Lecture 13: SQL

Monday, October 29, 2001

Outline

- Subqueries (5.3)
- Duplicates (5.4)
- Database Modifications (5.6)
- Defining Relation Schema in SQL (5.7)
- Defining Views (5.8)
- Indexes 5.7.7

Subqueries

A subquery producing a single tuple:

```
SELECT Purchase.product
FROM   Purchase
WHERE  buyer =
           (SELECT  name
            FROM    Person
            WHERE   ssn = "123456789");
```

In this case, the subquery returns one value.

If it returns more, it's a run-time error.

Can say the same thing without a subquery:

```
SELECT Purchase.product
FROM   Purchase, Person
WHERE  buyer = name AND ssn = "123456789"
```

This is equivalent to the previous one when the ssn is a key; otherwise they are different.

Subqueries Returning Relations

Find companies who manufacture products bought by Joe Blow.

```
SELECT  Company.name
FROM    Company, Product
WHERE   Company.name=Product.maker
        AND  Product.name  IN
             (SELECT Purchase.product
              FROM   Purchase
              WHERE Purchase .buyer = "Joe Blow");
```

Here the subquery returns a set of values

Subqueries Returning Relations

Equivalent to:

```
SELECT  Company.name
FROM    Company, Product, Purchase
WHERE   Company.name= Product.maker
        AND  Product.name  = Purchase.product
        AND  Purchase.buyer = "Joe Blow"
```

Is this query equivalent to the previous one ?

Beware of duplicates !

Removing Duplicates

```
SELECT  Company.name
FROM    Company, Product, Purchase
WHERE   Company.name= Product.maker
        AND  Product.name  = Purchase.product
        AND Purchase.buyer = "Joe Blow"
```

←Multiple copies

```
SELECT DISTINCT Company.name
FROM    Company, Product, Purchase
WHERE   Company.name= Product.maker
        AND  Product.name  = Purchase.product
        AND Purchase.buyer = "Joe Blow"
```

← Single copies

Removing Duplicates

```
SELECT DISTINCT Company.name
FROM    Company, Product
WHERE   Company.name= Product.maker
        AND  Product.name  IN
             (SELECT Purchase.product
              FROM   Purchase
              WHERE Purchase.buyer = "Joe Blow");
```

```
SELECT DISTINCT Company.name
FROM    Company, Product, Purchase
WHERE   Company.name= Product.maker
        AND  Product.name  = Purchase.product
        AND  Purchase.buyer = "Joe Blow"
```

Now they are equivalent

Subqueries Returning Relations

You can also use: s > ALL R
s > ANY R
EXISTS R

Product (pname, price, category, maker)
Find products that are more expensive than all those produced By "Gizmo-Works"

```
SELECT  name
FROM    Product
WHERE  price >  ALL (SELECT price
                     FROM    Purchase
                     WHERE  maker="Gizmo-Works")
```

Question for Database Fans and their Friends

- Can we express this query as a single SELECT-FROM-WHERE query, without subqueries ?
- Hint: show that all SFW queries are monotone (figure out what this means). A query with **ALL** is not monotone

Conditions on Tuples

```
SELECT  DISTINCT Company.name
FROM    Company, Product
WHERE   Company.name= Product.maker
        AND  (Product.name,price)  IN
             (SELECT Purchase.product, Purchase.price)
              FROM   Purchase
              WHERE Purchase.buyer = "Joe Blow");
```


Correlated Queries

Movie (title, year, director, length)
Find movies whose title appears more than once.

```
SELECT DISTINCT title
FROM   Movie AS x
WHERE  year < ANY
             (SELECT  year
              FROM    Movie
              WHERE  title =  x.title);
```

correlation

Note (1) scope of variables (2) this can still be expressed as single SFW

Complex Correlated Query

Product (pname, price, category, maker, year)

- Find products (and their manufacturers) that are more expensive than all products made by the same manufacturer before 1972

```
SELECT DISTINCT pname, maker
FROM   Product AS x
WHERE  price > ALL (SELECT price
                    FROM   Product AS y
                    WHERE  x.maker = y.maker AND y.year < 1972);
```

Powerful, but much harder to optimize !

