

# Building Queries: An Exploration

```
$ echo "Data Sciences Institute"
```

# Building Queries:

→ **Fundamental Three Commands**

**Two More Commands**

**Putting Things Together with JOIN**

# Fundamental Three Commands

# Fundamental Three Commands

- Our first three commands ( `SELECT` , `FROM` , `WHERE` ) are essential to nearly every SQL query
- The template for our initial SQL statement is as such:

`SELECT` : *the columns we want to retrieve*

`FROM` : *the table we are querying*

`WHERE` : *filters/conditions (optional)*

`ORDER BY` : *column sorting: ascending `ASC` or descending `DESC` (optional)*

`LIMIT` : *how many rows we want to return (optional)*

# Fundamental Three Commands

- Always specified in this order:
  - `SELECT` will come first
  - `FROM` will come after `SELECT`
    - when we are querying more than one table at a time, each will come after `FROM` but before `WHERE` (more on this later)
  - `WHERE` will come after `FROM`
  - `ORDER BY` will come after `WHERE` clauses

# Fundamental Three Commands

- We'll sometimes use the `LIMIT` clause to look at data
  - This comes at the very end of a query
  - `LIMIT` shouldn't be used for analytics unless you have a specific reason
    - `ORDER BY` often impacts the usefulness of `LIMIT`
- Remember:
  - In SQL, we use two dashes `--` to comment out lines, rather than `#`

# SELECT Command

- At its simplest `SELECT` specifies column names we are retrieving
  - commas come between each column name
    - `SELECT student, course, grade ...`
  - column names with a space need to be enclosed in square brackets
    - `SELECT [poorly named column], better_column_name, AnotherColumnName`

# SELECT Command


- Within `SELECT` statements we can perform manipulations on columns
  - e.g. rename a column
    - `SELECT [poorly named column] AS better_col`
  - combine two text columns
  - perform math on a numeric column
  - ...and many more things



# SELECT Command

- We can use `SELECT` to perform math without a `FROM` statement
  - `SELECT 1 + 1`
  - `SELECT 10*5, cos(2), pi()`
- And we can use `SELECT` to specify constant values
  - `SELECT 2025 AS this_year, 'August' AS this_month`
- When selecting columns, they need to exist in the table!

# FROM Command

- `FROM` statements indicate which table the data is from and where the table is located
  - in more complicated RDBMs, you will often have multiple databases on the same server and multiple schema within those databases
    - a fully qualified location of a table would thus be `database.schema.table`
- `SELECT * FROM table_name` indicates *everything* in the table
- Best practice suggests that we should explicitly call each column, even if we want all of them
  - Why do we think this is the case?  Think, Pair, Share

# SELECT & FROM

( SELECT & FROM live coding)

# WHERE Command

- `WHERE` clauses are conditions that the query will follow
- When we want to have multiple conditions, we use a single `WHERE` and then additional logical operations
- `WHERE` clauses always return rows evaluating to `TRUE`
  - Follows Boolean rules if more than one condition is present

# WHERE Command

```
SELECT *  
FROM students  
WHERE first_name = 'Thomas'  
AND last_name = 'Rosenthal'
```

- **Notice we put string values in single quotes**
  - SQLite also allows double quotes, with a few minor caveats

# WHERE Command

## Logical Operators

- AND
- OR
- NOT
- NOT IN
- equals: =
- does not equal: <> !=
  - (flavour dependent)

# WHERE Command

## Logical Operators (continued...)

- greater than (equal to): `>` `>=`
- less than (equal to): `<` `<=`
- `BETWEEN`
- `EXISTS`
  - table specific
- `IS`
  - `NULL` specific

# WHERE Command

- `NULL` is not a value (it's the absence of a value)
  - to check null values, we use `IS NULL` or `IS NOT NULL`
  - `= NULL` will not work



# WHERE Command

- `LIKE` allows for string wildcards
- `%` specifies the wildcard placement
  - `country_name LIKE 'and%'`
    - Andorra
  - `country_name LIKE '%and'`
    - Finland, Iceland ...more
  - `country_name LIKE '%and%'`
    - all of the above, *plus* Antigua and Barbuda, Netherlands, Rwanda ...more!
  - `country_name LIKE '%an%d%'`
    - Canada ...surely more!

# WHERE Command

( WHERE live coding)

What questions do you have about **SELECT**, **FROM**,  
**WHERE** ?

