Lecture 02: SQL

Friday, January 6, 2006

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Administrivia

- Homework 1 is out. Due: Wed., Jan. 18
- Did you login on IISQLSRV ?
- Did you change your password ?
- Did you subscribe to CSE444 ?

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Today's Reading Assigment

- Did you read it ?
- What does ACID mean ?
  A = atomicity
  C = consistency
  I = isolation
  D = durability

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Outline

- Data in SQL
- Simple Queries in SQL (6.1)
- Queries with more than one relation (6.2)

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SQL Introduction

Standard language for querying and manipulating data

Structured **Q**uery **L**anguage

Many standards out there:
- ANSI SQL, SQL92 (a.k.a. SQL2), SQL99 (a.k.a. SQL3), ….
- Vendors support various subsets: watch for fun discussions in class !

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SQL

- Data Definition Language (DDL)
  - Create/alter/delete tables and their attributes
  - Following lectures...
- Data Manipulation Language (DML)
  - Query one or more tables – discussed next !
  - Insert/delete/modify tuples in tables

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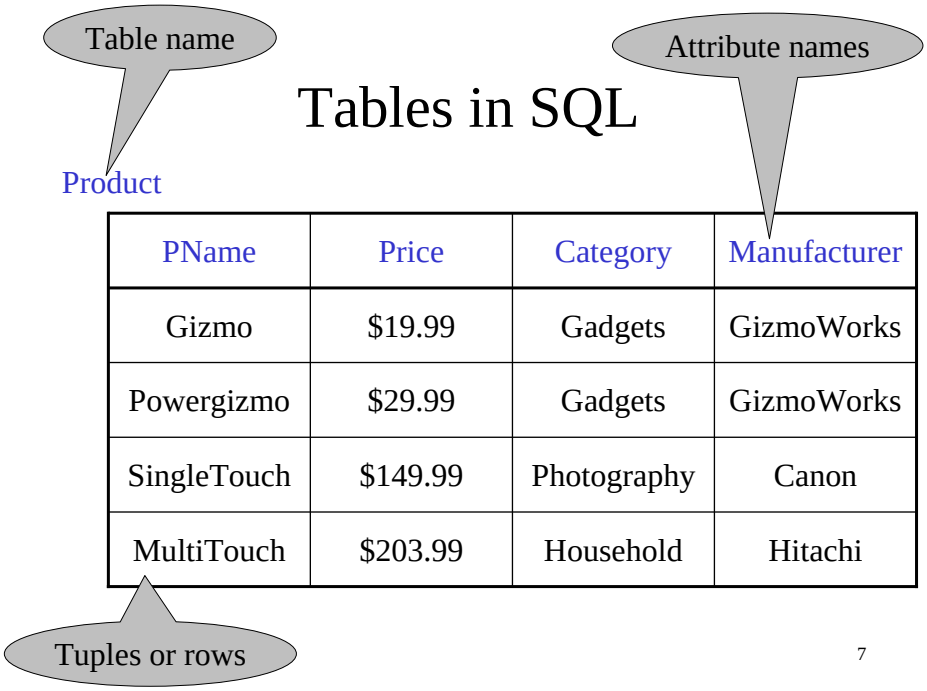
Tables in SQL



PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

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Tables Explained

- The *schema* of a table is the table name and its attributes:

Product(PName, Price, Category, Manfacturer)

- A *key* is an attribute whose values are unique; we underline a key

Product(PName, Price, Category, Manfacturer)

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Data Types in SQL

- Atomic types:
  - Characters: CHAR(20), VARCHAR(50)
  - Numbers: INT, BIGINT, SMALLINT, FLOAT
  - Others: MONEY, DATETIME, …
- Every attribute must have an atomic type
  - Hence tables are flat
  - Why ?

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Tables Explained

- A tuple = a record
  - Restriction: all attributes are of atomic type
- A table = a set of tuples
  - Like a list…
  - …but it is unorderd:
    no **first()**, no **next()**, no **last()**.

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SQL Query

Basic form: (plus many many more bells and whistles)

```
SELECT  <attributes>
FROM    <one or more relations>
WHERE   <conditions>
```

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Simple SQL Query

Product

PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

```
SELECT  *
FROM    Product
WHERE   category='Gadgets'
```

PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks

"selection"

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Simple SQL Query

Product

PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

```
SELECT   PName, Price, Manufacturer
FROM     Product
WHERE    Price > 100
```

"selection" and "projection"

PName	Price	Manufacturer
SingleTouch	$149.99	Canon
MultiTouch	$203.99	Hitachi

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Notation

Input Schema

Product(PName, Price, Category, Manfacturer)

```
SELECT   PName, Price, Manufacturer
FROM     Product
WHERE    Price > 100
```

Answer(PName, Price, Manfacturer)

Output Schema

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Details

- Case insensitive:
  - Same: SELECT Select select
  - Same: Product product
  - Different: ‘Seattle’ ‘seattle’
- Constants:
  - ‘abc’ - yes
  - “abc” - no

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The **LIKE** operator

```
SELECT  *
FROM    Products
WHERE   PName LIKE ‘%gizmo%’
```

- s **LIKE** p: pattern matching on strings
- p may contain two special symbols:
  - % = any sequence of characters
  - _ = any single character

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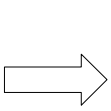
Eliminating Duplicates

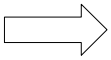
```
SELECT   DISTINCT category
FROM     Product
```



Category
Gadgets
Photography
Household

Compare to:

```
SELECT   category
FROM     Product
```



Category
Gadgets
Gadgets
Photography
Household

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Ordering the Results

```
SELECT   pname, price, manufacturer
FROM     Product
WHERE    category='gizmo' AND price > 50
ORDER BY  price, pname
```

Ties are broken by the second attribute on the ORDER BY list, etc.

