Presentation and Personalization of Information in the Semantic Web

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Abstract. Large information spaces and complex functionality of contemporary systems together with the advent of the Semantic web are big challenges for the design of simple yet powerful user interfaces. The complex nature of systems thus requires the use of several presentation, personalization and user modeling tools to address the growing needs and requirements of both users and systems. We propose the use of a set of interconnected tools for presentation, personalization and user modeling to support features such as navigation support and different views on the presented data, acquisition and evaluation of user characteristics and user adaptation and personalization.

1 Introduction

Present day information systems need to deal with increasing amounts of data. The vision of the Semantic Web introduced new challenges in data processing. Nevertheless, in addition to the processing of data it is also necessary to present the data and the results of its processing to human users. For this purpose many information systems have a presentation layer that takes advantage of one or more presentation tools, which create an interface between users and the system itself. To facilitate the development of information systems, entire presentation frameworks were created that support the operation of several interconnected presentation tools.

Furthermore, the increasing size of the available information space and the overall complexity of applications result in the need for adaptation of the aforementioned interface. Presentation tools need to create personalized output for individual users based on user characteristics stored in a user model maintained e.g. by a user modeling server [1] or by the system itself. Although the user model can be acquired by many different ways, the current focus is on methods that minimize user involvement in the process.

In this paper we propose a presentation and personalization layer with the respective "user modeling back-end" that allow for the creation of an effective adaptive user interface. We briefly describe the goals, requirements and methods used as well as the tools that are used to realize the required functionality together with their integration.

2 The presentation and personalization layer

The presentation and personalization layer performs two primary tasks. First, it provides a user interface that offers simple access to all of the system's functionality while effectively hiding all of the system's inner complexity from the user. Second, it dynamically adapts the user interface to the needs, usage patterns and goals of individual users in order to increase their comfort, productivity and satisfaction. A third – somewhat related task is to create a comprehensive log of user activity, evaluate it and extract and store meaningful user characteristics, which will then be used in the adaptation process.

As such, these tasks are performed by the presentation part, the personalization part and the user modeling part of the system respectively. Since these tasks somewhat depend on each other, they are usually performed by a set of cooperating tools. While one tool might perform only a single task, another tool might contribute to all three of these tasks.

2.1 Presentation and personalization

The purpose of the presentation and personalization layer is to provide an effective user interface while adapting to the individual needs of users by exploiting information stored in the user model provided by the user modeling part of the system. Thus a suitable presentation and personalization layer must fulfill the following requirements:

- Provide easy to use, user-friendly and intuitive user interface.
- Provide simple access to the system's functionality.
- Offer support for personalization by individual users.
- Offer support for adaptation to individual users' needs and usage patterns.
- Offer support for logging and acquisition of user activity and characteristics.

Two basic approaches to presentation and personalization exist. Personalization can either be performed by separate personalization tools on top of presentation tools or it can be built into presentation tools which effectively makes them presentation and personalization tools simultaneously. While both of these approaches have their advantages and disadvantages their combination is also often used. Thus the process of presentation may or may not be entirely separated from the process of personalization.

The advantage of separate personalization tools is their easier reusability and maintainability. The tradeoff however is their limited functionality, since they can only adapt the already existing output of presentation tools. On the other hand, combined presentation and personalization tools allow for the adaptation of the output generation process itself, while also introducing more complexity and a somewhat lower reusability because of their tight coupling with presentation.

In practice, the use of web interfaces has become common in many new applications. In project NAZOU [2] we used a web interface for the evaluation of its individual tools in the domain of online job offers. The primary means

of presentation is a web portal *JOP* [3], which provides access to individual functions of the system.

We also integrated other tools and thus their functionality into the web portal. To facilitate access to the large information space of job offers we used a combined presentation and personalization tool – a faceted browser *Factic* [4] with support for adaptation based on a user model. Furthermore, we decided to further process some of its output by the presentation framework *Prescott* [5]. Lastly, we also use other tools that require presentation to provide an alternative view on the information space such as the job clustering tool *JobClusterNavigator* or *CriteriaSearch* which searches for job offers that satisfy user specified criteria.

