

Presenting Information about Hospitals to Multiple User Groups via the World Wide Web

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Abstract

Potential patients, healthcare professionals, controllers and many others need structural information about hospitals. Examples for structural information are the number of departments, the number of cases and the areas of expertise. The CERES research project at Aachen University has developed an object-oriented metamodel to collect all relevant structural information about hospitals in an object database. The database content can be used for a variety of applications. The problem is that each of the potential user groups prefers a different structuring of the database content and a different way of presentation, eg. natural language text, tables, or data summarised to key figures.

A variety of approaches has been developed to define individual views on object databases and to present their content in different ways. Unfortunately, all of them suffer from the complexity trying to develop a universal approach. As a result, the proposed mechanisms are difficult to understand and to use for domain modellers and editors working on the presentation of data.

We developed an object-oriented view system combined with a presentation mechanism that is tailor-made to fit the task of presenting structural information about hospitals to multiple user groups. We allow for a simple view definition and for an easy-to-use, highly configurable presentation engine. The output is presented via the world wide web. Our approach is suitable to fit most, if not all, needs for presenting structural information about hospitals from a central database. For example, it can be configured as patient information platform, as support system for medical controllers, or to publish quality reports as required by the German law.

Keywords:

Hospital; Information system; Object-oriented views; Natural language generation; World wide web

1. Introduction

Many different user groups need structural information about hospitals. For example, potential patients are looking for a suitable hospital that offers optimal treatment for their specific disease, and there are healthcare professionals that support their patients in finding such a hospital. Each of these user groups accesses basically the same information about hospitals. A single database holding structural data about hospitals can serve as a central and thus easy to maintain data source for all these user groups.

What differs from user group to user group is the adequate view of the information, its specific selection, the level of detail, and the presentation. For example, patients in search of a special treatment need a comprehensive overview in natural language. On the other

hand, healthcare professionals are used to read tabular presentations opposed to paragraphs of text. Last, summarising detailed data in key figures is required to provide structural facts at a glance.

The CERES research project at the department of medical informatics at RWTH Aachen University has developed an object-oriented metamodel that describes the structure of a German hospital [1]. The metamodel is used as schema for an object database. CERES offers a set of web based applications running on a web server that present the hospital models in the database to users via the world wide web. CERES can be used by providers of information about hospitals, referred to as content providers. The CERES metamodel is expressed with a small subset of the standardised diagram language UML (the Unified Modelling Language [2]) consisting of classes that collect entities (objects) with common properties, relationships among classes, and generalisation relationships that build a hierarchy between classes.

Usually, there is much more hospital data stored in the database than a particular user group needs. The granularity of the required data almost always differs from the granularity the general-purpose metamodel allows. For example, medical controllers tend to prefer key figures as the number of departments, whereas consultants prefer detailed data about each department. A similar problem arises with the data presentation. Simply presenting data in the somehow self-suggesting way of tables or attribute lists is not satisfying for every user group. Instead, for particular user groups presenting natural language text or images is helpful [3].

To overcome the problem of extracting individually structured content from object databases in general, object-oriented views on databases were developed [4, 5]. Defining a view is like creating a metamodel for a certain user group, and specifying a derivation relationship between the database schema and the view metamodel. To overcome the presentation problem, database schemas were enriched with presentation information for each element [6]. As they were developed as generic approaches, all those solutions are loaded with features and require a lot of background knowledge. This interferes with the goal of CERES, which is to include domain experts, not computer experts, in the tasks of modelling and editing presentation templates.

Starting from the hypothesis that modelling and presenting object-oriented views in the hospital domain is easy because it is a very specific task, we developed a tailor-made, two-step approach to achieve ease of use on the back end. First, we developed an object-oriented view system that provides only two operations for deriving data from a database, sufficient for the hospital domain. Second, we allow an editor to design a set of web page templates for each view by putting together building blocks that are specific for the hospital domain. The blocks include a possibility to generate natural language text from database content. Moreover, the presentation adapts itself to user preferences such as the amount of presented information.

This paper is organised as follows. In section 2, we outline our approach and enlighten some details. In section 3, we present the experiences with the approach. In section 4, we compare our work to other works on this topic. In section 5, we give a short summary and present the future prospects of the CERES project.

2. Materials and methods

The view mechanism. The view mechanism allows the content provider to derive an individual metamodel, called a view, for each user group. The view is modelled exactly to fit the specific needs of a user group. The content of a view is derived from the central CERES database. The difficulty many published approaches of object-oriented views suffer

from is the number of different constructs that can be used in object-oriented modelling, and the resulting number of possibilities to derive views. Moreover, most of the approaches presented so far do not include a graphical view definition in the UML [4, 5].

To scale down the complexity of the view definition and to provide a simple to use view definition, we investigated the requirements of a view definition specific to the hospital domain. It turned out that we only need two very specific types of derivations. These two derivations are restructuring and analysis of information. Both derivations are strictly separated to prevent mixing up entities and key figures representing sets of entities in the model. See [7] for a detailed exploration on this subject.