Ordering is ascending, unless you specify the DESC keyword.

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PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

```
SELECT  DISTINCT category
FROM    Product
ORDER BY category
```

⇨ ?

```
SELECT  Category
FROM    Product
ORDER BY  PName
```

⇨ ?

```
SELECT  DISTINCT category
FROM    Product
ORDER BY PName
```

⇨ ?

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Keys and Foreign Keys

Company

CName	StockPrice	Country
GizmoWorks	25	USA
Canon	65	Japan
Hitachi	15	Japan

Key

Product

PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

Foreign key

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Joins

Product (pname, price, category, manufacturer)
Company (cname, stockPrice, country)

Find all products under $200 manufactured in Japan; return their names and prices.

Join between Product and Company

```
SELECT   PName, Price
FROM     Product, Company
WHERE    Manufacturer=CName AND Country='Japan'
         AND Price <= 200
```


Joins

Product

PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

Company

Cname	StockPrice	Country
GizmoWorks	25	USA
Canon	65	Japan
Hitachi	15	Japan

```
SELECT   PName, Price
FROM     Product, Company
WHERE    Manufacturer=CName AND Country='Japan'
         AND Price <= 200
```

PName	Price
SingleTouch	$149.99

More Joins

Product (pname, price, category, manufacturer)
Company (cname, stockPrice, country)

Find all Chinese companies that manufacture products both in the ‘electronic’ and ‘toy’ categories

```
SELECT   cname

FROM

WHERE
```

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A Subtlety about Joins

Product (pname, price, category, manufacturer)
Company (cname, stockPrice, country)

Find all countries that manufacture some product in the ‘Gadgets’ category.

```
SELECT   Country
FROM     Product, Company
WHERE    Manufacturer=CName AND Category=‘Gadgets’
```

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A Subtlety about Joins

Product

Name	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

Company

Cname	StockPrice	Country
GizmoWorks	25	USA
Canon	65	Japan
Hitachi	15	Japan

```
SELECT  Country
FROM    Product, Company
WHERE   Manufacturer=CName AND Category='Gadgets'
```

Country
??
??

What is the problem ? What's the solution ?

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Tuple Variables

Person(pname, address, worksfor)
Company(cname, address)

```
SELECT  DISTINCT pname, address
FROM    Person, Company
WHERE   worksfor = cname
```

Which address ?

```
SELECT  DISTINCT Person.pname, Company.address
FROM    Person, Company
WHERE   Person.worksfor = Company.cname
```

```
SELECT  DISTINCT x.pname, y.address
FROM    Person AS x, Company AS y
WHERE   x.worksfor = y.cname
```

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Meaning (Semantics) of SQL Queries

```
SELECT a1, a2, …, ak
FROM   R1 AS x1, R2 AS x2, …, Rn AS xn
WHERE  Conditions
```

```
Answer = {}
for x1 in R1 do
    for x2 in R2 do
        …..
            for xn in Rn do
                if Conditions
                    then Answer = Answer ∪ {(a1,…,ak)}
return Answer
```

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An Unintuitive Query

```
SELECT  DISTINCT R.A
FROM    R, S, T
WHERE   R.A=S.A    OR   R.A=T.A
```

What does it compute ?

Computes $R \cap (S \cup T)$

But what if $S = \phi$?

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Subqueries Returning Relations

Company(name, city)
Product(pname, maker)
Purchase(id, product, buyer)

Return cities where one can find companies that manufacture products bought by Joe Blow

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

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Subqueries Returning Relations

Is it equivalent to this ?

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

Beware of duplicates !

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Removing Duplicates

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

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

Now they are equivalent

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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')
```

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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

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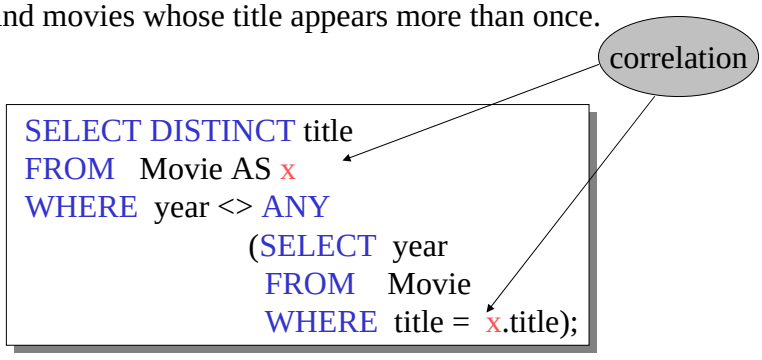
Correlated Queries

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



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

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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);
```

Very powerful ! Also much harder to optimize.

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Reading Assignment for Monday

SQL from the textbook:

- Renaming columns: SELECT x.name AS nom
- Union, intersection, difference

Chapter 3, “Simple Queries” from **SQL for Web Nerds,** by Philip Greenspun
http://philip.greenspun.com/sql/

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