



Advanced SQL: Subqueries and Set Operators

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Learning Objectives

After this lecture, you should be able to:

- Write advanced queries with **subqueries** in the **FROM**, **WHERE** and **SELECT** clauses
- Write advanced SQL sub-queries with Boolean Operators (ANY and ALL)

Subqueries

- A parenthesized SELECT-FROM-WHERE statement (*subquery*) can be used as a value in a number of places, including FROM and WHERE clauses.

SELECT *

FROM (SELECT * FROM Customer WHERE
name LIKE 'A%') as temp

WHERE temp.phone LIKE '5%';

Subqueries that Return Scalar

- If a subquery is guaranteed to produce one tuple with one component, then the subquery can be used as a value.
 - “Single” tuple often guaranteed by key constraint.
 - A run-time error occurs if there is no tuple or more than one tuple.

Example

From Sells(cafe, drink, price), find the café shops that serve Latte for the same price Espresso Royal charges for Cappuccino.

Two queries would surely work:

1. Find the price Espresso Royal charges for Cappuccino.
2. Find the café shops that serve Latte at that price.

Query + Subquery Solution

Find the café shops that serve Latte at that price

SELECT cafe

FROM Sells

WHERE drink = 'Latte' AND

price = (SELECT price

FROM Sells

WHERE cafe = 'Espresso Royal'

AND drink = 'Cappuccino');

Find the price **Espresso Royal** charges for Cappuccino.

Outline

- Advanced SQL
 - ✓ Subqueries
 - Boolean Operators (IN, ANY, EXISTS, ALL)
 - Set operations

Boolean Operators:

The IN Operator

- `<tuple> IN <relation>` is true if and only if the tuple is a member of the relation.
 - `<tuple> NOT IN <relation>` means the opposite.
- IN-expressions can appear in WHERE clauses.
- The `<relation>` is often a subquery.

Example


- From Drinks(name, manf) and Likes(customer, drink), find the name and manufacturer of each drink that Fred likes.

SELECT *

FROM Drinks

WHERE name IN (SELECT drink
FROM Likes
WHERE customer = 'Fred');

The set of
drinks Fred
likes



Boolean Operators: The Exists Operator

- EXISTS(<relation>) is true if and only if the <relation> is not empty.
- Being a boolean-valued operator, EXISTS can appear in WHERE clauses.

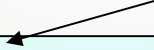
Example Query with EXISTS

Example: From Drinks(name, manf), and Sells (café, drink, price) find the name and manufacturer of drinks with price \geq \$4.99

```
SELECT *  
FROM Drinks b1  
WHERE EXISTS
```

```
(SELECT *  
FROM Sells  
WHERE drink = b1.name AND price  $\geq$  4.99);
```

Set of drinks (and their sales information)
with the same name as
b1 and price \geq 4.99



Read “Correlated Subqueries” Section 6.3.4.

Boolean Operators: The Operator ANY

- $x = \text{ANY}(\text{<relation>})$ is a Boolean condition meaning that x equals at least one tuple in the relation.
- Similarly, $=$ can be replaced by any of the comparison operators.
- Example: $x \geq \text{ANY}(\text{<relation>})$ means x is greater than or equal to at least one tuple in the relation.
 - Note tuples must have one component only.

Boolean Operators: The Operator ALL

- Similarly, $x \neq \text{ALL}(\text{<relation>})$ is true if and only if for every tuple t in the relation, x is not equal to t .
 - That is, x is not a member of the relation.
- The \neq can be replaced by any comparison operator.
- Example: $x \geq \text{ALL}(\text{<relation>})$ means there is x is larger than every tuple in the relation.

Example

- From Sells(cafe, drink, price), find the drink(s) sold for the highest price.

SELECT drink

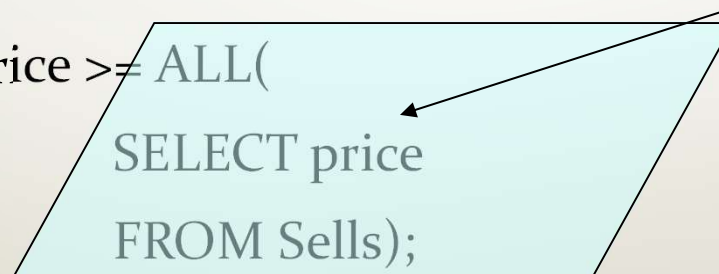
FROM Sells

WHERE price \geq ALL(

SELECT price

FROM Sells);

price from the outer
Sells must not be
less than any price.





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Union, Intersection, and Difference

- Union, intersection, and difference of relations are expressed by the following forms, each involving subqueries:
 - (subquery) UNION (subquery)
 - (subquery) INTERSECT (subquery)
 - (subquery) EXCEPT (subquery)

Example

From relations Likes(customer, drink), Sells(cafe, drink, price) and Frequents(customer, cafe), find the customers and drinks such that:

1. The customer likes the drink, and
2. The customer frequents at least one café shop that sells the drink.

How would we do this?

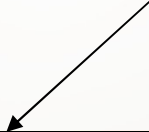
Solution

(SELECT * FROM Likes)

INTERSECT

(SELECT customer, drink
FROM Sells, Frequents
WHERE Frequents.cafe = Sells.cafe
);

The customer frequents
a café shop that sells the
drink.



Bag Semantics for Set Operations in SQL

Although the SELECT-FROM-WHERE statement uses bag semantics, the default for union, intersection, and difference is set semantics.

- That is, duplicates are eliminated as the operation is applied.

Controlling Duplicate Elimination

- Force the result to be a set by
SELECT DISTINCT . . .
- Force the result to be a bag (i.e., don't eliminate
duplicates) by ALL, as in
 - . . . UNION ALL . . .