2.2 User modeling

The goal of user modeling is to identify user characteristics, which might be consecutively used for the adaptation of the system's operation (e.g. information filtering), for the adaptation of its output (e.g. sorting of search results) or input (e.g. interpretation of user commands) [6]. Thus a successful set of user modeling tools must fulfill the following requirements:

- Provide means for both manual and automatic acquisition of user behavior and user characteristics ideally with little user involvement.
- Provide means of automatic evaluation of the acquired data.
- Allow for the scrutability of the user model by allowing the user to view, inspect and modify its content.

In general, the process of user modeling is perpetual and includes the following two stages [7]:

1. Collection of data about the user.
2. Processing of the collected data and the update of the user model.

Data collection. The primary purpose of the data collection stage is to acquire as much relevant data (e.g., user behavior, documents, preferences) about users as possible while ideally keeping the amount of necessary user involvement as low as possible. While many possible approaches to user modeling exist, we focus on an approach which is based solely on the analysis of a user's behavior within a system. This approach necessitates in the use of comprehensive logs of user actions that must fulfill the following requirements:

1. Each user action performed on an active element of the displayed page must be logged.
2. For each action the exact time (timestamp) must be logged.
3. Each action must be semantically described (i.e. its meaning must be known).

To fulfill the aforementioned requirements in project NAZOU [1], we chose to enhance the idea of a standard web server log by client side monitoring and by enriching logs by adding semantics to events. The client side monitoring is performed by the *Click* [8] tool which captures and logs events, which the server is normally unaware of (due to browser caching mechanisms, JavaScript interactions etc.). The *SemanticLog* [8] tool creates a comprehensive log of user actions with added semantics which are suitable for further processing.

Data Processing The aim of the data processing stage is to evaluate the acquired data and estimate meaningful user characteristics with high confidence that might be consequently used for adaptation. Individual user characteristics are estimated by analyzing user navigation on a web site or in the visible information space and user feedback on the displayed content. Since user modeling is a perpetual process, each time a user characteristic is identified, the user model is updated to reflect the newly acquired knowledge.

The data processing in project NAZOU is performed by *LogAnalyzer* [9] tool, which estimates user characteristics and stores them in a user model. Since the used method implies the mainly domain-dependent nature of the revealed characteristics, *LogAnalyzer* needs better "understanding" of the displayed domain content and uses the services provided by the *ConCom* [8] tool, which compares ontological concepts by using various comparison strategies.

3 Integration of individual tools

Coming back to the main focus of this paper – the architecture of the presentation and personalization layer for semantic web applications, we propose the integration and cooperation of individual presentation, personalization and user modeling tools as depicted in Figure 1.

Most presentation and personalization tools work with the domain and user models stored in the *CorporateMemory* (left). Individual presentation tools are depicted in the top center. *Factic* forwards its output either directly or indirectly via *Prescott* to *JOP*, which in turn provides an interface to the client web browser (right). The integration of additional tools that create output for the user is represented by *ToolX*. The user modeling part is shown at the bottom and right. *SemanticLog* aggregates log data from other tools (*Click*, *Factic*) and creates a comprehensive log for the *LogAnalyzer* tool, which estimates user characteristics and stores them in the *CorporateMemory*.

3.1 Presentation and personalization tools

In section 2.1 we introduced the basic requirements on the functionality of the presentation and personalization layer, which consists of several cooperating software tools.

