A Personalization Service for Curriculum Planning

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Abstract

In this work we describe a "semantic personalization" web service for curriculum planning. Based on a semantic annotation of a set of courses, provided by the University of Hannover, reasoning about actions and change —in particular classical planning— are exploited for creating personalized curricula, i.e. for selecting and sequencing a set of courses which will allow a student to achieve her learning goal. The specific student's context is taken into account during the process: students with different initial knowledge will be suggested different solutions. The Curriculum Planning Service has been integrated as a new plug-and-play personalization service in the Personal Reader framework.

1 Introduction

In this work we describe the integration of a *Curriculum Planning Service*, for building personalized paths in a space of semantic learning resources —university courses— as a *plug-and-play personalization service* in the Personal Reader (PR), a framework for designing, implementing and maintaining personalization services. Each personalization service offers some personalization functionality, e.g. recommendations tailored to the needs of specific users, pointers to *related / interesting / more detailed / more general* information, and so on. Thus, users receive personalized views on Web contents. The characteristic of the PR framework is that it treats a personalization functionality as a *service*, and, within the framework, a user can select and combine —plug together— which personalized treatment he or she wants to receive. The user interface of the PR framework has to adapt to the selected functionality and display the results of the personalization services in a device-dependent manner. This framework has already been used for developing Web Content Readers that present online material in an embedded context, i.e. the Personal Publication Reader [Baumgartner *et al.*, 2005] and the Personal Reader for e-learning [Henze, 2005].

Recently the PR framework has been extended with the introduction of *configurable web services* and the *Personal Reader Agent* [Abel *et al.*, 2006]. These new services can process RDF data, and provide RDF in return. Additionally, they have an OWL-S description, and provide information on how they can be configured and in which way they can be accessed. An agent is used to provide an interface to manage the configurations and adapt them according to the users interests.

In this paper, we describe the integration of a new personalization service into the PR framework which uses *reasoning on semantically annotated data* about courses held at the University of Hannover, for enabling a personalization functionality, i.e. planning curricula, that are personalized w.r.t. the student's context and learning goal. The idea is to embed into this new service a reasoner, which is realized by means of actions techniques [Baldoni *et al.*, 2004a]. The new service is activated on demand by a component of the PR by means of a proper request, which includes the user's learning goal (expressed as a set of knowledge entities taken from a shared ontology) the user's context, i.e. what the user (supposedly) already knows. Moreover, since the reasoner applies planning techniques for performing the sequencing, we provided a semantic annotation of the set of courses with preconditions and effects. In fact, in the spirit of [Baldoni *et al.*, 2004a], we interpret each course as an atomic action, on the basis of prerequisites (what the student should know for understanding the course contents) and effects (what the student is supposed to learn by attending the course). Given such input data, the Curriculum Planning Service returns to the PR a set of possible personalized curricula, i.e. a set of linear plans. Then the PR is in charge to present these plans to the user as personalized sequences of courses to attend for reaching the desired learning goal.

The next section describes our approach and the components we have developed in order to implement the new personalized Curriculum Planning Service. Section 3 shows an example session with a simple demonstrator application. Conclusions follow.

2 Personalized Service for Curriculum Planning

In order to build the new personalization service for curriculum planning, multiple steps are necessary.

2.1 Extraction and Preparation of Metadata

Concerning the extraction of metadata, we used the Lixto [Baumgartner *et al.*, 2001] tool for extracting metadata about the available courses at the University of Hannover from the public HIS-LSF web pages (HIS-LFS provides infrastructure for managing all information relevant to higher education). This approach is similar to the one used in the *Personal Publication Reader* [Baumgartner *et al.*, 2005]. Other possible approaches include direct access to the back-end database which is providing the course information, or access to other repositories like e.g. Learning Management Systems. Unfortunately, the quality of most

of the information in these databases turned out to be insufficient, and many inconsistencies in the description of prerequisites and effects of courses could be noticed by analyzing the extracted data. As a consequence, we focussed on a subset of courses (computer science and engineering courses), and manually post-processed the data. Courses are annotated with prerequisites and effects, that can be seen as knowledge concepts or competences, i.e. ontology terms. After automatic extraction and manual post-processing, prerequisites and effects of each course were translated into English, a necessary step to combine it with material from our partners in the NoE REWERSE[1]. Metadata about credits, location and time schedule of courses were also automatically extracted. All the metadata is stored in an RDF document.