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Conserving Duplicates

The UNION, INTERSECTION and EXCEPT operators operate as sets, not bags.

```
(SELECT name
 FROM   Person
 WHERE  City="Seattle")

   UNION ALL

(SELECT name
 FROM   Person, Purchase
 WHERE  buyer=name AND store="The Bon")
```

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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 peformance

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Data Types in SQL

- Character strings (fixed of varying length)
- Bit strings (fixed or varying length)
- Integer (SHORTINT)
- Floating point
- Dates and times

Domains (=types) will be used in table declarations.

To reuse domains:
CREATE DOMAIN address AS VARCHAR(55)

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Creating Tables

Example:

```
CREATE    TABLE Person(

        name                    VARCHAR(30),
        social-security-number  INTEGER,
        age                     SHORTINT,
        city                    VARCHAR(30),
        gender                  BIT(1),
        Birthdate               DATE

 );
```

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Deleting or Modifying a Table

Deleting:

Example:

```
DROP Person;
```

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  INTEGER,
        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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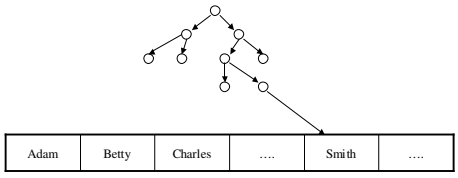
Indexes

- Create an index on name:



- B+ trees have fan-out of 100s: max 4 levels !

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Creating Indexes

Syntax:

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

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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"
```

But not in:

```
SELECT *
FROM   Person
WHERE city = "Seattle"
```

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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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Defining Views

Views are relations, except that they are not physically stored.

For presenting different information to different users

Employee(ssn, name, department, project, salary)

```
CREATE VIEW  Developers AS
   SELECT name, project
   FROM  Employee
   WHERE department = "Development"
```

Payroll has access to Employee, others only to Developers

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A Different View

Person(name, city)
Purchase(buyer, seller, product, store)
Product(name, maker, category)

```
CREATE VIEW  Seattle-view  AS

      SELECT  buyer, seller, product, store
      FROM    Person, Purchase
      WHERE   Person.city = "Seattle"    AND
              Person.name = Purchase.buyer
```

We have a new virtual table:
Seattle-view(buyer, seller, product, store)

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A Different View

We can later use the view:

```
SELECT   name, store
FROM     Seattle-view, Product
WHERE   Seattle-view.product = Product.name  AND
        Product.category = "shoes"
```

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What Happens When We Query a View ?

```
SELECT   name, Seattle-view.store
FROM     Seattle-view, Product
WHERE   Seattle-view.product = Product.name  AND
        Product.category = "shoes"
```

↓

```
SELECT  name, Purchase.store
FROM    Person, Purchase, Product
WHERE  Person.city = "Seattle"    AND
       Person.name = Purchase.buyer   AND
       Purchase.poduct = Product.name  AND
       Product.category = "shoes"
```

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Types of Views

- Virtual views:
  - Used in databases
  - Computed only on-demand – slow at runtime
  - Always up to date
- Materialized views
  - Used in data warehouses
  - Precomputed offline – fast at runtime
  - May have stale data

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Updating Views

How can I insert a tuple into a table that doesn't exist?

Employee(ssn, name, department, project, salary)

```
CREATE VIEW Developers AS
  SELECT name, project
  FROM Employee
  WHERE department = "Development"
```

If we make the following insertion:

```
INSERT INTO Developers
VALUES("Joe", "Optimizer")
```

It becomes:

```
INSERT INTO Employee
VALUES(NULL, "Joe", NULL, "Optimizer", NULL)
```

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Non-Updatable Views

```
CREATE VIEW Seattle-view AS

    SELECT seller, product, store
    FROM Person, Purchase
    WHERE Person.city = "Seattle" AND
          Person.name = Purchase.buyer
```

How can we add the following tuple to the view?

("Joe", "Shoe Model 12345", "Nine West")

We need to add "Joe" to Person first. One copy ? More copies ?

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