SUBQUERIES

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ANNOUNCEMENTS

- Homework 7 due tomorrow night
  - I am working on HW6 feedback
- Test 2 a week from today!
  - Joins through table alterations
  - No HW due next week
  - I'll be getting another study guide packet out on today
- Polling today: polling.jedrembold.prof

REVIEW QUESTION

Given the starting table called `rev`, what is the output of the last query?

name	num
A	1
B	2
C	3
D	4
E	5

```
CREATE TEMP TABLE rq AS (
  SELECT
    name,
    SUM(num) OVER () -
      LAG(num) OVER (ORDER BY name DESC)
      AS Q
  FROM rev
);
SELECT name FROM rq
WHERE Q = 11;
```

SUBQUERIES

- A *subquery* is simply a query embedded within another piece of SQL
- Commonly used to prepare some data or compute a value to be used by the surrounding SQL
- We have already seen very simple versions
  - Creating a new table, for example

```
CREATE TABLE new table AS (
  SELECT * FROM og table
);
```

- Often, you could have saved the subquery as its own table and then used that directly, but not always

COMMON USES OF SUBQUERIES

- Computing a single value to use in comparisons
- Computing a single column or list of values to use either directly in a table or in comparisons
- Performing “join-like” operations (potentially in a more flexible manner)
- Filtering one table based on the contents of another table
- Otherwise combining operations that would otherwise have taken several steps

FILTER ON SINGLE VALUE

- Think back to HW3 where you needed to filter out all the outlier taxi-ride speeds
  - There you had to compute the quartiles, the whisker edges, and then filter directly by tying that number back in
- Subqueries can combine those steps! You can directly compare a value to the subquery so long as the query outputs only a single value (one row, one column)

```
SELECT *
FROM table
WHERE column > (
  SELECT avg(column 2)
  FROM table 2
);
```

DERIVED TABLES

- You can use the output of a subquery anywhere you would normally reference a table name
- Such a table is then called a *derived table*
- You must give such subqueries a table alias, else you have no way to refer to them

```
SELECT *
FROM (
  SELECT column 1, column 2
  FROM table
) AS mytable;
```

REPEATING COLUMN VALUES

- Sometimes it is very useful to have a constant value assigned to an entire column
  - We can't just use an aggregate function (or similar) though, else we get mismatched column lengths
- You can include a subquery *in your selected columns* if it outputs only a single value
  - That value will be propagated to all the rows
- Give it an alias so the column heading has some meaning!

```
SELECT
  column 1,
  column 2,
  (SELECT avg(column) FROM table 2) AS avg_col
FROM table;
```

SUBQUERY EXPRESSIONS

- Can also use subqueries to filter based on whether certain content is present within the subquery output
- All of the following are comparisons that return a boolean
- Combinations of a keyword followed by the subquery
  - `expr IN (subquery)` and `expr NOT IN (subquery)`
  - `EXISTS (subquery)` and `NOT EXISTS (subquery)`
  - `expr op ANY (subquery)`
  - `expr op ALL (subquery)`
- `expr` is a column name or value, and `op` is a boolean operator (`=`, `>`, `>=` ,etc)
- All subquery expressions are evaluated in short-circuit mode: they will return an answer as soon as they can

IN SUBQUERY

- Will check to see if a term appears anywhere in the subquery output
- The subquery must output a single column (though it could be empty)
- `NOT IN` just reverses the situation
- Be careful of NULLs
  - `1 IN (1,2,3)` gives True
  - `1 IN (2,3)` gives False
  - `1 IN (NULL,2,3)` gives `NULL`
  - Most dangerous with `NOT IN`, since `1 NOT IN (NULL,2,3)` will give `NULL`, not True

EXISTS SUBQUERY

- Checks just to see if the subquery has any rows in the output
  - No expression to compare to, just looking at subquery output
- The *contents* of the subquery do not matter at all, so a simple `SELECT 1 FROM ...` is usually used
- Subqueries using `EXISTS` are frequently a form called a *correlated subquery*, where it references the table in the outer query

```
SELECT column 1, column 2
FROM table 1
WHERE EXISTS (
  SELECT 1
  FROM table 2
  WHERE table1.column1 = table2.column2
);
```

ANY AND ALL

- At times you don't want to see if a value is *in* the subquery output, but rather how it *compares* to the output
- A boolean expression needs to return a single True or False though
- `ANY` and `ALL` "broadcast" the boolean comparison across all the subquery rows
  - `ANY` will return True if *any* of the rows evaluate to True with the expression
  - `ALL` will only return True if *all* of the rows evaluate to True with the expression
- *expr* `= ANY (`*subquery*`)` is thus identical to `expr IN (subquery)`

```
SELECT column 1
FROM table
WHERE column 1 < ALL ( SELECT column FROM table 2);
```

SUBQUERIES VS JOINS

- You may have realized that subqueries can do many similar things to what we used joins for!
- When should each be used?
  - Subqueries are great when you only need information from a single table, but it depends on another table
  - Joins are necessary when you need information from multiple tables
- Historically, most RDMS were better optimized for joins, but many have improved substantially in recent years for subqueries
  - If in doubt, use the form that makes the most sense for what you *semantically* want to accomplish. You can always convert it later if better optimization is needed and could be achieved

BE CAREFUL!

