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Faculty of Engineering

Query Optimization For Distributed DataBase Systems

By

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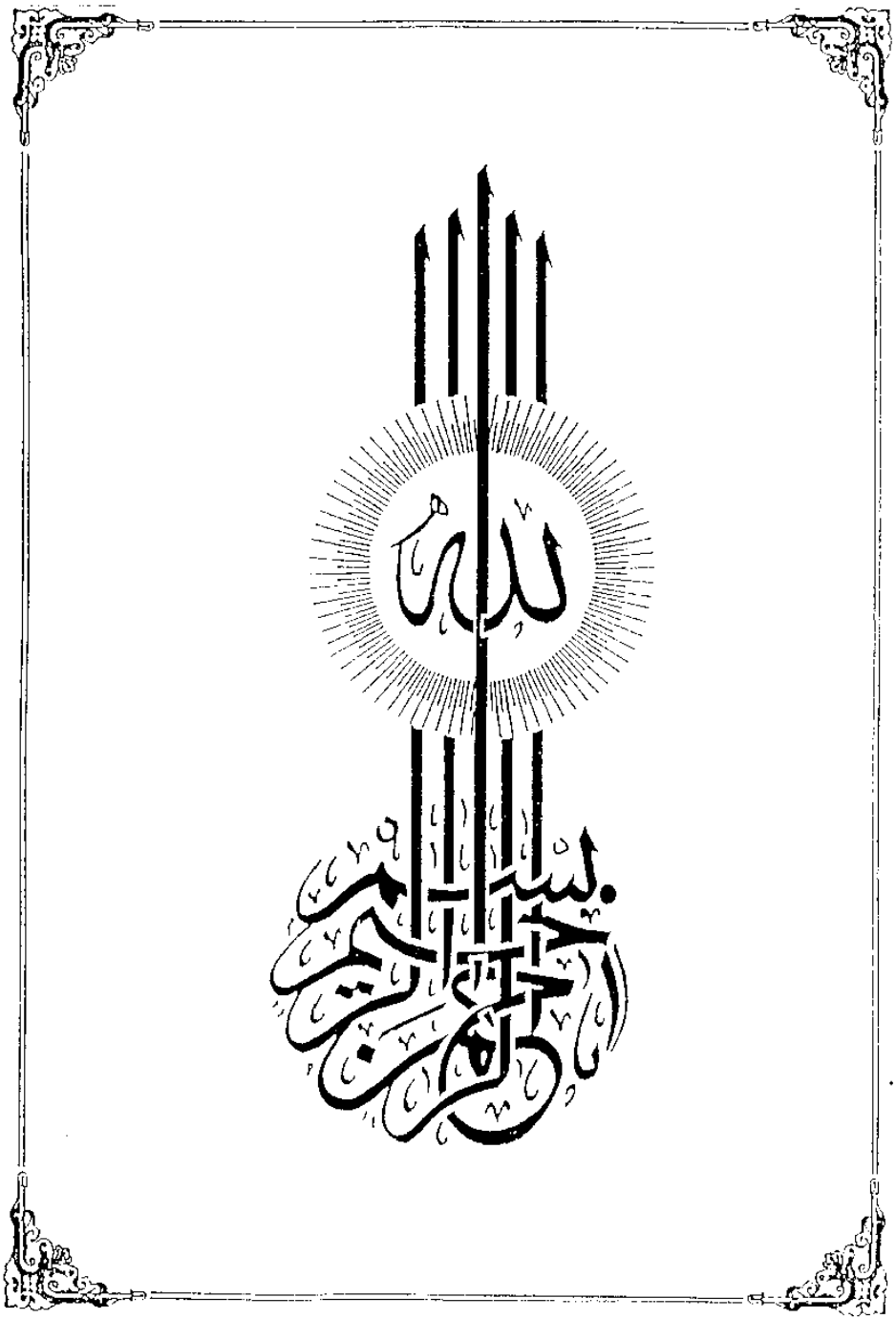

Statement

This dissertain is submitted to Ain Shams University for the degree of PH.D. in Electrical Engineering (Computer and Systems Engineering).

The work included in this thesis, was carried out by the auther in the Depertment of Computer and Systems Engineering , Faculty of Engineering, Ain shams University from 11/1/1986 to 2/4/ 1992.

No part of this thesis has been submitted for a degree or a qualification at any other university or institution

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Abstract

Most of the work done in this area give a good sequence or a close to optimal sequence for join queries, by using *heuristics* based on the semi-join operations. Most of these algorithms are implemented for a certain environment and can not solve the whole problem. Other works use *dynamic programming*, this approach is only good when queries reference a small number of relations because the search space becomes large quickly as the number of relations increase. In fact this rapid growth of the search space limits the usefulness of dynamic programming.

