Introduction to SQL

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: MySQL, Oracle, ... etc

SQL

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

Tables in SQL

Table name

Attribute names

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

Tuples or rows

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(<u>PName</u>, Price, Category, Manfacturer)

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

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()**.

SQL Query

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

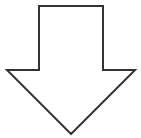
```
SELECT  <attributes>
FROM    <one or more relations>
WHERE   <conditions>
```

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

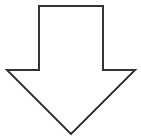
"selection"

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
```



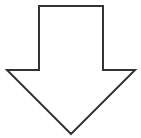
"selection" and "projection"

PName	Price	Manufacturer
SingleTouch	$149.99	Canon
MultiTouch	$203.99	Hitachi

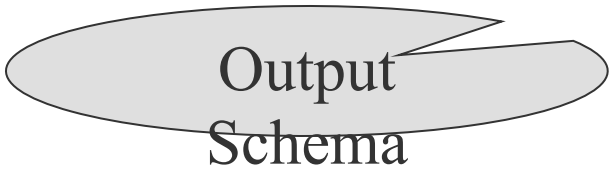
Notation

Product(PName, Price, Category, Manfacturer)

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



Answer(PName, Price, Manfacturer)



Details

- Case insensitive:
  - Same: SELECT Select select
  - Same: Product product
  - Different: ‘Seattle’ ‘seattle’

- Constants:
  - ‘abc’ - yes
  - “abc” - no

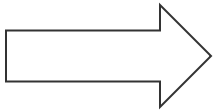
The **LIKE** operator

```
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

Eliminating Duplicates

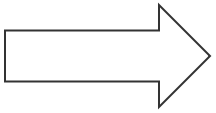
```
SELECT   DISTINCT category
FROM     Product
```



Category
Gadgets
Photography
Household

Compare to:

```
SELECT   category
FROM     Product
```



Category
Gadgets
Gadgets
Photography
Household

Ordering the Results

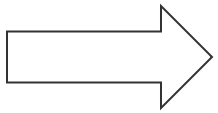
```
SELECT   pname, price, manufacturer
FROM     Product
WHERE    category='gizmo' AND price > 50
ORDER BY  price, pname
```

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

Ordering is ascending, unless you specify the DESC keyword.

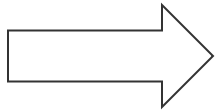
PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

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



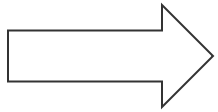
?

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



?

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



?

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

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
```

Joins

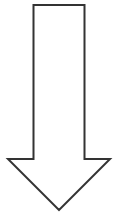
Product

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	
GizmoWorks	25	
Canon	65	
Hitachi	15	

```
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
```

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');
```

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')
```

Aggregation

```
SELECT  avg(price)
FROM    Product
WHERE   maker="Toyota"
```

```
SELECT  count(*)
FROM    Product
WHERE   year > 1995
```

SQL supports several aggregation operations:

sum, count, min, max, avg

Except count, all aggregations apply to a single attribute

Aggregation: Count

COUNT applies to duplicates, unless otherwise stated:

```
SELECT  Count(category)
FROM    Product
WHERE   year > 1995
```

same as Count(*)

We probably want:

```
SELECT  Count(DISTINCT category)
FROM    Product
WHERE   year > 1995
```

More Examples

Purchase(product, date, price, quantity)

```
SELECT  Sum(price * quantity)
FROM    Purchase
```

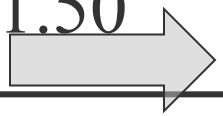
What do they mean ?

```
SELECT  Sum(price * quantity)
FROM    Purchase
WHERE   product = 'bagel'
```

Simple Aggregations

Purchase

Product	Date	Price	Quantity
Bagel	10/21	1	20
Banana	10/3	0.5	10
Banana	10/10	1	10
Bagel	10/25	1.50	20



```
SELECT  Sum(price * quantity)
FROM    Purchase
WHERE   product = 'bagel'
```

50 (= 20+30)

Grouping and Aggregation

Purchase(product, date, price, quantity)

Find total sales after 10/1/2005 per product.

```
SELECT    product, Sum(price*quantity) AS TotalSales
FROM      Purchase
WHERE     date > '10/1/2005'
GROUP BY  product
```

Let's see what this means…

Grouping and Aggregation

1. Compute the FROM and WHERE clauses.

2. Group by the attributes in the GROUPBY

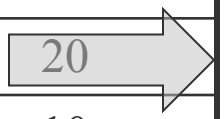
3. Compute the SELECT clause: grouped attributes and aggregates.

1&2. FROM-WHERE-GROUPBY

Product	Date	Price	Quantity
Bagel	10/21	1	20
Bagel	10/25	1.50	20
Banana	10/3	0.5	10
Banana	10/10	1	10

3. SELECT

Product	Date	Price	Quantity
Bagel	10/21	1	20
Bagel	10/25	1.50	20
Banana	10/3	0.5	10
Banana	10/10	1	10



Product	TotalSales
Bagel	50
Banana	15

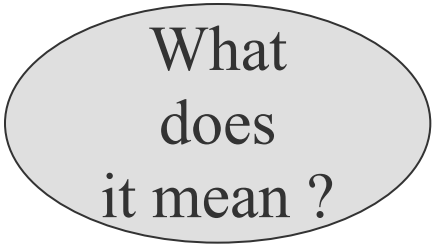
```
SELECT    product, Sum(price*quantity) AS TotalSales
FROM      Purchase
WHERE     date > '10/1/2005'
GROUP BY  product
```

GROUP BY v.s. Nested Quereis

```
SELECT      product, Sum(price*quantity) AS TotalSales
FROM        Purchase
WHERE       date > '10/1/2005'
GROUP BY    product
```

```
SELECT DISTINCT  x.product, (SELECT Sum(y.price*y.quantity)
                             FROM     Purchase y
                             WHERE x.product = y.product
                                   AND y.date > '10/1/2005')
                            AS TotalSales
FROM        Purchase x
WHERE       x.date > '10/1/2005'
```

Another Example




```
SELECT    product,
          sum(price * quantity) AS SumSales
          max(quantity) AS MaxQuantity
FROM      Purchase
GROUP BY product
```

HAVING Clause

Same query, except that we consider only products that had at least 100 buyers.

```
SELECT      product, Sum(price * quantity)
FROM        Purchase
WHERE       date > '10/1/2005'
GROUP BY    product
HAVING      Sum(quantity) > 30
```

HAVING clause contains conditions on aggregates.

General form of Grouping and Aggregation

SELECT S
FROM $R_1,\ldots,R_n$
WHERE C1
GROUP BY $a_1,\ldots,a_k$
HAVING C2

Why ?

S = may contain attributes $a_1,\ldots,a_k$ and/or any aggregates but NO OTHER ATTRIBUTES
C1 = is any condition on the attributes in $R_1,\ldots,R_n$
C2 = is any condition on aggregate expressions

General form of Grouping and Aggregation

```
SELECT   S
FROM     R1,…,Rn
WHERE    C1
GROUP BY a1,…,ak
HAVING   C2
```

Evaluation steps:

- Evaluate FROM-WHERE, apply condition C1
- Group by the attributes $a_1,\ldots,a_k$
- Apply condition C2 to each group (may have aggregates)
- Compute aggregates in S and return the result

Modifying the Database

Three kinds of modifications

- Insertions
- Deletions
- Updates

Sometimes they are all called “updates”

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.

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

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

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	-	-

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

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.

Updates

Example:

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