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

 SELECT Likes.customer, mix.soda1, mix.soda2
 FROM Likes, (SELECT s1.name AS soda1, s2.name AS soda2
 FROM Soda s1, Soda s2
 WHERE s1.manf = s2.manf AND s1.name < s2.name)
 AS mix
 WHERE Likes.soda = mix.soda1

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

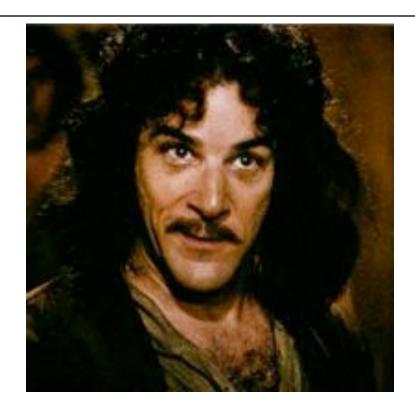
FROM table1, table2

Reporting

- □ Aggregation
- **Grouping**

Aggregation

- Calculations over rows
- □ Example:
 - SELECT AVG(price) FROM Sells WHERE 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 Sells
 GROUP BY soda

Having

□ Like a WHERE clause for groups □ SELECT ... FROM ... WHERE ... GROUP BY ... HAVING ...

-- filter rows -- group rows -- filter groups

Example: Having

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

Example: Having

- □ 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 tableVALUES (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, ...
 WHERE condition
 - ... -- attributes, new values -- rows to change

□ Change Fred's phone number to 555-1212

 Change Fred's phone number to 555-1212
 UPDATE Customer SET phone = '555-1212' WHERE name = 'Fred'

□ Raise all prices by 10%

- □ Raise all prices by 10%
- UPDATE SellsSET price = (price * 1.10)