

Introduction to Data Access and Storage

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Module 02

Building Queries:

Two More Commands

JOIN

Aggregation Functions

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Two More Commands

JOIN

Aggregation Functions

Two More Commands

CASE

DISTINCT

Two More Commands

CASE

DISTINCT

CASE

- CASE statements allow us to introduce conditional logic into our SELECT statements
- They are generally similar to if or if else statements in python, R, and other languages
 - When a condition is introduced, we check whether it evaluates to TRUE
 - If it is true, we proceed with a desired command, calculation, value, etc
 - If it is not true, we move to the next condition
 - If it is true, we proceed with another desired command, calculation, value, etc
 - ...all the way until we run out of conditions
 - For all FALSE conditions, we can use an ELSE statement if we want to
- The results of a CASE statement will be a new column
- Best practice is to name the new column using AS new_column_name

```
CASE
    WHEN [something is true]
        THEN [value or calculation]
    WHEN [something else is true]
        THEN [value or calcuation]
    ELSE [value or calcuation]
END
```

CASE

(CASE live coding)

Two More Commands

CASE

DISTINCT

DISTINCT

- Not all query results will result in unique rows (i.e. duplicates are present)
 - **Can we think of why this is?**
- **DISTINCT** has two possible spots within a query:
 - One comes immediately after **SELECT**, before column names are specified
 - e.g. **SELECT DISTINCT songs, albums, artists...**
 - This **DISTINCT** will govern the entire query
 - The other comes within aggregation
 - e.g. **COUNT(DISTINCT products)**
 - This **DISTINCT** will only affect this specific aggregation

DISTINCT

(DISTINCT live coding)

Building Queries:

Two More Commands

JOIN

Aggregation Functions

JOIN

INNER JOIN

LEFT (OUTER) JOIN

RIGHT (OUTER) JOIN

FULL OUTER JOIN

Multiple Table Joins

JOIN

- Joins are used to combine data stored in different tables into a single table
- Joins are the Cartesian product of two tables with conditional selection of specific rows
 - A Cartesian product combines all possible row values with another
 - An easy example is a deck of cards:

combining four suits: {♠, ♥, ♦, ♣}
with thirteen ranks: {A, K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3, 2}
produces 52 cards ($4 * 13$)
- Joins require relationships (one exception, we'll get to later) between tables
- Different joins create different results
 - Join names specify which conditional selection is desired
- There are three join types in SQL but different joining criteria can further limit results
- The most permitting join is a **FULL OUTER JOIN** and the least permitting is an **INNER JOIN**
 - Let's explore what this means by looking at each of them

JOIN

JOIN Syntax

Syntax for a join is as follows:

```
SELECT [columns]
FROM [left table]
JOIN [right table]
ON [left table.matching column] = [right table.matching column]
```

A couple of notes:

- You will need to specify which join type is desired:
 - e.g. `INNER JOIN`
- Matching columns do not need to have the same name, just the same value
 - e.g. `ON table1.LetterGrade = table2.Alphabet` will work because A=A, B=B, C=C, etc
- You can specify more than one column to be joined
 - e.g. `ON table1.FirstName = table2.FirstName AND table1.LastName = table2.LastName`

JOIN

INNER JOIN

LEFT (OUTER) JOIN

RIGHT (OUTER) JOIN

FULL OUTER JOIN

Multiple Table Joins

INNER JOIN

- INNER JOIN filters both tables to rows present in both tables
- INNER JOIN does not produce NULL values
- INNER JOIN is the "default" join
 - i.e. queries do not need to specify "INNER", though it's good practice to write INNER

