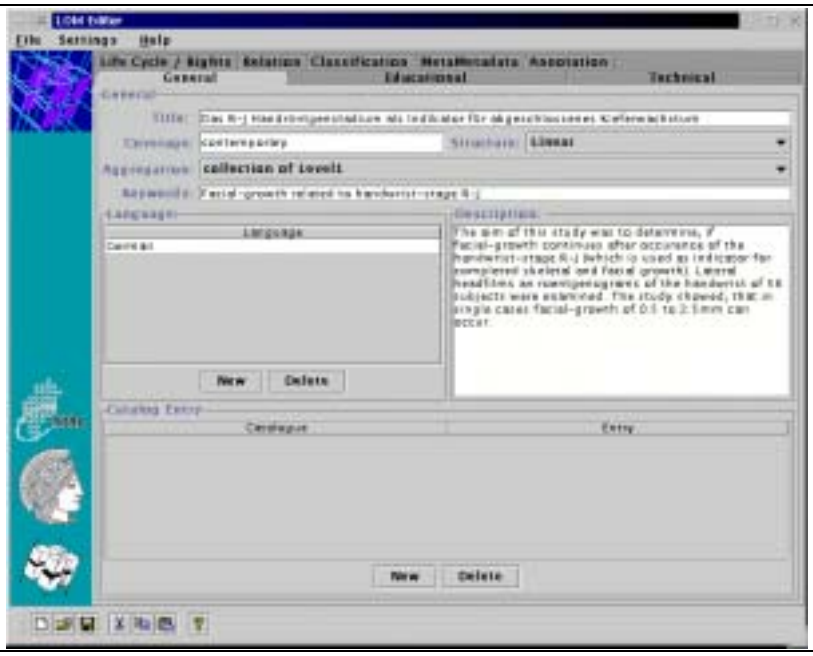

Figure 2: LOM Metadata Editor

4 Conclusion

As more and more descriptions in a standardized form will become available, it will become increasingly attractively for software developers to invest in developing these tools. The critical mass of learning objects has to be reached if they should be successful. Especially in today's information society the ability to find quickly the right information is a crucial factor. The whole band width of educational activities would benefit from one consistent description model and LOM could be the key to transport the structuredness of databases to the World Wide Web, nothing more and nothing less.

5 References

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