Lecture 02: SQL

Wednesday, October 2, 2002

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Outline

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

Reading assignment:

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

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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 of these
- What we discuss is common to all of them

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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
- Transact-SQL
  - Idea: package a sequence of SQL statements → server
  - Won't discuss in class

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Data in SQL

1. Atomic types, a.k.a. data types
2. Tables built from atomic types

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Data Types in SQL

- Characters:
  - CHAR(20) -- fixed length
  - VARCHAR(40) -- variable length
- Numbers:
  - BIGINT, INT, SMALLINT, TINYINT
  - REAL, FLOAT -- differ in precision
  - MONEY
- Times and dates:
  - DATE
  - DATETIME -- SQL Server
- Others... All are simple

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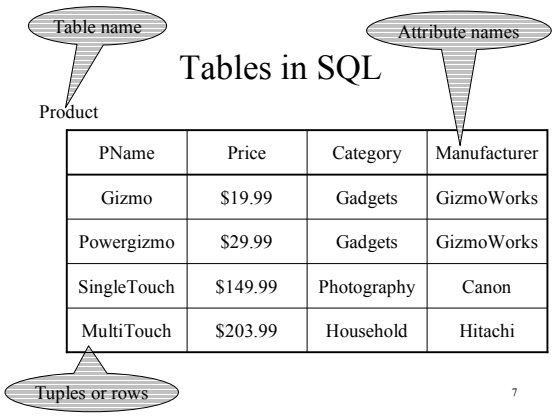
Tables in SQL



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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()**.
- No nested tables, only flat tables are allowed !
  - We will see later how to decompose complex structures into multiple flat tables

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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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SQL Query

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

```
SELECT  attributes
FROM    relations (possibly multiple, joined)
WHERE   conditions (selections)
```

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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
```

PName	Price	Manufacturer
SingleTouch	$149.99	Canon
MultiTouch	$203.99	Hitachi

"selection" and "projection"

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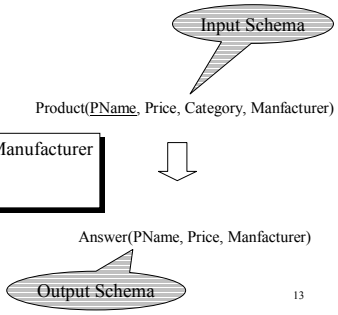
A Notation for SQL Queries



Selections

What goes in the WHERE clause:

- x = y, x < y, x <= y, etc
  - For number, they have the usual meanings
  - For CHAR and VARCHAR: lexicographic ordering
    - Expected conversion between CHAR and VARCHAR
  - For dates and times, what you expect...
- Pattern matching on strings: s LIKE p (next)

The **LIKE** operator

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

Product(Name, Price, Category, Manufacturer)
Find all products whose name mentions 'gizmo':

```
SELECT *
FROM Products
WHERE PName LIKE '%gizmo%'
```


Eliminating Duplicates

```
SELECT DISTINCT category
FROM Product
```

Category
Gadgets
Photography
Household

Compare to:

```
SELECT category
FROM Product
```

Category
Gadgets
Gadgets
Photography
Household

Ordering the Results

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

Ordering is ascending, unless you specify the DESC keyword.

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

Ordering the Results

```
SELECT category
FROM Product
ORDER BY pname
```

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

?

Ordering the Results

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

Category
Gadgets
Household
Photography

Compare to:

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

?

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Joins in SQL

- Connect two or more tables:

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

What is the Connection between them ?

Joins

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

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

```
SELECT   pname, price
FROM     Product, Company
WHERE    manufacturer=cname AND country='Japan'
         AND price <= 200
```

Join between Product and Company

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Joins in SQL

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

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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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Joins in SQL

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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Joins

Product (pname, price, category, manufacturer)
Purchase (buyer, seller, store, product)
Person(persname, phoneNumber, city)

Find names of people living in Seattle that bought some product in the 'Gadgets' category, and the names of the stores they bought such product from

```
SELECT   DISTINCT persname, store
FROM     Person, Purchase, Product
WHERE    persname=buyer AND product = pname AND
         city='Seattle'  AND category='Gadgets'
```

Disambiguating Attributes

- Sometimes two relations have the same attr:
  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
```

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Tuple Variables

Product (pname, price, category, manufacturer)
Purchase (buyer, seller, store, product)
Person(persname, phoneNumber, city)

Find all stores that sold at least one product that the store 'BestBuy' also sold:

```
SELECT DISTINCT  x.store
FROM     Purchase AS x, Purchase AS y
WHERE    x.product = y.product AND y.store = 'BestBuy'
```

Answer (store)

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Tuple Variables

General rule:
tuple variables introduced automatically by the system:

Product (name, price, category, manufacturer)

```
SELECT  name
FROM    Product
WHERE   price > 100
```

Becomes:

```
SELECT Product.name
FROM   Product AS Product
WHERE Product.price > 100
```

Doesn't work when Product occurs more than once:
In that case the user needs to define variables explicitely.

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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

1. Nested loops:

```
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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Meaning (Semantics) of SQL Queries

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

2. Parallel assignment

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

Doesn't impose any order !

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First Unintuitive SQLism

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

Looking for $R \cap (S \cup T)$

But what happens if T is empty?

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Exercises

Product (pname, price, category, manufacturer)
Purchase (buyer, seller, store, product)
Company (cname, stock price, country)
Person(per-name, phone number, city)

Ex #1: Find people who bought telephony products.
Ex #2: Find names of people who bought American products
Ex #3: Find names of people who bought American products and did not buy French products
Ex #4: Find names of people who bought American products and they live in Seattle.
Ex #5: Find people who bought stuff from Joe or bought products from a company whose stock prices is more than $50.

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