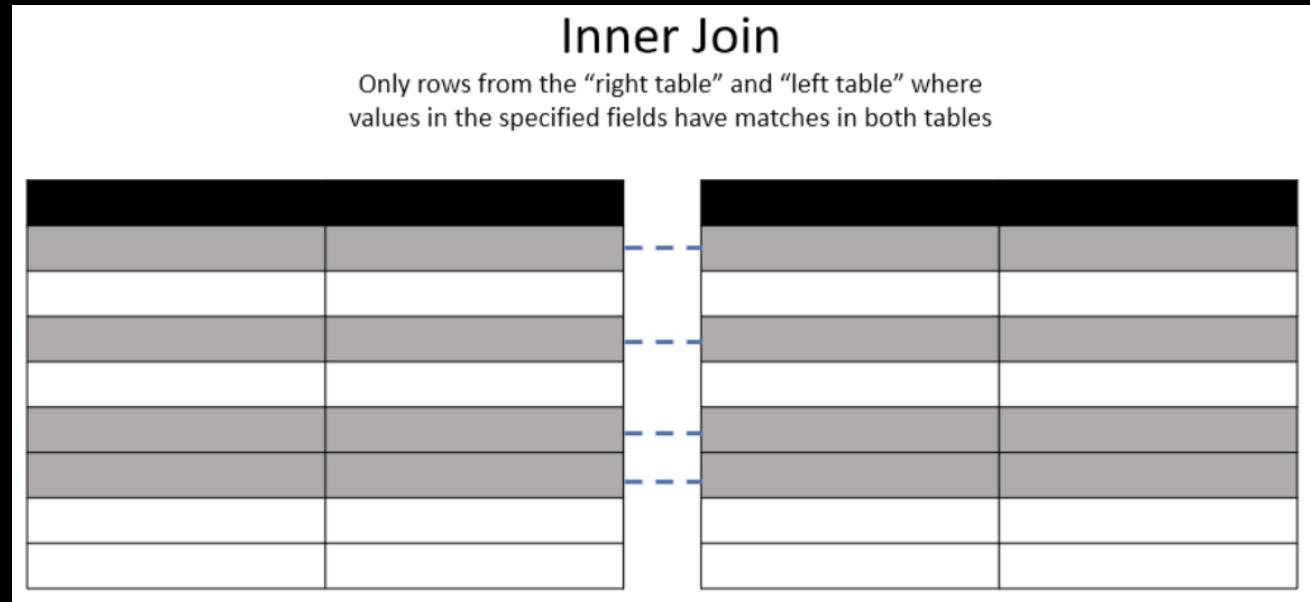


Image: Teate, Chapter 5

INNER JOIN

A quick note on table aliasing:

- It is very common practice to alias table names
 - It makes join criteria much more concise
 - It simplifies `SELECT` statements when column names are the same
 - This is a common error: "*ambiguous column name*"
 - SQL requires you to specify *which* table you are returning the result from
- Generally, tables are aliased with the first letter (or first few letters) of the table so they can be easily referenced
 - `product AS p`
 - `product_category AS pc`

INNER JOIN

(`INNER JOIN` live coding)

JOIN

INNER JOIN

LEFT (OUTER) JOIN

RIGHT (OUTER) JOIN

FULL (OUTER) JOIN

Multiple Table Joins

LEFT (OUTER) JOIN

- `LEFT JOIN` filters the "right" table to rows present in the "left" table
- `LEFT JOIN` will most often produce `NULL` values
- The "OUTER" in `LEFT OUTER JOIN` is optional
 - Generally, `OUTER` seems to be excluded but both are correct
- `LEFT` is *not* optional, there is no "OUTER JOIN"

