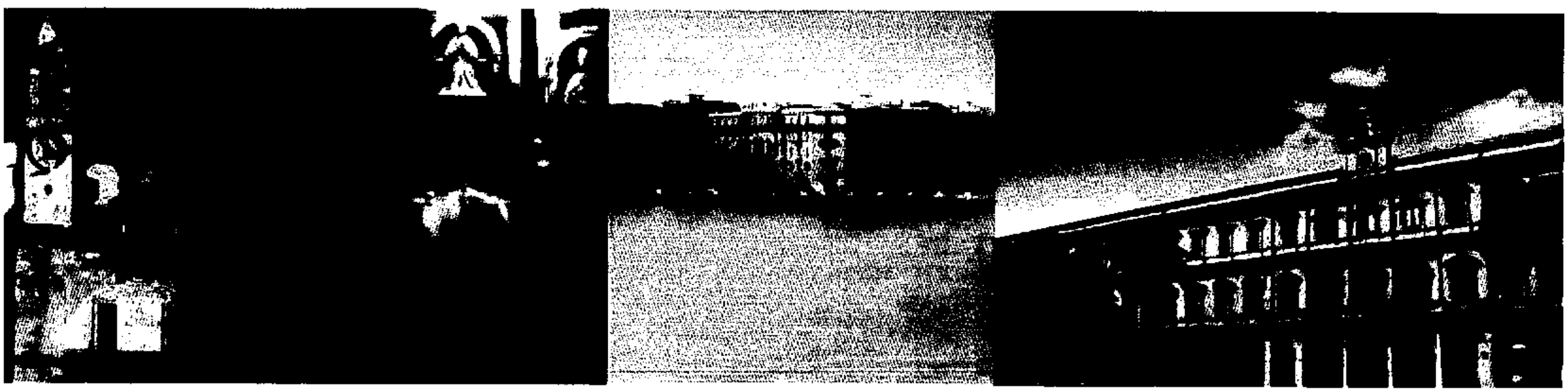
Proceedings of the 10th European Conference on

Software Maintenance and Reengineering

Bari, Italy
22-24 March 2006



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Conference on Software Maintenance and Reengineering

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MESSAGE FROM THE CHAIRS

Welcome to the 10th edition of the Conference on Software Maintenance and Reengineering (CSMR 2006), the leading European conference on the theory and practice of maintenance, reengineering and the evolution of software systems. In its first ten years, CSMR has grown more and more, becoming an important European forum for discussion and exchange of research and experience among researchers and practitioners both from academia and the industrial world in the field of Software Engineering. It attracts contributions from many countries all over the world.

The unceasing evolution of methods and technologies in software systems development speeds up the need to evolve existing systems that have to be continuously maintained to preserve their business value, allowing them to continue to be used effectively in new and modern modified environments. Moreover, new technologies themselves introduce new problems in the maintenance and evolution of the systems developed by them, requiring further new solutions.

The CSMR aims to be a reference point where new advances in the research of methods and techniques to efficiently and effectively maintain and evolve software systems are presented and discussed, as well as to promote cooperation among researchers to face problems and to provide new solutions to overcome them.

With this in the mind, the main theme of this year's conference is "Developing maintainable and maintaining Service Oriented Software Systems (SOSS)". The development of service-based systems (e.g. using web services) is increasing, thus we have to face new issues and problems to develop, maintain and evolve SOSS. The definition and adoption of methods and techniques to do this effectively, as well as to migrate or reengineer existing systems to SOSS is one of the grand challenges for the next few years.

Sixty-five technical papers, from countries across the world, were submitted to CSMR 2006. Each paper has been reviewed at least by three members of the Program Committee and twenty seven full papers and four short papers were accepted for presentation at the Conference and inclusion in the Proceedings. Moreover, the technical program includes three Special Sessions: a Doctoral Symposium, with 6 presentations, a Tool Demonstration, with 6 presentations, and an Industrial Track, with 3 presentations.

Two keynote speeches enrich the CSMR 2006 Program: the first, by Professor Mark Harman from King's College London, is on the application of the Search-Based Software Engineering to the field of systems maintenance and reengineering; the second, by Dr. Werner Sommer, from SAP Labs France, is on the management of product innovation. The presence of a keynote speaker from the academia and a keynote speaker from the industry, as well as the Industrial Track special session, would highlight and enforce the role of the CSMR as an important meeting point between the academia and the industrial world.

The program is completed by a half day pre-conference tutorial about the migration of legacy components to a service oriented architecture, and a half day post conference workshop on the maintenance and reengineering of web based applications.

We want thank all of those who have contributed to set up and hold this year's conference: the authors for submitting their papers, the Program Committee members for their valuable work in reviewing and selecting the papers and in promoting the conference, the chairs of the special sessions, the chairs of the organizing committee together with all the people that helped in arranging the conference, and the members of the Steering Committee for their encouragement and advice. We thank all the organizations that are financially sponsoring this event and the University of Bari for the local arrangements. We also thank the IEEE Computer Society for producing the final proceedings.

