Building Spatio-Temporal Presentations Warehouses from Heterogeneous Multimedia Web Servers

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Abstract. Building warehouses from existing data sources is one of the main challenges of future information systems. Over the last three years, we defined and experienced an infrastructure called JAGUAR (model, language, architecture, and prototype SMIL/JMF) to configure presentations warehouse(s) managers. Such managers provide means to play and query multimedia presentations stored in a warehouse. This paper summarizes the main results that we obtained.

1 Introduction

This paper presents JAGUAR, an infrastructure for configuring and generating multimedia Presentations Warehouse Managers (PWM) [Zec01, ZA01]. Having several multimedia distributed servers (text, image, audio, video), JAGUAR builds a PWM that can (1) retrieve specific objects coming from heterogeneous multimedia servers accessible through the Web; and (2) synchronize them and organize them spatially (on a screen) for building so called multimedia presentations (scenarios or multimedia documents). These presentations are themselves considered and stored as database objects and associated with specific spatio-temporal knowledge. Objects in these presentations are either referenced through their URL (*on-demand*) or copied into the presentations warehouse (*in-advance*), allowing static or dynamic links with the data sources.

Dealing with multimedia data brings new challenges because of their specific nature. Large volume of data; temporal and spatial attributes of respectively videos and images; continuous nature of video and audio data requiring specific QoS (Quality of Service) in order to be delivered to the user without alteration, are examples of these challenges. There exist many standards for multimedia data. The W3C proposes several (meta) languages for multimedia data exchange (XML family [W3C98]) and for specifying synchronization when

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presenting different objects (SMIL). Also, in the Java context, JMF [SI] is a proposal for implementing synchronization between objects coming from different sources (URL).

Multimedia DBMS [Vaz96, Jag96] have concentrated on extending traditional DBMS (e.g., relational, object) for storing and retrieving multimedia data. Querying support for retrieving multimedia data and building presentations has received particular attention [WML98, ASS00]. Yet, the problem of integrating different multimedia data sources is not fully addressed. Finally, mediation infrastructures have been proposed for integrating heterogeneous sources through mediators. However, very few approaches such as [MIKS00] address directly problems associated to multimedia data and classical data integration.

The remainder of this paper is organized as follows. Section 2 gives an overview of Jaguar our infrastructure for configuring PWM. Section 3 shows how our approach and prototype have been used for implementing a presentations warehouse for a forecast weather application. Finally, Section 4 concludes and introduces some research perspectives.

2 Jaguar Infrastructure for Presentations Warehouses

A Presentations Warehouse (PW) is a collection of spatio-temporal presentations of multimedia objects. Jaguar provides means to configure and generate what we call PWM (see Figure 1).

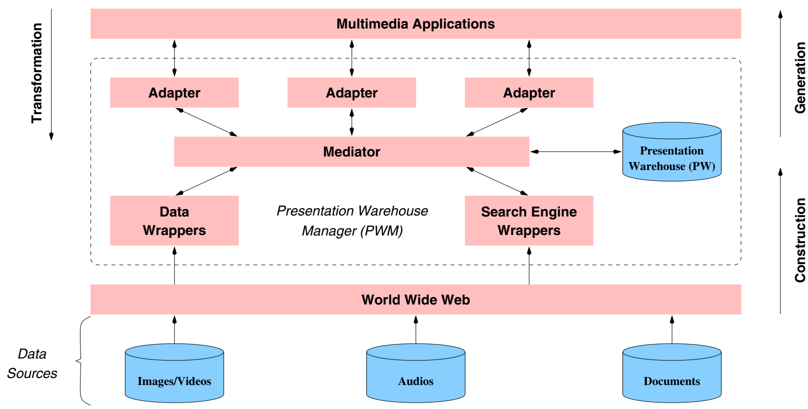

Fig. 1. General architecture of a PWM

Warehouse manager specification For specifying a PWM using Jaguar, a developer specifies (1) an *application data schema* that defines the data types to be used by applications (i.e., image, text, video, audio, document, etc.); (2) a *presentation context* to be used by applications that specifies how to present (visualize) each data type of the *application data schema*; and (3) for each application and source, its interaction with the PWM[1].

Warehouse manager generation Using this information JAGUAR associates each object type in the *application data schema* with a default presentation given in the *presentation context*. According to interaction rules, it configures the PWM for using specific wrappers to retrieve objects from sources. Transformation and generation rules specify how to configure adapters so that applications can communicate with the PWM.

Presentations warehouse manager It enables programmers to build and manage warehouses by gathering multimedia data over the Web and integrating functions provided by different standards and systems. It is a middleware configured for interacting with sources through wrappers and managing (defines, builds, stores, formats) data presentations used by several applications. Client applications can then use traditional browsers augmented with specific capabilities (CGI, Java, etc.) to deal with a very large spectrum of data. For defining their presentations (according to a predefined schema), applications interact with the PWM through adapters. Specifications are transformed into an OQLiST[2] expression that the PWM mediator understands. The mediator evaluates specifications with a PW to retrieve the whole presentation or part of it. Only missing parts are then retrieved from sources through wrappers. Supported by a presentation model [Zec01, ZA01], the mediator integrates results into a presentation and returns it to an adapter. The latter transforms it into a format understood by the client (e.g., a SMIL program).

3 Application to Presentations for Weather Forecast Data

As an illustrating example, we implemented a PWM for weather forecast data in Europe. Web applications running on different software and hardware platforms (e.g., PDA, PC, workstations, Web navigators) are used to exploit such information.

Weather forecast data are organized according to a star schema that implements the *application data schema* of a Weather Forecast Cube (WFC). Measures are forecast facts organized by Season, Year, and Zone. For analyzing such data given as OLAP query results, we adopted the cube metaphor to define a *presentation context*. The WFC is defined as a list of planes, each one being a list of cells. A cell is associated to a default presentation that displays the image of a zone with the a season average temperature in its center. Planes are presented as a table of cells with the name of the season at the upper left corner of the

[1] Interaction is defined by interaction, transformation and generation rules. In our prototype, these rules are of the form Condition/Action and expressed in Java.

[2] OQLiST stands for "Object Query Language integrating Spatial and Temporal aspects". It is an extension of OQL with specific constructors for spatial and temporal attributes.

first cell in each row. The default presentation of a cube displays a set of planes, one in front of the other with an offset corresponding to half of the cell length.

Using JAGUAR we generated a PWM for manipulating the WFC at different aggregation levels associated to dimensions. This is done using querying operators such as SLICE-N-DICE, ROLL-UP, PIVOT, etc. that we specified using OQLiST and that are supported by the generated PWM.

4 Conclusion

This paper addressed multimedia warehouse construction through the JAGUAR infrastructure. JAGUAR enables the specification and implementation of PWM that integrate heterogeneous and distributed data sources (Web, image databases, etc.). One of the main contributions of our work consists of offering flexible PWM for multimedia presentations enabling the integration and reuse of several existing objects. Two main aspects can be highlighted. First, our approach takes into account spatial and temporal characteristics that can be found in existing standards (e.g., SMIL). Second, the possibility of configuring PWM according to application needs (specification of types and their associated visualization) and data sources characteristics. Our approach is being used in a real application for medical data. The objective is to gather information from several (relational) databases and build a presentation warehouse showing how some diseases are distributed over geographical regions. This implies that we integrate data sources and geographical information systems, but also for analyzing medical data (statistic).

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