

E-Learning in the Semantic Web: The Personal Learning Object Readers

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Abstract: In this paper, we describe our ideas for personalized e-Learning in the Semantic Web which is based on configurable, re-usable Personalization Services. To realize our ideas, we have developed a framework for designing, implementing, and maintaining Personal Learning Object Readers, which enable learners to explore Learning Objects within an embedding and personalized context. We outline the architecture of the Personal Reader framework, and discuss how Personal Learning Object Readers can be created within the framework.

Keywords: semantic web, learning objects, personalization, web services, standards for learning objects, e-learning architectures.

Introduction

The Semantic Web initiative aims at an extension of the current Web in which *machines can understand the meaning* of Web resources [Berners-Lee et al., 2001]. This meaning, or, more precisely, these machine-readable descriptions of Web resources, are essential for building advanced Web applications that can process Web information, can reason about this information, and thus can provide better support for interactions with the Web.

The development of the Semantic Web has, as we believe, a great impact on the future of e-Learning. In the past few years, achievements in creating standards for Learning Objects (for example the initiatives LOM (Learning Objects Meta-data [LOM, 2002]) or IMS [IMS, 2002]) have been carried out, and large Learning Object repositories like Ariadne [Ariadne] and others have been built. This shifts the focus from the more or less closed e-Learning environments forward to open e-Learning environments, in which Learning Objects from multiple sources (e. g. from different courses, multiple Learning Object providers, etc.) can be integrated into the learning process. This is particularly interesting for university education and life-long learning where experienced learners can profit from self-directed learning, exploratory learning, or similar learning scenarios.

In this paper, we describe our approach to realize personalized e-Learning in the Semantic Web. Within the Personal Reader framework [Henze, 2005], we have developed an environment for designing, maintaining and running Personalization Services in the Semantic Web. The goal of the framework is to establish personalization functionality as semantic Web Services. In the run-time component of the framework, Personal Reader instances are generated by plugging one or several of these Personalization Services together. Each

developed Reader consists of a browser for Learning resources (the *reader part*), and a side-bar or remote, which displays the results of the Personalization Services, e.g. individual recommendations for learning resources, contextual information, pointers to further learning resources, quizzes, examples (the *personal part*), as can be seen in Figure 3. The following section outlines the basic idea of the Personal Reader Framework, and describes the authoring process for creating Personal Learning Object Readers within this framework. Afterwards we show an example of a Reader for Learning the Java programming language.

The Personal Reader Framework

The Personal Reader framework (PRF) makes use of recent Semantic Web technologies for realizing a service-based environment for personalized e-Learning. The main idea of the PRF is to provide an infrastructure for maintaining various kinds of Web Services: Web Services for creating a user interface (so-called *Visualization Services*), or Web Services which offer some personalization functionality (so-called *Personalization Services*). The core component of the PRF is the so-called *Connector Service* whose task is to pass requests and answers between the user interface component and available Personalization Services, and to supply user profile information, and available Meta-data descriptions on Learning Objects, courses, etc (see Figure 1). In this way, the Connector Service is the mediator between all Services in the PRF. Each Personalization Service offers some personalization functionality, e.g. recommends Learning Objects, points to more detailed information, quizzes, exercises, etc. The task of the Visualization Services is to provide the user interface for the Personal Readers: to interpret the results of the Personalization Services and to create the actual user interface with Reader- and Personalization-part.

