Introduction to Database Systems CSE 444

Lecture 04: SQL

October 3, 2007

Outline

- The Project
- Nulls (6.1.6)
- Outer joins (6.3.8)
- Database Modifications (6.5)

The Project

- Application:
  - Boutique online music and book store
- Project:
  - Create database, access through a Web interface
  - Import real data and develop inventory logic
  - Customer checkout
  - Advanced functionality (TBD)

The Project

- Team:
  - Two people
  - Find partner now!
- Tools:
  - SQL Server 2005
  - Visual Studio 2005
  - C# 2.0
  - ASP.NET 2.0

The Project

Phase 1: posted by end of week, due Oct.19

- Create a schema
- Populate the database: fake data for now
- Access through a simple Web interface

NULLS in SQL

- Whenever we don't have a value, we can put a NULL
- Can mean many things:
  - Value does not exists
  - Value exists but is unknown
  - Value not applicable
  - Etc.
- The schema specifies for each attribute if can be null (*nullable* attribute) or not
- How does SQL cope with tables that have NULLs ?

Null Values

- If x= NULL then 4*(3-x)/7 is still NULL
- If x= NULL then x="Joe" is UNKNOWN
- In SQL there are three boolean values:

FALSE	=	0
UNKNOWN	=	0.5
TRUE	=	1

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Null Values

- C1 AND C2 = min(C1, C2)
- C1 OR C2 = max(C1, C2)
- NOT C1 = 1 – C1

```
SELECT *
FROM Person
WHERE (age < 25) AND
      (height > 6 OR weight > 190)
```

E.g.
age=20
heigth=NULL
weight=200

Rule in SQL: include only tuples that yield TRUE

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Null Values

Unexpected behavior:

```
SELECT *
FROM   Person
WHERE  age < 25  OR  age >= 25
```

Some Persons are not included !

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Null Values

Can test for NULL explicitly:

- x IS NULL
- x IS NOT NULL

```
SELECT *
FROM   Person
WHERE  age < 25  OR  age >= 25 OR age IS NULL
```

Now it includes all Persons

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Outerjoins

Explicit joins in SQL = "inner joins":
Product(name, category)
Purchase(prodName, store)

```
SELECT Product.name, Purchase.store
FROM   Product JOIN Purchase ON
                 Product.name = Purchase.prodName
```

Same as:

```
SELECT Product.name, Purchase.store
FROM   Product, Purchase
WHERE  Product.name = Purchase.prodName
```

But Products that never sold will be lost !

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Outerjoins

Left outer joins in SQL:
Product(name, category)
Purchase(prodName, store)

```
SELECT Product.name, Purchase.store
FROM   Product LEFT OUTER JOIN Purchase ON
                 Product.name = Purchase.prodName
```

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Product

Name	Category
Gizmo	gadget
Camera	Photo
OneClick	Photo

Purchase

ProdName	Store
Gizmo	Wiz
Camera	Ritz
Camera	Wiz

Name	Store
Gizmo	Wiz
Camera	Ritz
Camera	Wiz
OneClick	NULL

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Application

Compute, for each product, the total number of sales in 'September'

Product(name, category)
Purchase(prodName, month, store)

```
SELECT Product.name, count(*)
FROM   Product, Purchase
WHERE  Product.name = Purchase.prodName
       and Purchase.month = 'September'
GROUP BY Product.name
```

What's wrong ?

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Application

Compute, for each product, the total number of sales in 'September'

Product(name, category)
Purchase(prodName, month, store)

```
SELECT Product.name, count(*)
FROM   Product LEFT OUTER JOIN Purchase ON
                  Product.name = Purchase.prodName
               and Purchase.month = 'September'
GROUP BY Product.name
```

Now we also get the products who sold in 0 quantity

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Outer Joins

- Left outer join:
  - Include the left tuple even if there's no match
- Right outer join:
  - Include the right tuple even if there's no match
- Full outer join:
  - Include the both left and right tuples even if there's no match

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Modifying the Database

Three kinds of modifications

- Insertions
- Deletions
- Updates

Sometimes they are all called "updates"

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Insertions

General form:

```
INSERT INTO R(A1,…., An) VALUES (v1,…., vn)
```

Example: Insert a new purchase to the database:

```
INSERT INTO Purchase(buyer, seller, product, store)
       VALUES ('Joe', 'Fred', 'wakeup-clock-espresso-machine',
               'The Sharper Image')
```

Missing attribute → NULL.
May drop attribute names if give them in order.