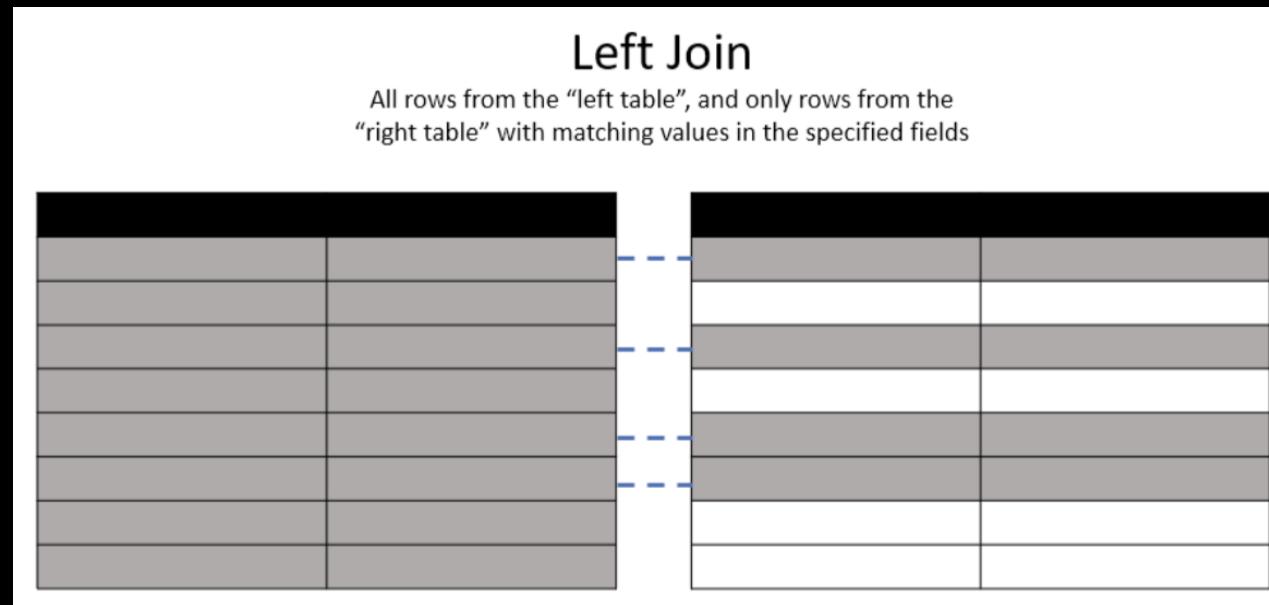


Image: Teate, Chapter 5

LEFT (OUTER) JOIN

(LEFT JOIN live coding)

JOIN

INNER JOIN

LEFT (OUTER) JOIN

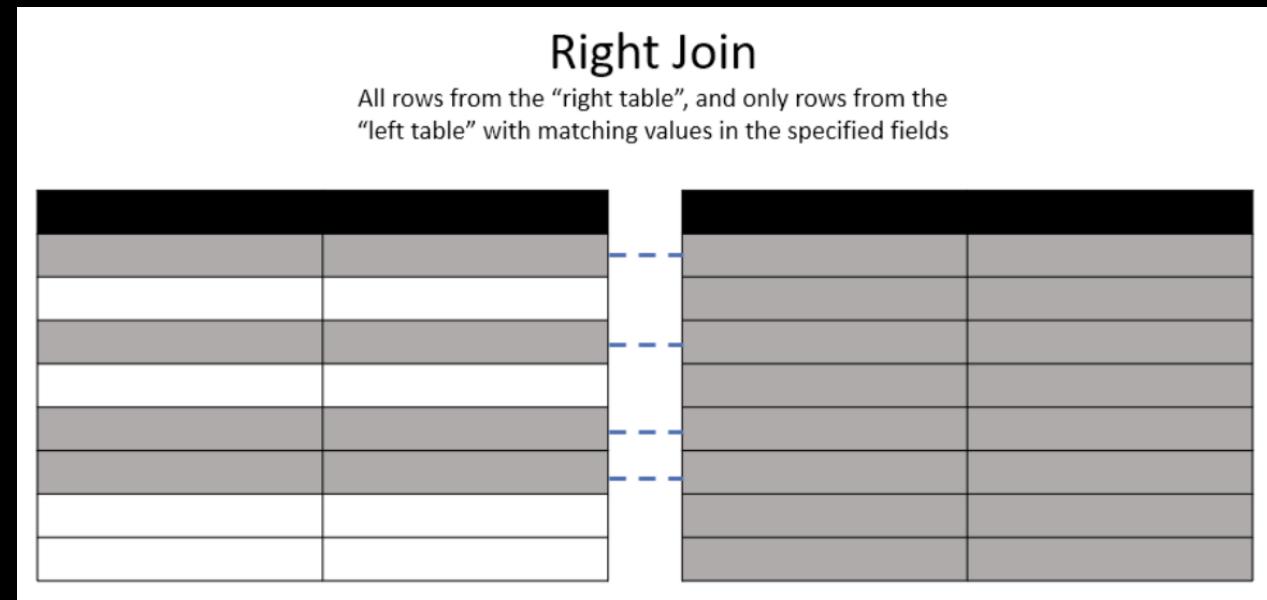
RIGHT (OUTER) JOIN

FULL (OUTER) JOIN

Multiple Table Joins

RIGHT (OUTER) JOIN

- `RIGHT JOIN` filters the "left" table to rows present in the "right" table
- `RIGHT JOIN` will most often produce `NULL` values
- The "OUTER" in `RIGHT OUTER JOIN` is optional
 - Generally, `OUTER` seems to be excluded but both are correct
- `RIGHT JOIN` is somewhat frowned upon, but sometimes they make sense
 - Often your query can be reorganized to use a `LEFT JOIN` instead
 - SQLite does not currently support `RIGHT JOIN`



JOIN

INNER JOIN

LEFT (OUTER) JOIN

RIGHT (OUTER) JOIN

FULL (OUTER) JOIN

Multiple Table Joins

FULL (OUTER) JOIN

- `FULL OUTER JOIN` does not filter either "left" or "right" table
- Expect `NULL` values to be produced from a `FULL OUTER JOIN`
- My experience has been to write `FULL OUTER JOIN` rather than `FULL JOIN` but this is personal preference
- Annoyingly, SQLite does not support `FULL OUTER JOIN` (*it really should*), but there is a work around to produce the results (we'll do it in Module 4)