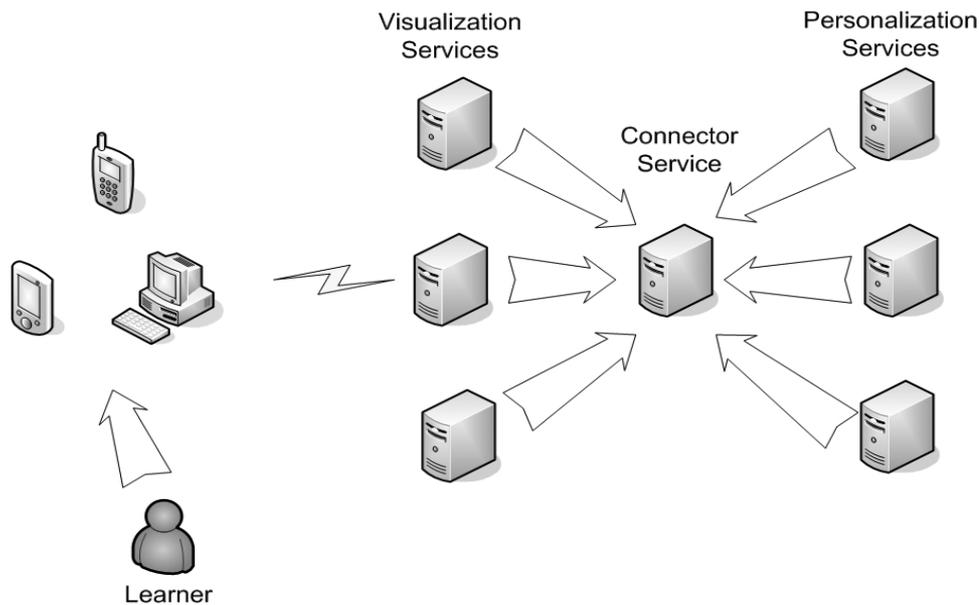


Figure 1: Architecture of the Personal Reader framework, showing the different components of Personal Readers: Visualization (user interface), the Personal Reader backbone (the Connector Service), and some Personalization Services.

Creating Personal Readers for e-Learning

The Personal Reader Framework (PRF) offers ready-to-use *Personalization Services* for e-Learning. These Personalization Services realize some of the adaptation techniques from the area of adaptive educational hypermedia (for an overview on methods and techniques of adaptive hypermedia, we refer the reader to [Brusilovsky, 1996]; a logical formalism for adaptive educational hypermedia is given in [Henze and Nejd, 2004]). Authoring is a very critical issue for successfully realizing adaptive educational hypermedia systems. As our aim in the PRF is to support the re-use of personalization functionality across different e-Learning courses and Learning Object Readers, authoring is particularly important in the PRF. As a guideline for our work, we established the following rule:

Learning Objects, course description, domain ontologies, and user profiles must be annotated according to existing standards (for details please refer to [Henze et. al., 2004]). The flexibility must come from the Personalization Services which must be able to reason about these standard-annotated.

For example, to create a new Personal Reader instance for an e-Learning course using the off-the-shelf Personalization Services, the author of the course has to provide a meta-data description of the new course according to some subset of the LOM standard. The PRF expects this meta-data description in the language of RDF (Resource Description Framework [RDF, 2004]). As an example, the following code gives an example of such a course description for a course on Java

Programming:

```
<rdf:RDF xml:lang="en"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:dc="http://purl.org/dc/elements/1.1/"
  xmlns:dcterms="http://purl.org/dc/terms#"
  xmlns:lom="http://ltsc.ieee.org/2002/09/lom-base#"
  xmlns:vCard="http://www.w3.org/2001/vcard-rdf/3.0#">
  <rdf:Description rdf:about=
    "http://java.sun.com/.../tutorial/index.html">
    <rdf:type rdf:resource="http://ltsc.ieee.org/...#Book"/>
    <dc:title>The Java Tutorial (SUN)</dc:title>
    <dc:creator>
      <lom:entity> <vCard:FN>M. Campione</vCard:FN>
      </lom:entity>
      <lom:entity> <vCard:FN>K. Wallrath</vCard:FN>
      </lom:entity>
    </dc:creator>
    <dcterms:hasPart>
      <rdf:Seq> <rdf:li rdf:resource=".../tutorial/java/index.html"/>
      </rdf:Seq>
    </dcterms:hasPart>
  </rdf:Description>
  ...
  <rdf:Description rdf:about=
    "http://java.sun.com/.../concepts/message.html">
    <rdf:type rdf:resource="http://ltsc.ieee.org/...#LO"/>
    <dc:title>What Is a Message?</dc:title>
    <dc:subject rdf:resource= "http://www.personal-reader.de/rdf
      /java_ontology.rdf#OO_Methods"/>
    <dcterms:isPartOf rdf:resource="http://.../index.html"/>
  </rdf:Description>
  ...
</rdf:RDF>
```

The course can be described solely in terms of itself, e.g. by describing a section-subsection-subsubsection like structure (in the example code, this is done using

the standard `dcterms:isPartOf` meta-data entry from LOM; LOM includes the Dublin Core Standard (DC), thus `dcterms:isPartOf` refers rather to an entry in DC). Alternatively, Learning Objects can be described independently of the course by using keyword annotations (in the example code, this is done using `dc:subject` to refer to keywords which describe the content of the Learning Object). In the latter case, the keywords are assumed to belong to a controlled vocabulary, and should belong to some ontology which models the domain of the course in question. In summary, the author of a Personal Course-Reader has to

1. annotate the course according to the LOM standard (mandatory)
2. point to or provide an ontology for the course's domain knowledge (optional)
3. provide an entry point to the course: where learners should start with the course (mandatory).

The administration component of the Personal Reader framework provides an author interface for registering new instances of course-Readers (see Figure 2): Course materials which are annotated as described above, can immediately be used to create a new Personal Reader instance which offers all the personalization functionality which is available via the Personalization Services.