Finally, we want thank all the attendees of CSMR 2006 who will make it a successful event, and we hope you will find the program interesting and enjoy your stay in Bari, a town rich in history and tradition.

Giuseppe Visaggio, General Chair
Giuseppe Antonio Di Lucca, Program Chair
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Obtaining Web Services from Relational Databases

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Abstract

Database reverse engineering in general has only been used to recover the conceptual schema employed during its construction. To the best of our knowledge, none of this work has made use of that static structure to perform a deep analysis to infer functionality, or in other words, services over data that could be offered via Web Services.

Our work goes beyond the discovery of functionality, generating Web Service-based applications to allow the remote access and management of legacy databases.

1. Introduction

When we speak about reengineering, we imagine a legacy application from which (and by means of a reverse engineering technique) we extract information about its most relevant entities, with the possible goal of generating an improved version. Reengineering has many purposes, namely improving the quality of an application, obtaining a new version of the software system, adding new features, etc.[1].

Not only old applications but also relational databases should be considered as legacy systems, because relational databases are subjects of reengineering processes.

Having a multi-tier application [2], we have to realize that the domain tier is chiefly responsible for implementing the required operations to achieve the objective for which the system was developed; moreover, this tier is usually considered as the conceptual model for building the relational database. Because of that, the database can be used not only to extract the static structure in a reengineering process but also to infer many of the original system functionalities.

Our research area is *reengineering relational databases to Web Service-based applications*, and related to this, we are developing a reengineering tool, in which we are implementing all our research results [3].

If we try to develop a general and partially-automated reengineering process for relational databases, we generally need to specify which kind of relational databases are involved. As far as we know, despite SQL-99 (object-relational databases) being the current standard, most legacy databases are still supported by SQL-92. For this reason, we are now mainly focusing on SQL-92- based databases, to exploit all its features, in order to develop a set of patterns which can help us find potential services in the schema of the database, using a model-driven pattern matching process as a sub-step of our general reengineering process.

The paper is organized as follows: Section 2 provides a brief description of the related work; Section 3 overviews Relational Web, our reengineering environment; Section 4 summarizes a part of our work; Section 5 depicts the role of Web Services in our context; Section 6 gives some conclusions and future work.

2. Related Work

Until recently, data reengineering (and more specifically reverse engineering) had not been one of the most important topics in reengineering for two straightforward reasons: (1) the traditional partition of software engineering and database systems, and (2) source code reverse engineering seems more interesting in many aspects in the academic environment [4]. Even though we can find significant research work in the context of database reengineering, almost all of it focuses on recovering the conceptual schema used during initial development to migrate the database from an old data model to a new one, to a new DBMS in the same model, etc.

As well as tools, methodologies have also been designed. [5, 6] present a reengineering database project named DB-MAIN. DB-MAIN is a generic methodology with the following steps: (1) database structure extraction and (2) data structure conceptualization. This methodology is implemented in a tool also called DB-MAIN.

In [7], the MIDAS framework is described. MIDAS tackles the task of migrating net databases into relational databases. MIDAS implements can also replace database access subroutines for SQL statements by means of a set of graph-based transformations.

Model management, one of the most important drivers in current reengineering theory, is used, of course, to join traditional techniques with current advantages in reengineering. In this respect, we can mention [8, 9], where the MOMENT framework for model management is explained. Model management is a new discipline in model engineering that considers models (and metamodels) as first order citizens and also provides a set of generic operators in order to manipulate them. In MOMENT, models are specified as sets of elements different from the metamodel, so the algebraically specified operators by means of Maude (see below) can access these elements with no knowledge of the model representation [10]. MOMENT also deals with database reengineering. MOMENT applies model transformation only to recover the structure and to generate applications, taking relational databases as the starting point.

3. Relational Web: a brief description

Relational Web is a tool which implements a whole reengineering process for relational databases. The different database vendors supported are Microsoft Acces, SQL Server, Caché Intersystems and Oracle.

Figure 1 summarizes the process, setting aside many technical and algorithmic details (see [3, 11]). As can be seen in Figure 1, the starting point is a relational database from which we obtain the logical schema corresponding to the physical database, which is represented using a *"database metamodel"*. To take advantage of the object-oriented paradigm, the instance of the current database metamodel is transformed into an instance of the ***"Object Oriented System"*** metamodel, which is itself nearly a representation of the end-application. Having this instance of the OOS metamodel, we use different code-factories depending on the sort of application we want/need to generate.

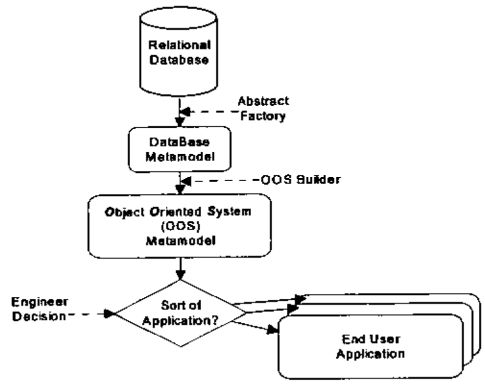

Figure 1. Relational Web abstract process representation

As previously mentioned, it is difficult to infer behaviour from a relational database, even more so when we are dealing with SQL-92 databases. But *Relational Web* implements two mechanisms to give behaviour to final applications: implementing the well known *CRUD operations* and building state machines.