The suggested work is based on using an A^* algorithm which is a known heuristic search technique in Artificial Intelligence. In A^* algorithm the solution can be found without necessarily having to compute the cost of all states or even having to construct them.

The suggested work has been designed to cover the following:

1. **Selecting one copy of each relation referenced by the query.**
2. **Elimination of sending unnecessary relations to assembly site.**
3. **Constant and variable Communication cost between sites, and local processing costs.**

Simulation has been utilized to study the effect of the following parameters on response time of the query:

1. **Input parameters, such as, rate of queries, and distribution of queries among sites.**
2. **System parameters, such as, communication channel capacity and protocols, and computers.**
3. **Configuration parameters, such as, allocation of relations.**

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CHAPTER 1

CHAPTER 1: Thesis Objective And Overview 1

CHAPTER 1

Thesis Objective And Overview

Distributed databases are important for economical, organizational and technological reasons. They can be implemented in large geographical computer networks and in small local networks. The number of applications of distributed databases will grow in the next years, as distributed database management systems will become available.

Distributed database technology extends traditional database technology in a nontrivial way. In this environment, several technical problems require different solutions, and several completely new issues arise.

This research is concerned with the problem of query processing optimization in distributed database. The goal of query optimization is to find an execution strategy which minimizes the cost of a query, given by the sum of the transmission costs and of the local processing costs. Depending on the characteristics of the communication network and of the local systems, local processing costs can be disregarded in the optimization of the execution strategy of the query. This is typically the case of large geographical networks with low bandwidth, which have transfer rates

of an order of magnitude lower than the disk-to-memory transfer rate. On the Contrary, for fast local networks local processing costs must be considered.

Most of the work done in this area gives a good sequence or a close to optimal sequence for join queries, by using *heuristics* based on the semi-join operations. Most of these algorithms are implemented for a certain environment and cannot solve the whole problem. Other works use ***dynamic programming***, this approach is only good when queries reference a small number of relations because the search space becomes large quickly as the number of relations increase. In fact this rapid growth of the search space limits the usefulness of dynamic programming.

The suggested work is based on using **A*** algorithm which is a known heuristic search technique in Artificial Intelligence. In **A*** algorithm the solution can be found without necessarily having to compute the cost of all states or even having to construct them.

This thesis is organized as follows:

Chapter 2 discusses the aspects of databases and computer networks that are required in order to understand the rest of the thesis. It also discusses the query processing optimization in distributed database systems.

Chapter 3 illustrates the formulation of the query processing optimization problem and the different models of distributed database for query processing optimization.

Chapter 4 is concerned with the suggested model for query processing optimization in distributed database.

Chapter 5 studies the sensitivity analysis of query processing optimization in distributed database. The study is done using simulation techniques. NETWORK II.5 version 3 is the simulation package used.

Chapter 6 concludes the thesis and points to further work.

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CHAPTER 2

Query Processing Optimization In Distribution DataBase Systems

The collection of data is usually referred to as the *database*. The *DBMS*s are designed to improve the productivity of application programmers and facilitate data access by computer end users.
The database that is stored on, or manipulated from one computer only is called a *centralized database*, while if the database is resident in, or manipulated from several computers, it is called a *distributed database*.
A language expression used to enable users to retrieve data from a database is called a *query*. When a query is presented to the system, it is necessary to find the best method of finding the answer using the existing database structure. There are a large number of possible strategies for processing a query , especially if the query is complex. The goal of this research is the query processing optimization in distributed databases.

In this chapter, first, I will review the data models, the basic concepts about computer networks, queries, relational algebra operators, and distributed databases. Then, I will talk about the framework for query processing optimization, and factors affecting it. Then, I present the optimization of Join-Query. Finally, I will talk about special problems of the database machine, and multiple query processing optimization.

2.1. Database Models:

The database models are used in describing data at the conceptual and view levels. There are three database models.

Relational model:

The data and the relationships among data are represented by a collection of tables each of which has a number of columns with unique names. Figure 2.1 is a sample relational database. For more details about relational model and its normal forms (first, second, third, boyce/codd, fourth, and fifth normal forms) see [DATE74], [MART75], [KRON77], and [DATE86].

Name	Street	City	Number
Lowery	Maple	Queens	900
Shiver	North	Bronx	556
Shiver	North	Bronx	647
Hodges	Sidehill	Brooklyn	801
Hodges	Sidehill	Brooklyn	647

Number	Balance
900	55
556	100000
647	105366
801	10533

Figure 2.1
A sample relational database.

Network model:

Data in the network model are represented by a collection of records and relationships among data are represented by links, which can be viewed as pointers. The records in the data base are organized as collections of arbitrary graphs. Figure 2.2 is a sample network database that has the same information as in