- It can be pretty easy to leap off the deep end with subqueries
- Always keep in mind what you want the subquery to achieve, and test it individually to make sure it is doing what you expect
  - Use them where they fit the needs of the situation
  - A nice aspect of subqueries is that you can work from the “bottom-up”, starting with smaller subqueries you know and building on them
- Organize your queries nicely!
  - This becomes even more important with subqueries

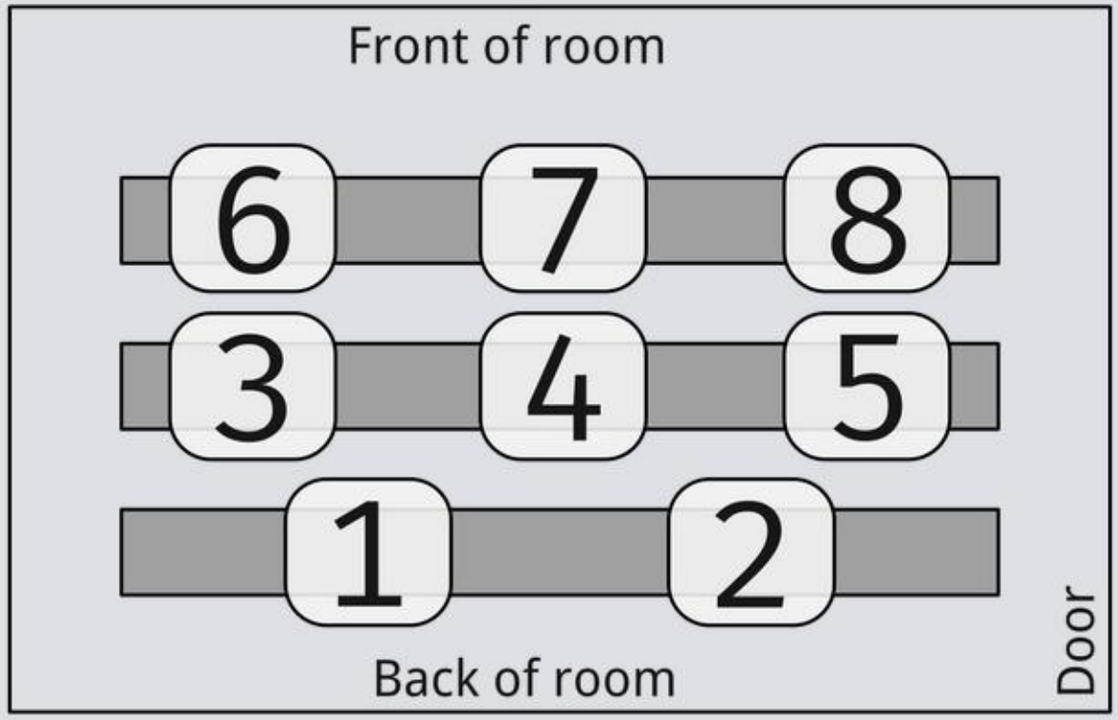
ACTIVITY

SUBQUERY GRADES

- I've prepped a simple grades database here that you can download and run the sql file to create a `subq1` schema in your database of choice which will contain three common tables: `roster`, `assignments`, `submissions`
- See if you can answer the first two questions below without using any joins. (You can use them on the third, as it gets crazy otherwise I think)
  - Which student(s) have turned in *nothing*?
  - Which assignment name has the worst raw scored average overall?
  - Which students scored below average on every quiz?

TODAY'S GROUPS

- Group 1: Dayton, Harleen, Finn
- Group 2: Michael, Haley, Jack
- Group 3: Evan, Aurora, Connor
- Group 4: Mallory, AJ, Nick
- Group 5: Matthew, Sam H, Tippy
- Group 6: Myles, Sam J, Hannah, Marcus
- Group 7: Grace, Jerrick, Tiffany
- Group 8: Sergio, Jordan, Greg



Group Areas

SOLUTIONS

- Which student(s) have turned in *nothing*?
  - One student: Frederick Moore
- Which assignment name has the worst raw scored average overall?
  - Homework 4
- Which students scored below average on every quiz?
  - Jackie Mathews, Antonio Gardner, Lee Bell