New Personalization Services: Extensions of the Personal Reader Framework

Another possibility to work with the Personal Reader

Framework is to extend the set of off-the-shelf Personalization Services by new Personalization Services. The integration of new Web Services is facilitated by the use of ontologies (for describing the kind of personalization offered by a Service) and standardized Internet registries for Web Services like UDDI (Universal Description, Discovery and Registration). A newly added Personalization Service can then be discovered via such an Internet registry, invoked and its results (described in RDF) is sent to the Visualization Service. In case the new Personalization Service offers a functionality not yet realized in a Visualization Service, a modification of these Visualization Services has to be done in order to create appropriate an user interface.

Example: A Personal Reader for Learning Java Programming

An example of a Personal Learning Object Reader is the Personal Reader for learning Java programming. This Reader displays the Learning Resources of the Sun Java Tutorial [Campione and Walrath, 2003], a freely available Online-Tutorial on Java programming.

The Personal Reader for Java Programming helps the learner to view the Learning Resources in a context: In this context, more *details* related to the topics of the Learning Resource, the *general topics* the learner is currently studying, *examples, summaries, quizzes*, etc. are generated and enriched with personal recommendations according to the learner's current learning state, as shown in Figure 3.

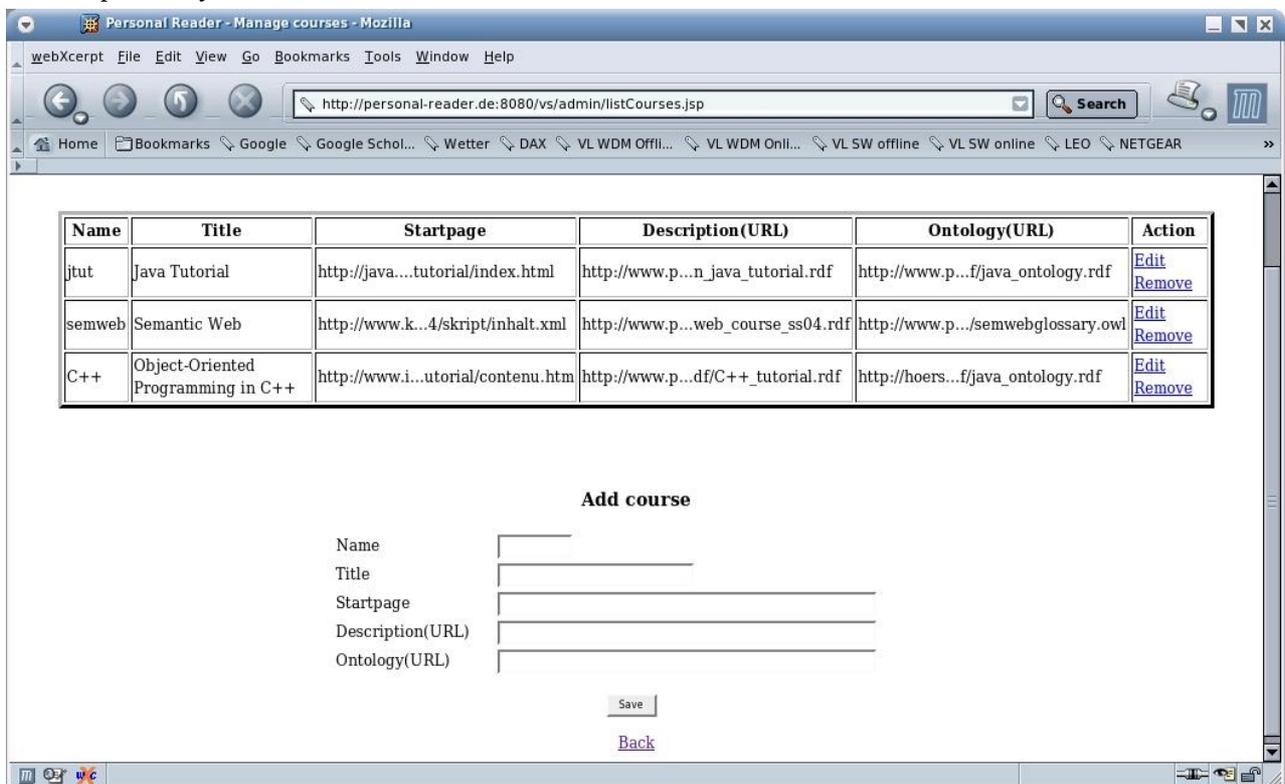


