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ITB9207

Chapter XIV

Active Rules and Active Databases: Concepts and Applications

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ABSTRACT

This chapter surveys the topic of active rules and active databases. We analyze the state of the art of active databases and active rules, their properties and applications. In particular, we describe the case of triggers following the SQL-1999 Standard Committee point of view. Then, we consider the case of dynamic constraints for which we use a temporal logic formalism. Finally, we discuss the applicability, limitations and partial solutions found when attempting to ensure the satisfaction of dynamic constraints.

INTRODUCTION

Databases are essentially large repositories of data. From the mid-1980s to the mid-1990s, a considerable effort has been paid to incorporate reactive behavior to the data management facilities available (Dayal et al., 1988; Chakravarthy, 1989; Stonebraker, 1986). Reactive behavior is seen as an interesting and practical way for checking satisfaction of integrity constraints. Nevertheless, constraint maintenance is not the only area of application of data repositories with reactive behavior. Other interesting applications areas are materialized view maintenance (especially useful in the warehousing area), replication of data for audit purpose, data sampling, workflow processing,

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implementation of business rules, scheduling and many others. In fact, practically all products offered today in the marketplace support complex reactive behavior on the client side. Nevertheless, the reactive behavior supported by these products on the server side is in fact quite poor. Recently, the topic has regained attention because of the inherent reactive nature demanded in Web applications, and the necessity of migrating many of their functionality from browsers to active Web servers (Bonifati et al., 2002).

We can find several applications in the electronic commerce arena. In Abiteboul et al. (1999), the authors present the Active Views system, which can be seen as an application generator oriented to solve the problems faced in application development in an electronic commerce environment. In this system, an Active View specification is a declarative description of an application. The authors consider that an electronic commerce application involves several types of actors, for instance customers and sellers. Basically, a specification includes, for each type of actor: (a) the data and operations available, (b) the activities and (c) active rules specifying the sequence of activities and events about which the actor wants to be notified. Even though the rules are very simple, interesting is the novel way the rules are integrated in a general framework, and how they are used for sequencing activities, notification and tracing. In particular, an active rule in Active Views has the following components:

- *Events:* method calls, operations on instance variables and detection of change.
- *Conditions:* XML queries returning a Boolean value.
- *Actions:* method calls, operations on instance variables, notification or traces.

In Bailey et al. (2001), the authors describe an event-condition-action (ECA) rule language in XML to provide reactive functionality on XML repositories. The language is based on fragments of the XPath and XQuery standards, and the components of an ECA are, again, *events*, *conditions* and *actions*. The event part of a rule is an expression <operation> *e*, where e is a simple XPath expression. The condition part of a rule is either the constant TRUE or one or more Xpath expressions connected by Boolean connectives **and**, **or**, **not**, and it is evaluated on XML documents that have been changed by the event specified in the event part of the rule. Finally, the action part of the rule specifies actions to be executed on one or more XML documents which have been changed as a consequence of the event and for which the condition part of the rule evaluates to TRUE. An action is an expression of the form:

Insert *r* below e [before|after *q*] or delete *e*

where r, e and q are a simple XQuery expression, a simple XPath expression, either the constant TRUE or an Xpath qualifier, respectively.

Bonifati et al. (2001a) study the problem of pushing information to clients in the case when the pushing logic is distributed. They propose a class of Internet services that are performed by means of active rules in a remote site. The active rules monitor the events that happen at remote sites and notify the interested clients. The rules represent diverse e-services. These kinds of active rules simplify the original problem of active rules for XML (Bonifati et al., 2001), since the rules can just notify remote users and, consequently, cannot trigger each other.

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