# Building Queries:

Fundamental Three Commands

→ Two More Commands

Putting Things Together with JOIN

## Two More Commands

- **CASE** : Implements conditional logic.
- **DISTINCT** : Returns unique values.

# CASE Command

- CASE statements allow us to introduce conditional logic into our SELECT statements

# CASE Command

- 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

# CASE Command

- 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 calculation]
  ELSE [value or calculation]
END
```



# CASE Command

( CASE live coding)

# DISTINCT Command

- Not all queries will result in unique rows (i.e. duplicates are present)
  - **Can we think of why this is? Write your thoughts in the etherpad!**

# DISTINCT Command

- `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 (we'll get to this later)
    - e.g. `COUNT(DISTINCT products)`
    - This `DISTINCT` will only affect this specific aggregation

# DISTINCT Command

( `DISTINCT` live coding)

# Building Queries:

Fundamental Three Commands

Two More Commands

→ Putting Things Together with JOIN

# Joining Tables

- Joins are used to combine data stored in different tables into a single table

# Joining Tables

- Joins are the "Cartesian product" of two tables with *conditional selection(s)* 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 ( $4 * 13$ )

- To create a Cartesian Product in SQL we use `CROSS JOIN` (rare, but not unheard of)

# Joining Tables

- Joins require relationships (with one exception, `CROSS JOIN` ) between tables
- Different joins create different results
  - Join names specify which conditional selection is desired



# Joining Tables

- 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 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]
```

# Joining Tables

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`

# 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

Source: Image: Teate, Chapter 5

## Inner Join

Only rows from the "right table" and "left table" where values in the specified fields have matches in both tables

Colour	Quantity
Pink	1
Blue	1
Green	2
Yellow	2
Black	6
Orange	3
Red	1
Purple	1

Colour	Quantity
Pink	1
Teal	3
Green	2
Gold	2
Black	6
Orange	3
Crimson	2
Purple	2

# 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)

# 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"

## Left Join

All rows from the "left table", and only rows from the "right table" with matching values in the specified fields

Colour	Quantity		Colour	Quantity
Pink	1	---	Pink	1
Blue	1		Teal	3
Green	2	---	Green	2
Yellow	2		Gold	2
Black	6	---	Black	6
Orange	3	---	Orange	3
Red	1		Crimson	2
Purple	1		Purple	2

# LEFT (OUTER) JOIN

( `LEFT JOIN` live coding)



# 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

Source: Image: Teate, Chapter 5

## Right Join

All rows from the "right table", and only rows from the "left table" with matching values in the specified fields

Colour	Quantity		Colour	Quantity
Pink	1	---	Pink	1
Blue	1		Teal	3
Green	2	---	Green	2
Yellow	2		Gold	2
Black	6	---	Black	6
Orange	3	---	Orange	3
Red	1		Crimson	2
Purple	1		Purple	2

# RIGHT (OUTER) JOIN

- `RIGHT JOIN` is somewhat frowned upon, but sometimes they make sense
  - Often your query can be reorganized to use a `LEFT JOIN` instead

Source: Image: Teate, Chapter 5

## Right Join

All rows from the "right table", and only rows from the "left table" with matching values in the specified fields

Colour	Quantity		Colour	Quantity
Pink	1	- - -	Pink	1
Blue	1		Teal	3
Green	2	- - -	Green	2
Yellow	2		Gold	2
Black	6	- - -	Black	6
Orange	3	- - -	Orange	3
Red	1		Crimson	2
Purple	1		Purple	2

# 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

# 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}
```

# Multiple Table Joins

- More than one table can be joined at a time

```
SELECT *  
FROM table_1  
{INNER | LEFT | FULL JOIN table_2  
  ON table_1.key = table_2.key  
{INNER | LEFT | FULL JOIN table_3  
  ON {table_1 | table_2}.key = table_3.key  
{INNER | LEFT | FULL JOIN table_n  
  ON {table_1 | table_2 | table_3}.key = table_n.key
```

# Multiple Table Joins

- The order and type of joins will have significant effect on the final table
- It's important to determine which table should be the `FROM` table
- Sometimes you have to experiment a bit to get things right
- **Can you imagine scenarios based on your knowledge of different `JOIN` types that result in significantly different outputs?**

# Multiple Table Joins

(Multiple Table Joins live coding)

**What questions do you have about anything from today?**