[1] Project NAZOU, `http://nazou.fiit.stuba.sk`

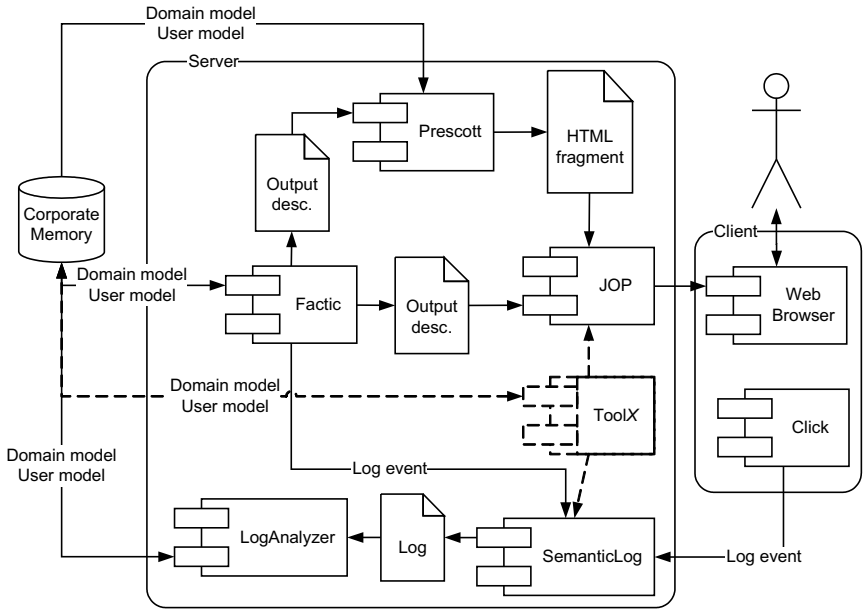

Fig. 1. Overview of the architecture of the presentation and personalization layer.

The *JOP – Job Offer Portal* tool is the primary user interface and processes all user inputs while returning the corresponding outputs. It allows users to register, log in and use the functionality offered by the system. Furthermore, the individual functionality and results of all other tools are integrated into the user interface provided by the *JOP* tool. Since *JOP* is based on Apache Cocoon[2] which supports flexible inclusion of existing functionality into the portal solution, adding other tools is a relatively straightforward process.

Factic – Faceted Semantic Browser is a tool which allows users to effectively navigate in the information space by choosing restrictions on the displayed content. It is fully integrated into *JOP*, which supplies it with information about the current user for adaptation purposes. As input it takes user actions and returns the logical description of the content that should be displayed. Its output can be further processed by a set of XSL transformations to directly create valid XHTML output or alternatively it can be sent to *Prescott* for further processing.

Prescott is a presentation tool able to visualize domain dependent content (e.g., job offers) in a flexible and configurable manner using the *Fresnel* presentation ontology. It defines various views on domain content using "lenses", which can be defined dynamically based on the user's preferences.

As input, *Prescott* takes the logical description of the content that should be displayed (e.g., the URIs of job offer instances) and returns an XHMTL fragment

[2] Apache Cocoon project, `http://cocoon.apache.org`

with the visualization of the content. Additionally, *Prescott* can take advantage of user characteristics stored in a user model to choose the most appropriate lens to apply on the ontological individuals that should be displayed. *Prescott* is invoked mainly by *Factic* every time the user changes the selected restrictions or decides to view details of a job offer.

3.2 User modeling tools

The functionality described in section 2.2 is performed by the following set of cooperating software tools:

The *Click* and *SemanticLog* tools perform the *Data collection* stage of the user modeling process. *Click* is a JavaScript based tool which captures events fired by a web browser and sends them to the *SemanticLog* web service, which combines information about events from *Click* with information from other presentation tools (e.g., *Factic*) to create one comprehensive log of user actions.

The created log is consecutively processed by the *LogAnalyzer* tool that performs the *Data processing* stage of the user modeling process and whose output are records about user characteristics in the user model ontology.

4 Conclusions

We identified challenges in the field of presentation and personalization of information in semantic web applications. We described several requirements that should be met by successful information systems and their respective presentation, personalization and user modeling parts.

We proposed the architecture of the presentation and personalization layer that consists of several cooperating tools that in combination provide the presentation of data, adaptation of the system's operation and the automatic acquisition and evaluation of user characteristics.

Furthermore, we will evaluate the proposed architecture as well as its individual tools within project NAZOU in the domain of the online labor marker and also in the domain of research articles. Some of the possible problems include the performance and communication overhead associated with the use of independent tools as well as the immaturity of individual tools and technologies which are still in development.

Future work will include the integration of additional tools into the main web portal *JOP*, the evaluation of additional interconnections between tools and the possible addition of new tools for specific tasks.

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