Figure 2: Course Administration Component of the Personal Reader Framework

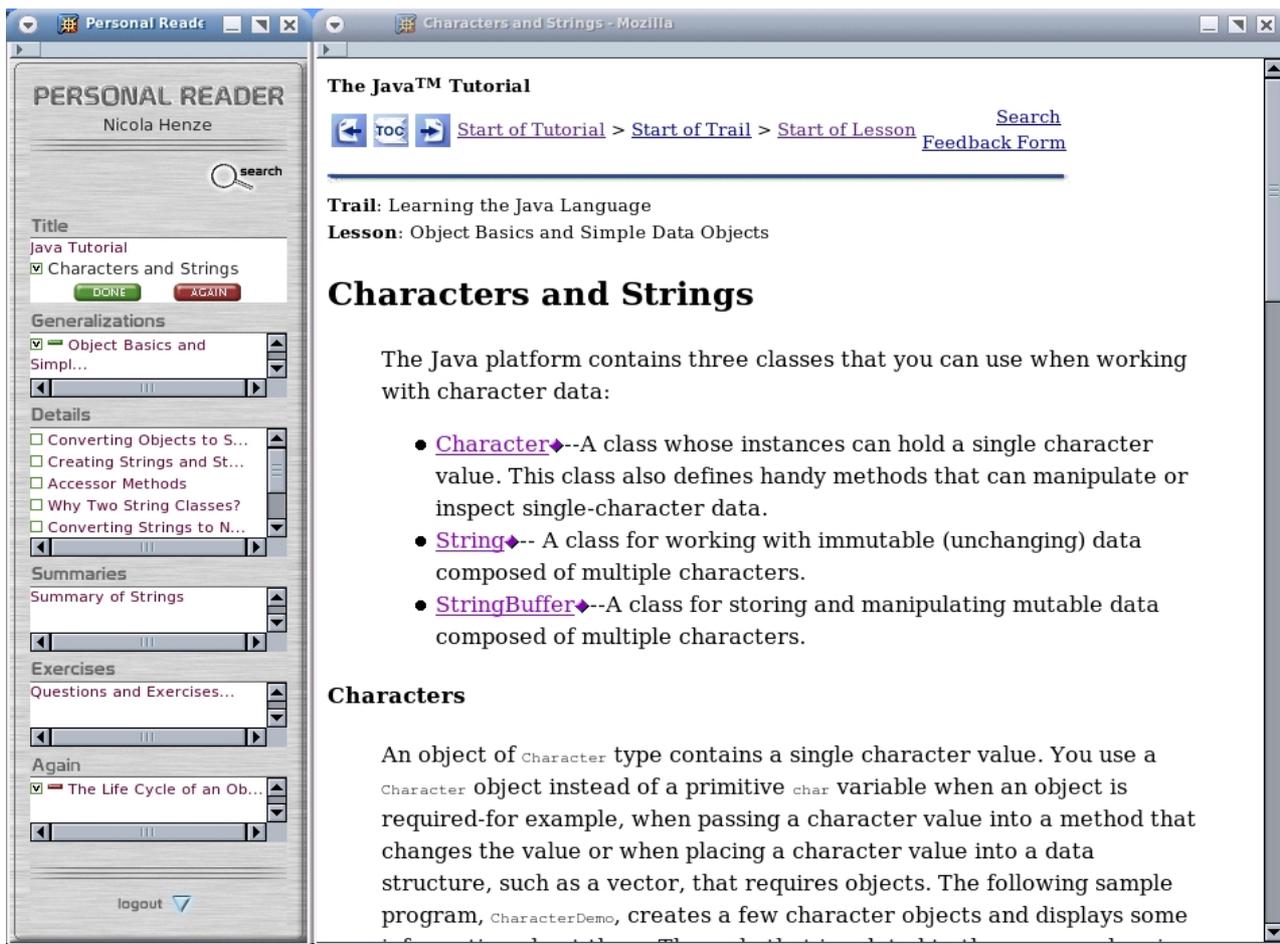


Figure 3: Screenshot of the Personal Reader for learning the Java Programming Language. The Personal Reader consists of a browser for Learning Objects (the *Reader* part), and a side-bar or remote, which displays the results of the Personalization Services, e.g. individual recommendations for Learning Objects, contextual information, pointers to further Learning Objects, pointers to quizzes, exercises, examples, etc. (the *Personal* part). Personal Readers are available via www.personal-reader.de.

Another Personal Reader for e-Learning has been developed for “Learning about the Semantic Web”, a Reader for Kobun is currently under development.

Conclusion and Future Work

In this paper, we have shown how recent Semantic Web technologies can be used for creating Learning Object Readers which embed Learning Objects into a meaningful context: Details of some Learning Object, its general objectives as well as pointers to quizzes, examples, etc. are offered to the learner by these Learning Object Readers. The core idea of our Personal Reader framework is to realize this context provision or other personalization functionality as *Personalization Services*. Up to now, we have realized several Personal Learning Object Readers (for Java Programming, Semantic Web, and Kobun). All Personal Readers are available at www.personal-reader.de. In future work, we will extend the user interface component of the Personal Readers in order to allow a learner to enable, disable or combine Personalization Services as she or he likes.

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