By means of a state machine, we can establish a set of different states where an instance representing a record of a table could be found in any moment of its life-cycle. For example, imagine an object representing an instance of the table *Account*, representing a banking account. Its possible set of states could be: *BalanceZero*, *BalancePositive* and *BalanceNegative*.

In the current version, the decision about making one set of states or another falls to the engineer, that is to say, the state machine generation process is not an automatic process, but a manual one. For further information, please see [3].

4. Eliciting information from SQL-92 databases

As far as we know, there are no studies that deal with the task of inferring functionality from the static representation of a relational database. We are now working in this area, using the MDA approach [12] to solve it.

The current standard in relational (object-relational in fact) databases is SQL-99, but the reason we are starting our research work in the SQL-92 standard is because SQL-92 is one of the most common set-up databases (as for example can be seen in [13], where most reversed databases were relational), and thus, the most suitable candidate for a reengineering process (to expose the database to the web by means of Web Services, in our context).

The full structure of SQL-92 databases is represented in the metamodel presented in [14]. This metamodel has been developed for SQL-2003, but since SQL-92 is a subset of SQL-99, and the latter is also a subset of SQL-2003, we can customize the SQL-2003 metamodel by means of a projection (which can be seen as a model transformation in the MDA approach).

Taking these assumptions, we can extend and improve all the results obtained from the research done on SQL-92 to the following versions of the SQL standard.

4.1. Model-Driven Pattern Matching

As noted above, the database schema is considered as the reflection of the domain layer, so it is very possible that many of the functionalities of the application are reflected in the schema of the relational database.

Although it is a difficult task, we are trying to discover patterns to identify functionality in the recovered schema of the relational database.

Considering the relational database schema and the patterns as models, we can make pattern matching using a transformational language, such as QVT [15], which is the OMG proposal to make queries, create views and perform transformations over models.

4.2. An example of our database patterns

In this section, we are going to briefly present another kind of pattern we have discovered (because of the available space, this is only a very short summary and serves as an example of our work):

- Pattern 1: If more than one foreign key exists between two tables, we generate for the secondary table (the table which is the origin of the foreign key) a method into which an SQL sentence is built automatically. This SQL sentence joins, using "ORs", different combinations of the pair "foreign key columns-referenced columns". This SQL acts as a more flexible filter which could give us more information.
- Pattern 2: In addition to the inherent security in SQL-92 databases (which acts at table level), we can generate source code in order to allow manipulation of a database record only by the user who added this record. For this pattern we suppose that a "users table" exist and the constrained table is related to the users table by means of a foreign key. Having that, we know the user who (perhaps) inserted a given record, and thus, we can generate code to allow constrained access.

4.3. Automatic generation of state machines

As noted in section 3, Relational Web has the possibility of adding state machines to customize the behaviour of the classes representing the tables in the relational database.

We think that a deep analysis of the structure of the database (SQL-92 at this time) could reveal enough information to say whether a class representing a record of a table is in one state or another.

5. Exposing functionality with Web Services

Up to now, we have spoken about reengineering SQL-92 databases to infer functionality, but we have not mentioned how we are going to offer this functionality.

In the end, all the functionality extracted can be viewed as operations over the database and our intention is to use Web Services to expose these operations (**Figure 2**). The current version of *Relational Web* makes it possible to generate EJB-based applications (EJB artefacts [16], the distributed components of Java); in the same way, Web Services (which are more flexible and heterogeneous) could perform the same goal. The reason for using Web Services instead of other types of component or software artefacts, is that Web Services have been created for system integration and to wrap legacy systems among other things [17].

The generated Web Services will expose the following operations: *CRUD operations*, Business operations defined in the state machines and Operations due to patterns.

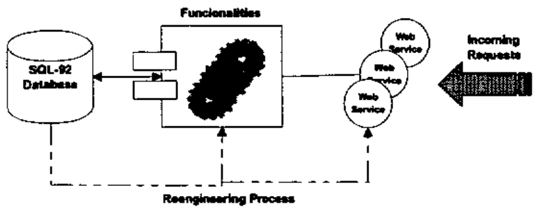

Figure 2. Web Service role inside the process

6. Conclusions and future work

Up to now, we have developed a complex but full functional environment for database reengineering, Relational Web, whose efficiency has been proven in many projects.

Despite the fact that SQL-92 databases are obsolete, they are the real legacy systems, and most companies are working over this kind of database. For this reason, we are designing an effective process for reengineering this kind of database towards the web, exposing functionalities and operations.

Our research work is mainly focused on discovering hidden functionalities by means of pattern matching and state machines. These functionalities are exposed by means of Web Services, which are also automatically generated inside the reengineering process.

7. Acknowledgements

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