2.2 Reasoning on Metadata

Given a semantic annotation with preconditions and effects of the courses, classical planning techniques are exploited for creating personalized curricula, in the spirit of the work in [Baldoni *et al.*, 2004a; 2004b]. The curriculum planning task is accomplished by a reasoning engine, which has been implemented in SWI Prolog[2].

The interesting thing of using SWI Prolog is that it contains a semantic web library allowing to deal with RDF statements. Since all the inputs are sent from the PR to the reasoner in a *RDF request document*, it actually simplifies the process of interfacing the planner toward the Personal Reader. In particular the request document contains a) links to the RDF document containing the database of courses, annotated with metadata, b) the user's context c) the user's actual learning goal, i.e. a set of knowledge concepts that the user would like to acquire, and that are part of the *domain ontology* used for the semantic annotation of the actual courses. The reasoner can also deal with information about credits provided by the courses, when the user sets a credit constraint together with the learning goal.

Given a request, the reasoner runs the Prolog planning engine on the database of courses annotated with prerequisites and effects.

The initial state is set by using information about the user's context, which is maintained by the User Modeling component of the PR. In fact such user's context includes information about what is considered as already learnt by the student (attended courses, learnt concepts) and such information is sent to the planner as a part of the request document. The planning process is driven by the user's learning goal (and possibly by credit constraints), which is again provided by the PR in the request document. The Prolog planning engine has been implemented by using a classical depth-first search algorithm [Russell and Norvig, 1995]. This algorithm is extremely simple to implement in declarative languages as Prolog.

At the end of the process a *RDF response document* is returned as an output. It contains a list of plans (sequences of courses) that fulfill the users learning goals and profile. The maximum number of possible solutions to compute can be set by the user in the request document. Notice that further information stored in the user profile maintained by the PR could be used at this stage for sorting the list of plans with the aim of adapting the presentation of the solutions.

[1] http://www.rewerse.net/

[2] http://www.swi-prolog.org/

2.3 Embedding the Reasoner in a Web Service

In order to integrate the Curriculum Planning Service as a plug-and-play personalization service in the PR architecture we worked at embedding the Prolog reasoner into a web service. Figure 1 gives an overview over the components in the current implementation. The web service implements the Personalization Service (*PService* [Henze and Kriesell, 2004]) interface, defined by the Personal Reader framework, which allows for the processing of RDF documents and for inquirying about the services capabilities. The Java-to-Prolog connection runs the SWI-Prolog executable in a sub-process; essentially it passes the RDF document containing the request *as-is* to the Prolog system, and collects the results, already represented as RDF. While the request and response documents are transferred between the different components, these documents contain references to external resources, which are managed by other services in the framework, here the User Model and the Database of University Courses. The service itself can be accessed directly, as shown in Section (3), as well as being integrated as a PService into the Personal Reader Framework.

3 Demonstration

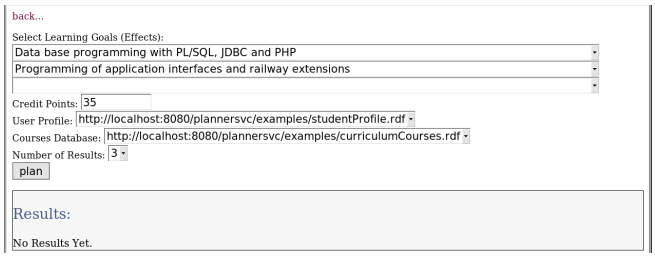

Figure 2: Starting page with two goals selected

As a proof-of-concept, we created a simple Visualization Servlet, which can be extended to become a Visualization Service (*VService* [Henze and Kriesell, 2004]) for the Personal Reader Framework.

Figure 2 shows a simple html form which allows the selection of learning goals as input for creating the curriculum sequences. Pressing the submit button "plan" sends a request to the servlet powering this interface, and an RDF request document will be created which then will be used to invoke the web service. The input data consists of 65 courses with 390 effects and 146 preconditions.

The returned RDF Response is parsed by the Servlet, and —in this prototype— a very simple List of Courses is displayed which fulfills the given goals.