Filtering a FULL (OUTER) JOIN

- All OUTER JOIN syntax can be filtered to exclude the *matching* criteria
 - Often called an ANTI JOIN, i.e. what's *not* in the other table

```
SELECT *
FROM table_1
{LEFT | RIGHT | FULL} OUTER JOIN table_2
ON table_1.key = table_2.key
WHERE {table_1.key IS NULL | table_2.key IS NULL |
       table_1.key IS NULL OR table_2.key IS NULL}
```

JOIN

INNER JOIN

LEFT (OUTER) JOIN

RIGHT (OUTER) JOIN

FULL OUTER JOIN

Multiple Table Joins

Multiple Table Joins

- More than one table can be joined at a time
- The order and type of joins will have significant effect on the final table
 - **Pause to imagine what these scenarios might look like based on your knowledge of different JOIN types**

Multiple Table Joins

For example, let's combine these three tables:

FirstName	Number
A	1
Thomas	2

(Table 1)

LastName	Number
Mahfouz	1
Rosenthal	2

(Table 2)

FirstName	LastName	Symbol
A	Smith	!
Edward	Rosenthal	?

If the desired outcome table is:

FirstName	LastName	Number	Symbol
A	Mahfouz	1	!
Thomas	Rosenthal	2	?

What are the correct JOIN criteria?

Multiple Table Joins

(Multiple Table Joins live coding)

Building Queries:

Two More Commands

JOIN

Aggregation Functions

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

GROUP BY

- Aggregations generally require a *group*
- GROUP BY is mandatory any time a column aside from the one being aggregated is present

For example, a query wanting to know the number of days in each month:

```
SELECT  
COUNT(days)  
,months  
  
FROM calendar  
GROUP by months
```

- GROUP BY comes after a WHERE clause
- Remember: with all aggregation functions, values will be calculated *per group*

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

COUNT

- COUNT performs counts of any given column or set of columns
- COUNT(*) provides a count of rows in a given table
 - no GROUP BY is required here
- Multiple counts are treated as separate columns
 - e.g. counting the number of days and months in a year ` SELECT COUNT(days) ,COUNT(months) ,years FROM calendar GROUP by years`
- When COUNT is combined with DISTINCT, only unique values are counted

COUNT

(COUNT live coding)

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

SUM & AVG

SUM

- **SUM** performs the sum total of any numeric column
 - Be wary, SQLite may be more permissive for columns with numbers; it's best practice to coerce (**CAST**) these values into numbers before summing to be certain of their validity
 - e.g. `CAST(SUM(column1) AS INTEGER) AS column1`
- SUM can accommodate multiple columns using the plus **+** operator
 - e.g. `SUM(column1 + column2)`
- Thinking about **SUM** and **COUNT** combined (i.e. a rolling total)? We'll get to that in the next session!

AVG

- **AVG** performs the average of any numeric column
- Like **SUM**, it can accommodate multiple columns
 - we can also use other mathematical operations for **SUM** and **AVG**, like **-,*,/,%** (i.e. modulo, not percent), etc

SUM & AVG

(SUM & AVG live coding)

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

MIN & MAX

- `MIN` takes the single minimum value of a given column; `MAX` takes the maximum
- Be wary of combining `MIN` & `MAX` with other aggregating functions like `SUM` or `AVG`
- **What do we think happens when `MIN` is performed on a string? Error? Something else? What about `MAX`?**

MIN & MAX

(`MIN` & `MAX` live coding)

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

Arithmetic

- SQL can perform many basic (and some complex) calculations
 - addition, subtraction, multiplication, division, power, etc
 - geometric/trigonometric functions sin, cos, tan, degrees, radians, etc
- These calculations can also be combined inside aggregation functions
 - e.g. multiplication inside a `SUM . . . SUM(quantity * cost)` would create a column like `total_spent` per group
- SQL is similar to other programming languages in its ability to handle floating point values
- **Because columns are type specific, how would we perform integer division on two numbers?**

Arithmetic

(Arithmetic live coding)

Aggregation Functions

GROUP BY

COUNT

SUM & AVG

MIN & MAX

Arithmetic

HAVING

- WHERE clauses filter rows *before* an aggregation occurs
 - ...so HAVING clauses allow us to filter rows *after* an aggregation is calculated
- HAVING clauses come after GROUP BY, but before ORDER BY
- HAVING clauses only filter aggregated calculations
 - you can have both WHERE and HAVING
 - they are not interchangeable

HAVING

(HAVING live coding)