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Insertions

```
INSERT INTO PRODUCT(name)
   SELECT DISTINCT Purchase.product
   FROM Purchase
   WHERE Purchase.date > "10/26/01"
```

The query replaces the VALUES keyword.
Here we insert *many* tuples into PRODUCT

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Insertion: an Example

Product(name, listPrice, category)
Purchase(prodName, buyerName, price)

prodName is foreign key in Product.name

Suppose database got corrupted and we need to fix it:

Product

name	listPrice	category
gizmo	100	gadgets

Purchase

prodName	buyerName	price
camera	John	200
gizmo	Smith	80
camera	Smith	225

Task: insert in Product all prodNames from Purchase

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Insertion: an Example

```
INSERT INTO Product(name)
SELECT DISTINCT prodName
FROM Purchase
WHERE prodName NOT IN (SELECT name FROM Product)
```

name	listPrice	category
gizmo	100	Gadgets
camera	-	-

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Insertion: an Example

```
INSERT INTO Product(name, listPrice)
SELECT DISTINCT prodName, price
FROM Purchase
WHERE prodName NOT IN (SELECT name FROM Product)
```

name	listPrice	category
gizmo	100	Gadgets
camera	200	-
camera ??	225 ??	-

← Depends on the implementation

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Deletions

Example:

```
DELETE FROM PURCHASE
WHERE seller = 'Joe' AND
      product = 'Brooklyn Bridge'
```

Factoid about SQL: there is no way to delete only a single occurrence of a tuple that appears twice in a relation.

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Updates

Example:

```
UPDATE PRODUCT
SET price = price/2
WHERE Product.name IN
        (SELECT product
         FROM Purchase
         WHERE Date ='Oct, 25, 1999');
```

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Data Definition in SQL

So far we have see the ***Data Manipulation Language***, DML
Next: ***Data Definition Language*** (DDL)

Data types:
Defines the types.

Data definition: defining the schema.

- Create tables
- Delete tables
- Modify table schema

Indexes: to improve performance

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Creating Tables

```
CREATE   TABLE Person(
        name                    VARCHAR(30),
        social-security-number  INT,
        age                     SHORTINT,
        city                    VARCHAR(30),
        gender                  BIT(1),
        Birthdate               DATE

);
```

Deleting or Modifying a Table

Deleting:

Example: `DROP Person;` Exercise with care !!

Altering: (adding or removing an attribute).

Example:

```
ALTER TABLE   Person
      ADD   phone  CHAR(16);

ALTER  TABLE   Person
      DROP  age;
```

What happens when you make changes to the schema?

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Default Values

Specifying default values:

```
CREATE  TABLE Person(
        name                    VARCHAR(30),
        social-security-number  INT,
        age          SHORTINT   DEFAULT 100,
        city      VARCHAR(30) DEFAULT  'Seattle',
        gender       CHAR(1)  DEFAULT  '?',
        Birthdate                DATE
```

The default of defaults: NULL

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Indexes

REALLY important to speed up query processing time.

Suppose we have a relation

Person (name, age, city)

```
SELECT *
FROM    Person
WHERE   name = "Smith"
```

Sequential scan of the file Person may take long

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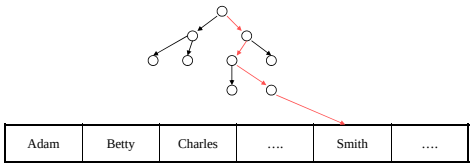
Indexes

- Create an index on name:



B+ trees have fan-out of 100s: max 4 levels !
Will discuss in the second half of this course

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Creating Indexes

Syntax:

```
CREATE INDEX  nameIndex ON Person(name)
```

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Creating Indexes

Indexes can be useful in range queries too:

```
CREATE INDEX ageIndex ON  Person (age)
```

B+ trees help in:

```
SELECT *
FROM Person
WHERE age > 25 AND age < 28
```

Why not create indexes on everything?

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Creating Indexes

Indexes can be created on more than one attribute:

Example:

```
CREATE INDEX doubleindex ON
                Person (age, city)
```

Helps in:

```
SELECT *
FROM    Person
WHERE age = 55 AND city = “Seattle”
```

and even in:

```
SELECT *
FROM    Person
WHERE age = 55
```

But not in:

```
SELECT *
FROM    Person
WHERE city = “Seattle”
```

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The Index Selection Problem

- Why not build an index on every attribute ? On every pair of attributes ? Etc. ?
- The index selection problem is hard: balance the query cost v.s. the update cost, in a large application workload

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