

8-15-1997

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Recommended Citation

Chen, Nai-Kuang Andrew, "Flexible Database Systems for Rapid Query Processing in a Dynamic and Uncertain Query Environment" (1997). *AMCIS 1997 Proceedings*. 123.
<http://aisel.aisnet.org/amcis1997/123>

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Flexible Database Systems for Rapid Query Processing in a Dynamic and Uncertain Query Environment

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I. Introduction and motivation:

Today businesses are facing a dynamic environment of global competition, rapid information technology innovations, and manifold customers' needs. In order to strive for success, businesses have to use quality information to assist decision-making and problem-solving. The need for timely information provides the impetus for research on relationships between speed of response, database structures, and query types. To date, for conventional database systems in fairly stable environments, research has focused on: (1) developing a proper fixed database structure to process pre-defined query sets with speed, or (2) applying techniques to improve speed of responses for an existing fixed database structure. For (1), the typical procedure has been to conduct a one-time development effort to design a fixed database structure based on a set of pre-defined routine queries. Examples include research on conceptual design and logical design. For (2), the typical approach has been to fine-tune the fixed database structure to efficiently process queries. Examples include research on physical design, query optimization, and database tuning.

Fixed database structures actually perform well in providing relatively fast responses to predictable queries in a stable environment. However, performance of fixed database structures may decline precipitously in today's dynamic environments where we face more *ad hoc* (uncertain and dynamic) queries from an increasingly diverse population of information users. Thus, we seek to develop a *flexible* database system with adaptive capability enabling the dynamic assignment of queries to alternative database structures. The objective is to maintain performance levels (fast response times) under changing query patterns and changing business environments.

II. Model and methodology:

We build an analytical model to investigate the relevant factors which affect query processing time. This model also help us to conduct a careful cost/benefit analysis and to show that the benefits from getting fast response time for information queries will outweigh the relative costs. The objective function of this model is set to maximize the benefit of getting fast query processing time with relative costs incurred such as access costs, update costs, storage costs, and opportunity costs of data redundancy. At the same time, we use laboratory experiments to demonstrate our methodology and illustrate potential benefits from implementing the process in real-world applications. We choose the laboratory environment since it is very difficult and expensive for an organization to experiment on actual data environments. The experiment showed that applying learning techniques which identify and assign proper alternative database structures for processing

specific queries in a query set had better performance levels than using any single fixed database structure to process all queries in the query set.

In this experiment, we demonstrated the ability of learning tools to help databases provide fast responses to uncertain queries. We also expect that higher accuracy rates can be achieved when the size of training data increases as we expand in applying the techniques in real-world settings.

III. Remarks:

We demonstrated the use of learning techniques to search through queries to identify useful patterns and relationships among query properties, alternative database structures, and processing time. The findings can be used as a guide of assigning queries to alternative database structures in order to provide fast response for any variety of uncertain queries. We used inductive learning and neural network in similar experiments to demonstrate our methodology and illustrate potential benefits from implementing the process. The experiment illustrated the use of learning tools to assign queries to different database structures for processing different queries had better performance than processing all queries in a single fixed database structure.