4 Conclusion and Further Work

In this work we have shown the integration of a new semantic personalization web service for curriculum planning within the Personal Reader Framework. The goal of personalization is to create sequences of courses that fit the specific context and learning goal of individual students. Despite some manual post-processing for fixing inconsistencies, we used real data from the Hannover University database of courses.

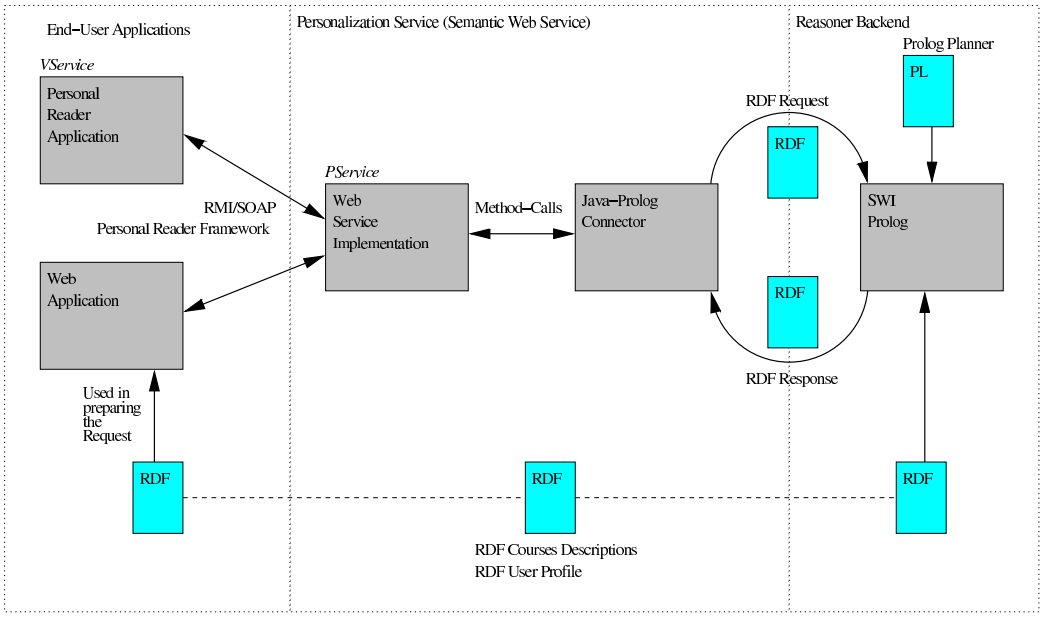

Figure 1: Curriculum Planning Web Service

Results:

Processing Time: 1133ms

Solution 1

- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Complexity of algorithms
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems I
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems IIa
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Seminar to database systems
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems IIb
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Datenbankpraktikum

Solution 2

- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Complexity of algorithms
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems I
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems IIa
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems IIb
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Datenbankpraktikum

Solution 3

- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Complexity of algorithms
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems I
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems IIa
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Database systems IIb
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Seminar to database systems
- http://localhost:8080/plannersvc/examples/curriculumCourses.rdf#Datenbankpraktikum

Figure 3: Simple List of Results

The Curriculum Planning Service can be useful in many practical contexts. Exchanging Courses, and taking courses at different Universities becomes more and more common in Europe. Universities try to reduce costs and to cooperate in designing and integrating curricula. Through the Bologna Process initiative, the European Community aims at harmonizing the academic careers across Europe and curricula integration[3]. Curriculum planning might become a complicated task for students, who must build a reasonable path trough an enormous set of courses across the European countries. Especially in this scenario, there are further factors that the Curriculum Planning Service could take into account by exploiting further metadata concerning time and location of courses, that are actually already available in the course database as room-numbers, addresses and teaching hours. Such metadata could be used by the reasoner, besides the learning prerequisites and effects, in order to find a proper sequence of courses that is personalized also w.r.t. user's characteristics concerning time and location. We are actually investigating how to extend the application with a module of geo-spatial reasoning working on meta-data like floor-plans and locations.

More information about the Personal Reader can be found at the Homepage at `http://www.personal-reader.de/`, as well as for the Agent, located at `http://www.personal-reader.de/agent/` The Curriculum Planning Demonstrator is available at `http://semweb2.kbs.uni-hannover.de:8080/plannersvc`.

[3] `http://europa.eu.int/comm/education/policies/educ/bologna/bologna_en.html`

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