

COLLABORATIVE RESEARCH IN LOCATION DEPENDENT DATA MANAGEMENT

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Project Award Information

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- Title: Collaborative Research in Location Dependent Data Management

Keywords

Mobile computing, databases, location dependent data, caching

Project Summary

The objective of this research is to further explore the concept of LDD, its impact on transaction processing, and develop efficient schemes for its management. As a result of this research, approaches will be produced which facilitate the storage of location dependent data at Mobile Units and techniques to efficiently process transactions which access this type of data.

Publications and Products

- Qun Ren and Margaret H. Dunham, "Using Semantic Caching to Manage Location Dependent Data in Mobile Computing," May 2000, *Proceedings of the international Conference on Mobile Computing*.
- Qun Ren, Margaret H. Dunham, and Vijay Kumar, "Semantic Caching in Mobile Computing," February 2001, conditional acceptance for publication in *IEEE Transactions on Knowledge and Data*

Engineering.

- Margaret H. Dunham, Ayse Yasemin Seydim, Ahmad Al-Mogren, and Vijay Kumar, “Data in Your Space”, invited paper to appear in *Proceedings of WECWIS*, 2001.
- Ayse Yasemin Seydim, Margaret H. Dunham, and Vijay Kumar, “Location Dependent Query processing”, accepted to appear *Proceedings of Mobide*, 2001.
- Vijay Kumar, Kalpana Dash, Margaret H. Dunham, and Ayse Yasemin Seydim, “A Timeout-Based Mobile Transaction Commitment Protocol”, November 2000, submitted to *Very Large Database* .
- Ayse Yasemin Seydim, Margaret H. Dunham, and Vijay Kumar, “Location Dependent Query Processing: Overview of a Framework”, March 2001, submitted to MDDS 2001.
- Ahmad S. Al-Mogren and Margaret H. Dunham, “BUC, a Simple Yet Efficient Concurrency Control Technique for Mobile Data Broadcast Environment”, March 2001, submitted to MDDS 2001.

Project Impact

- This grant has supported two women PhD students. One successfully defended in February 2000
- Grant funds are being used to purchase needed PCs and printer.
- The PI has been collaborating with several companies who are currently developing location based service products.

Goals, Objectives, and Targeted Activities

The initial goal for this research was to define how *Semantic Caching* can be used to effectively manage *Location Dependent Data (LDD)* . An LDD query workload is more likely to exhibit a semantic locality in terms of the locations, rather than one defined by the database physical organization. This unique characteristic makes the traditional page or tuple caching inappropriate to the LDD applications in mobile computing. In addition this observation motivates the development of cache replacement strategies built around location and movement. The idea of *semantic caching* is that the mobile client maintains both the semantic descriptions and associated answers of previous queries in the cache. If a new query is totally answerable from the cache, no communication with the server is necessary; if it can only be partially answered, the original query is trimmed and the trimmed part is sent to the server to be processed. Semantic caching is by nature an ideal cache scheme for location dependent applications. We have developed a formal semantic caching model suitable for LDD and developed query caching strategies. By binding each location dependent query to a precise location, a location dependent query can be treated as a traditional database query. We have proposed a mobility-based semantic cache replacement policy, *Further Away Replace (FAR)* . Those segments in the cache which are not in the moving direction and are furthest from the user will be discarded first, as we believe that they won't be visited in the near future. Simulation performance studies have validated the effectiveness of this approach. FAR consistently outperforms LRU and MRU replacement strategies.

Current research is defining precisely what *Location Dependent Queries (LDQ)* are and how to process them. An LDQ is a query whose results dependent on the location of the issuer. Thus as the client moves around the results may change. *Non-Location Related Queries (NLR)* are traditional queries which contain no location predicates. If a query contains a location predicate which is not based on movement then this query is referred to as a *Location Aware Query (LAQ)* . When processing an LDQ, it is first translated into an LAQ by binding the query to a specific location and thus is converted into an LAQ. Depending on the support provided by the server, the LAQ may actually be converted into an NLR for processing.

We have designed a middleware approach to processing LDQs which involves five phases: Semantic Analyzer and Query Binder, Location Leveler and Query Builder, Query Fragmenter and Sender, Result Analyzer and Query Filter, and Merge and Change Format. The design for this *Location Dependent Services Manager* is underway in preparation for the building of a prototype LDQ testbed. A major research issue for the next year is the technique to be used to perform leveling. *Leveling* is used to solve the granularity mismatch problem which exists between the location granule to which the LDQ is bound and that which is supported by the server.

Area Background

Unlike conventional data processing systems, in a mobile computing environment the value of data may depend on location, and processing of a transaction at one site may give different results than that at another. *Location Dependent Data (LDD)* is data whose value is determined by (a) the geographical location of data storage and (b) the geographical location of the Mobile Unit (MU) where the query originated. For example, when a query from an MU wants to find out information about local hotels, it will get a different answer in Dallas than in Kansas City. It would even be possible for a traveler driving from Dallas to Kansas City to ask the same question en route but request the response using Kansas City data rather than data based on the location from which he requests the query. The query may be stated exactly the same.

Area References

We maintain a link of [my favorite mobile computing references](#) on my home page.

Potential Related Projects

This is collaborative work with Vijay Kumar at the University of Missouri at Kansas City. Dr. Kumar is concentrating more on the transaction processing aspects of location dependent data while we're working on caching. Ouri Wolfson at the University of Illinois at Chicago has developed a model of query processing, MOST, which is based on the usage of location dependent data. We have based many of our ideas for query processing types on his work. Michael Franklin at Berkeley has worked on semantic caching and was the first to propose the usage of a cache replacement policy based on location and movement of a mobile unit.