# Structured Query Language – Continued

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### The Story Thus Far

- □ SELECT ... FROM ... WHERE
- □ SELECT \* ...
- □ SELECT Foo AS Bar ...
- □ SELECT *expression* ...
- □ SELECT ... FROM ... WHERE ... LIKE ...
- □ SELECT ... FROM Foo, Bar ...
- □ SELECT ... FROM Foo f1, Foo f2 ...

# Next Up: Subqueries

- □ As values
- □ As relations

### Subqueries as Values

- Only allowed when subquery evaluates to single value
  - Run-time error otherwise
- □ Example: Find the restaurants that sell Slice for the price the Joe's charges for Pepsi

#### Subqueries as Relations – in FROM

#### Subqueries as Relations – in WHERE

- □ value IN relation
- □ Evaluates to **true** if relation contains value
- □ SELECT \*

FROM Soda

WHERE name IN (SELECT soda

FROM Likes

WHERE

customer = 'Fred')

#### Subqueries as Relations – in WHERE

- □ EXISTS relation
- □ Evaluates to **true** if relation is non-empty
- ☐ Find every soda where its manufacturer does not make anything else
- □ SELECT name
  FROM Soda s1
  WHERE NOT EXISTS (
  SELECT \*
  FROM Soda s2
  WHERE s2.manf = s1.manf
  AND s2.name <> s1.name)

#### Subqueries as Relations – in WHERE

- □ ANY
  - x comp ANY(relation)
  - comp can be <, >, =, <>, >=, <=
  - Evaluates to **true** if comparison holds for any tuple in relation
- ALL
  - x comp ALL(relation)
  - comp can be <, >, =, <>, >=, <=
  - Evaluates to **true** if comparison holds for every tuple in relation

□ SELECT soda
FROM Sells
WHERE price >= ALL(SELECT price
FROM Sells)

# Subqueries Summary

- □ As values
- □ As relations in FROM clause
- □ As relations in WHERE clause
  - IN
  - EXISTS
  - ANY
  - ALL

# Combining Relations

- □ Union, Intersection, Difference
- □ Joins

### Union, Intersection, and Difference

- □ Union
  - (subquery) UNION (subquery)
- □ Intersection
  - (subquery) INTERSECT (subquery)
- □ Difference
  - (subquery) EXCEPT (subquery)

### SQL Goofiness – Sets vs. Bags

- □ Bags by default
  - SELECT
- □ Sets by default
  - UNION
  - INTERSECT
  - EXCEPT

- Overriding defaults
  - SELECT DISTINCT
  - UNION ALL
  - Cannot override
  - Cannot override

□ Find all the different prices charged for sodas

- □ Find all the different prices charged for sodas
  - SELECT DISTINCT price FROM Sells

#### Theta Join

- □ Syntax:
- □ SELECT ...

FROM table1 JOIN table2 ON condition

. . .

☐ Give name and phone number of all customers that frequent Joe's Sushi

- □ SELECT name, phone
  FROM Customer JOIN Frequents
  ON name = customer
  WHERE rest = 'Joe''s Sushi'
- □ Compare:
  - SELECT name, phone
     FROM Customer, Frequents
     WHERE name = customer
     AND rest = 'Joe"s Sushi'

#### Natural Join

- □ Not in SQL Server
- □ But some DBMS allow:
  - SELECT ...

FROM table1 NATURAL JOIN table2

#### **Outer Joins**

- □ Recall: solution to dangling tuple problem
- □ Make sure every tuple shows up, even if no "mate", by inserting nulls if needed
- □ Three basic forms:
  - SELECT ... FROM t1 LEFT OUTER JOIN t2
  - SELECT ... FROM *t1* RIGHT OUTER JOIN *t2*
  - SELECT ... FROM *t1* OUTER JOIN *t2*

#### Cross Product

- □ Possible, though less common
- □ SELECT ...
  FROM table1 CROSS JOIN table2
- □ Or just write:
  - SELECT ...

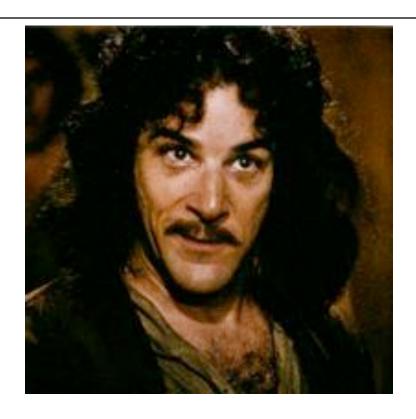
FROM table1, table2

# Reporting

- □ Aggregation
- □ Grouping

# Aggregation

- Calculations over rows
- □ Example:
  - SELECT AVG(price)FROM SellsWHERE soda = 'Pepsi'
- Other aggregations:
  - SUM
  - AVG
  - COUNT, COUNT(\*)
  - MIN, MAX



"Let me explain. No, would take too long. Let me sum up."

### Aggregation and Duplicates

- □ Can use DISTINCT inside an aggregation
- □ Example Find the number of different prices charged for Pepsi

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- □ Can use DISTINCT inside an aggregation
- □ Example Find the number of different prices charged for Pepsi
  - SELECT COUNT(DISTINCT price)
     FROM Sells
     WHERE soda = 'Pepsi'

# Grouping

- □ For aggregating subsections of result
- □ SELECT ...
  FROM ...
  WHERE ...
  GROUP BY attr,...



# Example: Grouping

□ Find the average price for each soda

# Example: Grouping

- □ Find the average price for each soda
- □ SELECT soda, AVG(price)FROM SellsGROUP BY soda

### Having

- □ Like a WHERE clause for groups
- □ SELECT ...

FROM ...

WHERE ... -- filter rows

GROUP BY ... -- group rows

HAVING ... -- filter groups

# Example: Having

□ Find the average price of those sodas that are served by at least three restaurants

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- □ Find the average price of those sodas that are served by at least three restaurants
- SELECT soda, AVG(price)
   FROM Sells
   GROUP BY soda
   HAVING COUNT(rest) >= 3

# Modifying the Database

- □ Insert
- Delete
- □ Update

#### Insertion

- □ Single tuple, quick and dirty:
  - INSERT INTO table VALUES (value1, ...)
- □ Single tuple, more robust:
  - INSERT INTO table(attr1, ...)
    VALUES (value1, ...)
- □ Many tuples:
  - INSERT INTO *table* (*subquery*)

#### Deletion

- □ Single tuple:
  - DELETE FROM table WHERE condition
- □ All tuples (zoinks!):
  - DELETE FROM table

### Updates

- □ Syntax:
  - UPDATE table
     SET attr1 = expr1, ... -- attributes, new values
     WHERE condition -- rows to change

□ Change Fred's phone number to 555-1212

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- □ UPDATE Customer

  SET phone = '555-1212'

  WHERE name = 'Fred'

□ Raise all prices by 10%

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- □ UPDATE Sells
  SET price = (price \* 1.10)