When restructuring information in a view, one takes a class from the base metamodel and selects this class's properties that should be visible in the view. Joining and splitting classes is only possible in special situations where each object of one class is connected to exactly one object of another class.

When analysing information in a view, one does not directly take over a class but summarises the information from all objects connected to an object via a certain relationship into one or more key figures. Thus, analysing view classes are derived from base relationships instead of base classes. A view modeller specifies the calculation expression for such an analysis in simple terms similar to the Object Constraint Language (OCL) used for specifying derived attributes in the UML.

The presentation mechanism. The presentation mechanism allows an editor from the content provider to define a set of highly configurable templates. All web pages that are presented by the presentation mechanism are divided into atomic parts such as text paragraphs, tables, images, headings etc. These atoms are called nuggets. The editor has to arrange the "raw" nuggets, i.e. skeletons of nuggets not yet augmented with information from the database, for each web page. Additionally, the editor assigns a priority to each raw nugget and optionally an alternative raw nugget, i.e. an image as alternative to a text.

The presentation mechanism itself consists of three determination levels: content selection, representation, and style. On the content selection level, the presentation mechanism takes a template and removes all raw nuggets from it that have a priority less than a threshold specified by the user viewing the web page created from the template or replaces them by an alternative nugget. This priority-based presentation behaviour follows the newspaper customs principle "important things first".

On the representation level, the presentation mechanism fills the remaining raw nuggets with content from the database. For filling a text nugget, natural language generation is required. Therefore, the editor specifies a template text where several words are tagged so that the presenter can determine either a replacement of the word by a value from the database, or an adaptation of case, number, and gender of the tagged word. The inflection is done by looking up the word in a morphologic database, and by evaluating the value from the database the word refers to. This way, there is no need for the editor to learn a special definition language like SPL [8]. Details on the text generation can be found in [9].

As the last step, style information is added on the third level of the presentation specification. The user of the web application is given full control over all style parameters as font family, font sizes, colours and other style information via a special menu.

3. Results

The modellers in the CERES project model the view for a certain user group with the same UML editor (developed especially for CERES) they use for modelling the base model. By restricting the set of operators for the definition of views to only two clearly defined types

of operations, the view creation is much simpler than in the general case where modellers have to select from abstract operations like join, split, selection, projection, and so on. Every time a view model construct is created (e.g. a class, an attribute or an association), the metamodel editor application asks from which base construct the view element should be derived. As the daily project work shows, this is found to be a natural extension of the modelling work and therefore greatly accepted by the CERES modelling team that comprises of computer scientists, medical professionals, and business professionals. As the view mechanism was developed upon the requirements of the modelling team, it is expected to greatly improve the usability and usefulness of the CERES information system for many different user groups.

Placing information referring to presentational issues on top of each view enables a content provider to truly address distinct user groups with both the appropriate substance and form of wanted information. First responses from project members when presenting a demonstration of both the idea of editing templates out of building blocks called nuggets and the resulting presentation were promising. The new presentation system is expected to replace existing CERES web applications that can only present data in tabular or diagrammatic form and have no possibility to edit the generated presentation.

4. Discussion

Both ideas presented in this paper, the object-oriented view definition and the specification of presentation options for object-oriented metamodels, are accepted approaches to solve the problems of content and presentation individualisation for different user groups. However, we extended the existing approaches. The object-oriented view mechanisms published so far [4, 5] all try to develop a general-purpose view approach and strand on the complexity of the resulting view definition. Opposite to this, we analysed the modelled domain and developed a slim, clear, and easily understandable approach. This is mostly important for the researchers that actually create the metamodel.

The parametrisation of a metamodel in order to generate an automatic presentation is a common idea, too [6]. We backed out of the common approaches of defining detailed presentation information on a per-attribute way, e.g. specifying that a particular attribute should be shown as a text editing field with 20 characters length. Instead, we let the modeller parametrise larger units of information in a kind of top-down procedure. The parametrisation itself evolves from an atomic task to editorial work.

5. Conclusion

In this paper, we described how we achieve the presentation of information about hospitals to very different user groups. The information presented to each user group is essentially the same as all groups look at the same hospitals. What differs is the amount and the granularity of the information. Furthermore, each user group needs individual presentation types, as there are natural language text, tables, and diagrams.

We focused on how this individual presentation is achieved from the back end, i.e. on the technical solution and on how the modellers and editors that create the metamodel and the presentation benefit from it. The development of the presented approach was driven by requirements that arose during the daily work of the modelling team. A detailed evaluation of the impact of our approach on the end users of the CERES project is planned as the next step.

The target of the approach presented in this paper is to extend the possibilities of using

structural information about hospitals to many different areas on the one hand, and to make modelling and configuring a content presentation more comfortable to domain experts opposed to computer experts. Two special views are currently under development: a view for potential patients looking for a specific hospital, and a view for creating quality reports as required by German law.

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7. References

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