Grouping, Aggregation, Subqueries

PDBM 7.3–7.3.1.4

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state	city	revenue
Maharashtra	Achalpur	10000
Uttar Pradesh	Achhnera	20000
Gujarat	Adalaj	10000
Uttar Pradesh	Agra	30000
Gujarat	Ahmedabad	40000
Maharashtra	Ahmednagar	10000
Maharashtra	Akola	40000

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state	sum(revenue)
Maharashtra	60000
Uttar Pradesh	50000
Gujarat	50000

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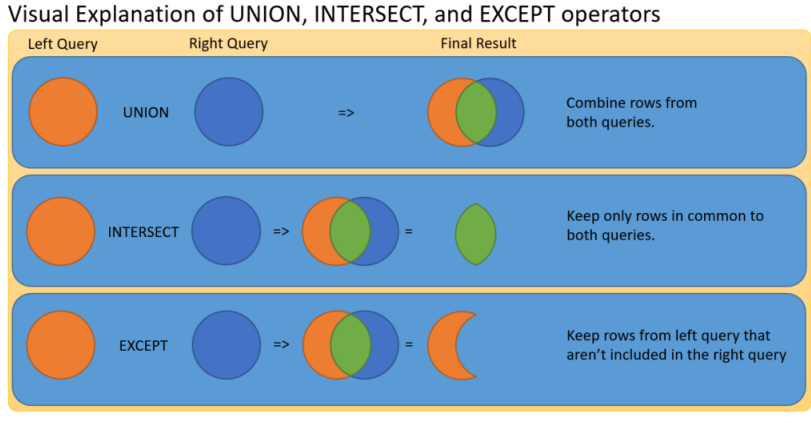

Aggregation

Common functions

- COUNT, SUM, AVG, MIN, MAX
- https://www.postgresql.org/docs/11/static/functions-aggregate.html

```
SELECT min(year), max(year), count(year)
FROM movie
WHERE title = 'Frozen';
```

More commonly used in groups:

```
SELECT year, count(*)
FROM movie
WHERE title = 'Frozen'
GROUP BY year
ORDER BY year;
```

GROUP BY

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Maharashtra	Achalpur	10000
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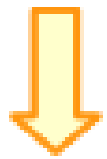

state	sum(revenue)
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HAVING vs WHERE

- `WHERE` = before grouping
- `HAVING` = after grouping

```
-- titles used more than 50 times
SELECT m.title, k.kind, count(*)
FROM movie AS m
  JOIN kind_type AS k ON m.kind_id = k.id
WHERE year > 2010
  AND m.title NOT LIKE '(%'
GROUP BY m.title, k.kind
HAVING count(*) > 50
ORDER BY count DESC
```

Aggregation with NULLs

Three ways of counting:

- `SELECT count(*) FROM cast_info; -- count rows`
- `SELECT count(person_id) FROM cast_info; -- count values`
- `SELECT count(DISTINCT person_id) FROM cast_info;`

NULL values are ignored!

```
SELECT
  m.title, m.year, m.kind_id, -- see GROUP BY
  max(r.info) AS max_runtime, count(*)
FROM movie AS m
  LEFT JOIN movie_info AS r
    ON m.id = r.movie_id AND r.info_id = 1
GROUP BY m.title, m.year, m.kind_id
```

NULLs can be confusing!

R	
a	*b*
NULL	NULL

```
SELECT a, count(b)
FROM R
GROUP BY a;
```

- Returns (NULL, 0)

```
SELECT a, sum(b)
FROM R
GROUP BY a;
```

- Returns (NULL, NULL)

SQL Exercises: `imdb`

How many of each kind of movie?

How many of each type of info?

What else would you like to know?

Hello TPC-H

The Transaction Processing Performance Council is a non-profit corporation that defines performance benchmarks for comparing database systems.

- All the major database companies from industry
- Founded in 1988; new benchmarks every few years

TPC-H is a business-oriented "decision support" database consisting of customers, orders, parts, suppliers, etc.

- The data is synthetically generated
- A driver simulates many transactions

Set Operations

PDBM 7.3.1.11 and PG 7.4, 10.5

Set operations

These queries eliminate duplicates (unless you use `ALL` keyword)

