Towards an XML-Based Query and Contextual Information Model in Context-Aware Mobile Information Systems

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Outline

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Context aware mobile information systems (CAMISs):

- understand the context within which their users operate,
- process queries of the users based on the user context,
- use caching techniques to optimize query processing time and the energy consumption
In order to support CAMISs, there is a need to

- model the contextual information related to mobile clients,
- model queries issued by these mobile clients, and
- notify these mobile clients by any relevant update to cached data
Although, database systems (DBSs) are state-of-the-art for managing complex data in information systems,: 

- DBSs are not aware of the context of their usage,
- Query results are retrieved without considering the context of the user/device issuing the query
- DBSs does not have an update notification mechanism
Research Problem

Problem Statement

Move the complexity of managing context-aware query processing and cache management from middlewares to a built-in function within DBMSs.
Research Objective

Objective Statement

- modeling the contextual information related to mobile clients and their queries executed at the DB server, and
- Realizing such model within DBSs to support context-aware query processing and cache management.
we assume a mobile service provider (MSP) is to prepare for their customers contextual information document.

The mobile users are supposed to issue ad-hoc or preregister queries.

These queries might be continuous or non-continuous queries.
XReAl: An XML-Based Model for Queries and Contextual Information

- **XReAl** stands for **XML-Based Relational Algebra**
- **XReAl** formalizes:
  - the contextual information of mobile clients
  - queries issued by these clients
  - manipulation operations
- The XReAl specifications are XML documents that could be managed using any DBMS supporting XML management
XReAl: An XML-Based Model for Queries and Contextual Information

The XReAl model for the mobile client

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**XReAl: An XML-Based Model for Queries and Contextual Information**

<table>
<thead>
<tr>
<th>A) Part of the physical context</th>
<th>B) Part of the informational context</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;relative_position&gt;</code></td>
<td><code>&lt;quote&gt;</code></td>
</tr>
<tr>
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<tr>
<td><code>&lt;/relative_position&gt;</code></td>
<td><code>&lt;/quote&gt;</code></td>
</tr>
</tbody>
</table>
XReAl: An XML-Based Model for Queries and Contextual Information

Example

The QCL query

retrieve the name, street, and hotline of cinemas in my current location, where the rate of the cinema is greater than four

An equivalent relational algebra for the QCL query

Projection Predicate

$$\pi_{ctab.cname, ltab.street, ctab.hotline}$$

Selection Predicate

$$\sigma_{ctab.RATE > 4 \land \text{current location}}$$

Join Predicate

$$\rho_{ctab\,(cinema\_tab) \bowtie_{ctab.LID = ltab.LID} \rho_{ltab\,(location\_tab)}}$$
XReAl: An XML-Based Model for Queries and Contextual Information

An equivalent relational algebra for the QCL query

**Projection Predicate**

\[ \pi_{ctab.cname, ltab.street, ctab.hotline} \]

**Selection Predicate**

\[ (\sigma_{ctab.RATE > 4 \land \text{current location}}) \]

**Join Predicate**

\[ (\rho_{ctab(cinema\_tab) \bowtie_{ctab.LID=ltab.LID} \rho_{ltab(location\_tab)})}) \]

An equivalent relational algebra for the QCL query

\[ (\pi_{ctab.cname, ctab.hotline, ctab.LID})(\sigma_{ctab.RATE > 4}(\rho_{ctab(cinema\_tab)}))) \]

\[ \bowtie_{ctab.LID=ltab.LID} \]

\[ (\pi_{ltab.street, ltab.LID})(\sigma_{\text{current location}}(\rho_{ltab(location\_tab)}))) \]
XReAl: An XML-Based Model for Queries and Contextual Information

An Example

The XReAl specification of the QCL query

```
<query QID="QID1" MCID="MC101">
  <relations>
    +<relation RID="RID01">
    +<relation RID="RID02">
  </relations>
  <join>
    <jpredicate>
      <simplePredicate>
        <attribute ofRelation="RID01">
          <name>LID</name>
        </attribute>
      </simplePredicate>
    </jpredicate>
  </join>
</query>
```

```
<operator>eq</operator>
<operand>
  <attribute ofRelation="RID02">
    <name>LID</name>
  </attribute>
</operand>
</jpredicate>
</join>
</query>
```
**A Prototype System**

Our prototype system:

- is a proof-of-concept system utilizes XREAL to realize within DBMS:
  - a context-aware query processor
  - an update notification mechanism (*Essam Mansour, Hagen Höpfner, EDBT 09*)
- is implemented using Sun Java 1.6 and DB2 Express-C 9.5
The ER diagram of the XReAl Repository

<table>
<thead>
<tr>
<th>MClient</th>
<th>Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>+MCID: CHARACTER (5)</td>
<td>+QID: CHARACTER (5)</td>
</tr>
<tr>
<td>+MCINFO: XML</td>
<td>+MCID: CHARACTER (5)</td>
</tr>
<tr>
<td></td>
<td>+QTree: XML</td>
</tr>
</tbody>
</table>

issues queries
Context-Aware Relational Algebra is a relational algebra with context aware operators, such as:

- current location
- close to
- approaching
- ...

A Prototype System: Context-Aware Query Processor
An equivalent relational algebra for the QCL query

\[
\left(\pi_{ctab.cname,ctab.hotline,ctab.LID}\left(\sigma_{ctab.RATE > 4}\left(\rho_{ctab}(cinema_tab)\right)\right)\right) \bowtie_{ctab.LID = ltab.LID} \left(\pi_{ltab.street,ltab.LID}\left(\sigma_{current\ location}\left(\rho_{ltab}(location_tab)\right)\right)\right)
\]

An equivalent relational algebra for the QCL query

\[
\left(\pi_{ctab.cname,ctab.hotline,ctab.LID}\left(\sigma_{ctab.RATE > 4}\left(\rho_{ctab}(cinema_tab)\right)\right)\right) \bowtie_{ctab.LID = ltab.LID} \left(\pi_{ltab.street,ltab.LID}\left(\sigma_{postal\ code = 76646}\left(\rho_{ltab}(location_tab)\right)\right)\right)
\]

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The major advantages of the XREAL model:
- the direct integration into modern DBSs,
- XREAL provides context-aware management support within these DBSs, and
- the XREAL specification is to be shared among heterogeneous applications and systems.
Future work

- the support of all relational algebra operation in the XREAL model
- the formalization of the correlation between different contexts
- the formalization of advanced context-aware predicates in the form relational algebra operations, and
- Developing a context-aware query processor within DBMSs based on XREAL.
Thank You

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