DATABASE THEORY AND IMPLEMENTATION

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ABSTRACT

This paper (presentation) demonstrates how to use a hands-on approach to teaching database theory and implementation. One of the unique features of this approach is that it shows how to download software and set up a reader's own pc as a database web server. Readers can begin exploring database theory immediately. Relational database theory and algebra are defined and presented mathematically with ample examples and experiments.

INTRODUCTION

This book is about Relational Database Theory and Implementation. The book is aimed towards students at the upper division level who have had a course in SQL. The entire book is online at http://lochsa.lcsc.edu/Databasetext.html.

One of the unique features of this book is that it begins with a hands-on chapter that allows readers to download software to set up their own pc as a database web server. Students or readers are expected to have a pc with either Windows XP or Linux as its operating system.

From this point relational database theory and algebra are defined and presented mathematically with ample examples and experiments that students conduct on their pc's database server. This approach continues in an exploration of Entity-Relationship Modeling and is incorporated into a mathematical approach to Normalization.

Multiple Case Studies are included and used to illustrate database concepts. Although students are expected to have a previous course in sql, a self-contained chapter on sql follows after the theoretical material.

PRELIMINARIES

The goal of this section is to make your personal computer into a web-database server.
Open a browser and go to http://apache2triad.net/ and download the most recent version of apache2triad. This will install a web server: Apache2Triad, [4], is an apache2 bundle installed and configured working out of the box that contains : SERVERS: Apache2 , MySQL , PostgreSQL , OpenSSL , Xmail , SlimFTPd INTERPRETERS: PHP , Perl , Python SCRIPTS: PHPmyadmin , PHPXMail , PHPSftpD + AWStats , SSLCert etc.
Once installation is complete, you may need to reboot your system.
Now open a browser and go to http://localhost. You should see something like this:

Index of /

Name   Last modified   Size Description
_____

phpmyadmin/   19-Jan-2006 20:21   -
phpsftpd/   19-Jan-2006 20:21   -
phpxmail/   19-Jan-2006 20:21   -
uebimiau/   19-Jan-2006 20:21   -
htdocs   19-Jan-2006 20:20 233

Select phpmyadmin to open an interface to the database.

A SAMPLE FROM THE MATHEMATICS OF RELATIONS

Definition 12 – A Cartesian Product of n sets $D_1, D_2, ..., D_n$ is defined by

$$\mathop{X}_{i=1}^{n} D_i = \{(d_1, d_2, ..., d_n) \mid d_1 \in D_1, d_2 \in D_2, ..., d_n \in D_n\}$$ and has cardinality $\prod_{i=1}^{n} c_i = c_1 \cdot c_2 \cdot ... \cdot c_n$ where c_i is

the cardinality of D_i.

Definition 13- A relation (table) schema is a name followed by a set of attribute and domain name pairs. Go to your mysql database server and select the database mysql. Then select the table columns_priv. The schema can be described this way: columns_priv{Host: char(60),Db: char(64), User: char(16), Table_name: char(64),Column_name: char(64), Timestamp: timestamp(14), Column_priv : set('Select', 'Insert', 'Update', 'References')}

Definition 15 - A base relation is a relation that represents an entity in the conceptual schema of a database. If you look at the mysql database 7 tables are entities (base relations).

Definition 16 – A view is the result of relational operations operating on the base relations to produce another relation. The view is a virtual relation that does not actually exist as a table in the database. We are now in position to use relational algebra to create views. We will convert relational algebra to sql.

Definition 17 - $\sigma_{predicate}(R)$ Selection of tuples from a relation R those tuples that satisfy the predicate. For example $\sigma_{SEX=F}(student)$ has the sql equivalent of "select * from student where SEX = 'F'".

Definition 18 - $\prod_{col1,...,coln}(R)$ is a projection of all the tuples in R but only from the fields listed in {col1,…,coln}.

For example, $\prod_{NAME,CITY} student$ has the sql equivalent "select NAME,CITY from student".

Definition 19 - $R \times S$ is the Cartesian product that defines a new relation that consists of all tuples from the relation R concatenated with all tuples from S. For example, $student \times module$ yields a relation with 54 tuples each with 9 fields. (Why?).

Definition 20 - $R \cup S$ is the union of two relations that have the same attributes. Duplicates are discarded. It can be viewed as a set concatenation of tuples of R followed by tuples of S with matches tossed out.

Try this one on your test database: $\prod_{CODE} \mathrm{mod}\,ule \cup \prod_{MCODE} preq$. Here is the sql:

SELECT CODE FROM `module` UNION SELECT MCODE FROM 'preq'

Definition 21 – Set Difference Operation - $R - S$ defines a relation containing all tuples in R but not in S. Set theoretically this is $R \cap \sim S$ where $\sim S$ is the complement of S.

Definition 22 – Theta – join: $R \mathbin{><}_F S = \sigma_F(R \times S)$. This is a Cartesian product of two relations that satisfy the predicate F. F is of the form $R.a_i \theta S.b_i$ where θ is one of the comparison operators <, $\leq, >, \geq, =, !=$.

Example:

Try this relational algebra

$$\left(\prod_{SNAME,MCODE} register\right) \mathbin{><}_{register.SNAME=student.NAME} \left(\prod_{CITY} student\right)$$

And this equivalent sql: Select SNAME, MCODE, CITY from register join student on SNAME = NAME

REFERENCES

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[3] Thomas Connolly and Carolyn Begg and Anne Stachan, Database Systems, Second Edition, Addison-Wesley, 1998
[4] Apache2triad 1.5.3, apache2triad.net
[5] MySQL 4.1.14-nt-log, mysql.com