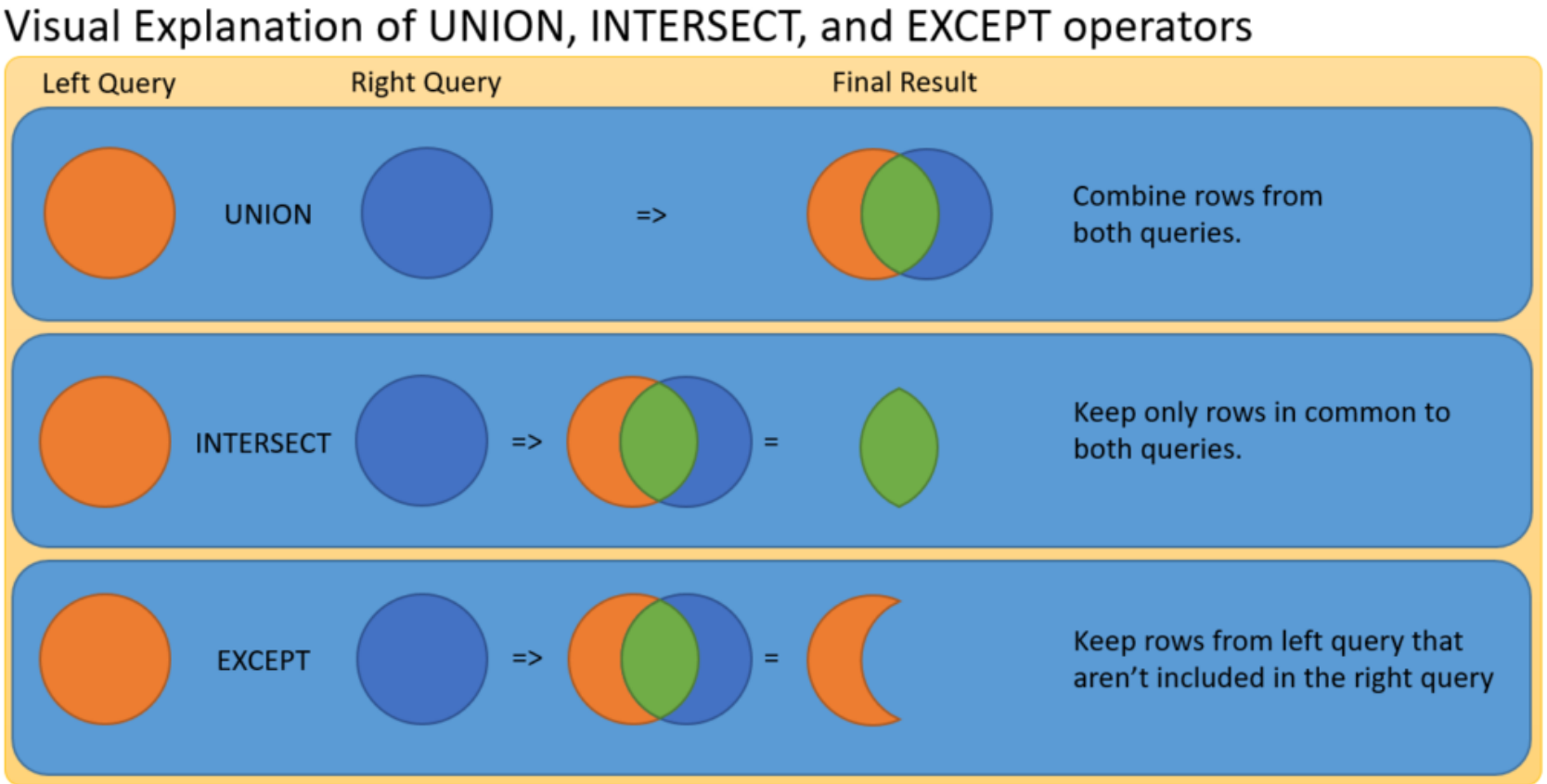
```
SELECT c_name, c_address FROM customer
UNION -- or UNION ALL
SELECT s_name, s_address FROM supplier;

SELECT c_name, c_address FROM customer
INTERSECT -- or INTERSECT ALL
SELECT s_name, s_address FROM supplier;

SELECT c_name, c_address FROM customer
EXCEPT -- or EXCEPT ALL
SELECT s_name, s_address FROM supplier;
```

Set operations are not joins!

Venn diagrams



https://www.essentialsql.com/sql-set-operations-sql-server/

Example query

```
-- customers with negative balance
SELECT c_custkey, c_name, c_acctbal
FROM customer
  JOIN orders ON c_custkey = o_custkey
  JOIN lineitem ON o_orderkey = l_orderkey
WHERE c_acctbal < 0
EXCEPT
-- customers who live in Africa
SELECT c_custkey, c_name, c_acctbal
FROM customer
  JOIN nation ON c_nationkey = n_nationkey
  JOIN region ON n_regionkey = r_regionkey
WHERE r_name = 'AFRICA'
-- ORDER BY and LIMIT apply to entire query
ORDER BY c_acctbal
LIMIT 50
```

Note: HW4 doesn't require set operations

Subqueries

PDBM 7.3.1.7–10 and PG 7.2, 9.22

Subqueries with scalar values

"Find the name of the professor who teaches CS 474."

```
SELECT name
FROM professor
  JOIN teach ON pid = prof_pid
WHERE dept = 'CS' AND number = 474;
```

Another way:

```
SELECT name
FROM professor
WHERE pid = (  -- subquery in WHERE should return a single row
  SELECT prof_pid
  FROM teach
  WHERE dept = 'CS' AND number = 474);
```

More common: FROM subqueries

```
SELECT name
FROM MovieExec, (
  SELECT producerC#
  FROM Movies, StarsIn
  WHERE title = movieTitle
    AND year = movieYear
    AND starName = 'Harrison Ford'
  ) AS Ford
WHERE cert# = Ford.producerC#;
```

Subquery relations must be given a name

- (i.e., `AS Ford`)

Subquery expressions

Let R be a relation and t be a tuple from R

- `EXISTS R`
- `t IN R`
- `t > ALL R`
- `t > ANY R`

"Remove from the `Ships` relation all ships that sunk in battle."

```
DELETE FROM Ships
WHERE name IN (
  SELECT ship FROM Outcomes
  WHERE result = 'sunk');
```

Use `NOT` to negate `EXISTS`, `IN`, `ALL`, `ANY`
https://www.postgresql.org/docs/11/static/functions-subquery.html

Correlated subqueries

"Find course names that have been used for multiple courses."

```
SELECT name
FROM courses AS c1
WHERE name IN (
  SELECT name
  FROM courses AS c2
  WHERE c2.dept <> c1.dept
     OR c2.number <> c1.number);
```

Read this query from the inside out!

Another exercise

```
--
\echo QUERY #8
\echo
-- Find the minimum cost supplier for each part.
--
-- You must use a subquery to receive full credit.
-- Hint: Find the minimum cost of each part first.
--
-- Schema: ps_partkey, ps_suppkey, min_supplycost
--  Order: ps_partkey
```