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SQL Lesson 1: SELECT queries

To retrieve data from a SQL database, we need to write SELECT statements, which are often colloquially refered to as queries. A query in itself is just a statement which declares what data we are looking for, where to find it in the database, and optionally, how to transform it before it is returned. It has a specific syntax though, which is what we are going to learn in the following exercises.

As we mentioned in the introduction, you can think of a table in SQL as a type of an entity (ie. Dogs), and each row in that table as a specific instance of that type (ie. A pug, a beagle, a different colored pug, etc). This means that the columns would then represent the common properties shared by all instances of that entity (ie. Color of fur, length of tail, etc).

And given a table of data, the most basic query we could write would be one that selects for a couple columns (properties) of the table with all the rows (instances).

Select query for a specific columns

```
SELECT column, another_column, …
FROM mytable;
```

The result of this query will be a two-dimensional set of rows and columns, effectively a copy of the table, but only with the columns that we requested.

If we want to retrieve absolutely all the columns of data from a table, we can then use the asterisk (*) shorthand in place of listing all the column names individually.

Select query for all columns

```
SELECT *
FROM mytable;
```

This query, in particular, is really useful because it's a simple way to inspect a table by dumping all the data at once.

Exercise

We will be using a database with data about some of Pixar's classic movies for most of our exercises. This first exercise will only involve the Movies table, and the default query below currently shows all the properties of each movie. To continue onto the next lesson, alter the query to find the exact information we need for each task.

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1999	93
4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101

Find the Title of each film

```
SELECT Title FROM movies;
```

Table: Movies

Title
Toy Story
A Bug's Life
Toy Story 2
Monsters, Inc.
Finding Nemo
The Incredibles
Cars
Ratatouille
WALL-E
Up

```
SELECT Title FROM movies;
```

RESE

Find the director of each film

```
SELECT Director FROM movies;
```

Table: Movies

Director
John Lasseter
John Lasseter
John Lasseter
Pete Docter
Andrew Stanton
Brad Bird
John Lasseter
Brad Bird
Andrew Stanton
Pete Docter

```
SELECT Director FROM movies;
```

RESE

Find the title and director of each film

```
SELECT Title, Director FROM movies;
```

Table: Movies

Title	Director
Toy Story	John Lasseter
A Bug's Life	John Lasseter
Toy Story 2	John Lasseter
Monsters, Inc.	Pete Docter
Finding Nemo	Andrew Stanton
The Incredibles	Brad Bird
Cars	John Lasseter
Ratatouille	Brad Bird
WALL-E	Andrew Stanton
Up	Pete Docter

```
SELECT Title, Director FROM movies;
```

RESE

Find the title and year of each film

```
SELECT Title, Year FROM movies;
```

Table: Movies

Title	Year
Toy Story	1995
A Bug's Life	1998
Toy Story 2	1999
Monsters, Inc.	2001
Finding Nemo	2003
The Incredibles	2004
Cars	2006
Ratatouille	2007
WALL-E	2008
Up	2009

```
SELECT Title, Year FROM movies;
```

RESE

Find all the information about each film

```
SELECT * FROM movies;
```

Table: Movies

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1999	93
4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101

```
SELECT * FROM movies;
```

RESE

SQL Lesson 2: Queries with constraints (Pt. 1)

Now we know how to select for specific columns of data from a table, but if you had a table with a hundred million rows of data, reading through all the rows would be inefficient and perhaps even impossible.

In order to filter certain results from being returned, we need to use a WHERE clause in the query. The clause is applied to each row of data by checking specific column values to determine whether it should be included in the results or not.

```
SELECT column, another_column, …
FROM mytable
WHERE condition
    AND/OR another_condition
    AND/OR …;
```

More complex clauses can be constructed by joining numerous AND or OR logical keywords (ie. num_wheels >= 4 AND doors <= 2). And below are some useful operators that you can use for numerical data (ie. integer or floating point):

Operator	Condition	SQL Example
=, !=, <, <=, >, >=	Standard numerical operators	col_name **!=** 4
BETWEEN … AND …	Number is within range of two values (inclusive)	col_name **BETWEEN** 1.5 **AND** 10.5
NOT BETWEEN … AND …	Number is not within range of two values (inclusive)	col_name **NOT BETWEEN** 1 **AND** 10
IN (…)	Number exists in a list	col_name **IN** (2, 4, 6)
NOT IN (…)	Number does not exist in a list	col_name **NOT IN** (1, 3, 5)

In addition to making the results more manageable to understand, writing clauses to constrain the set of rows returned also allows the query to run faster due to the reduction in unnecessary data being returned.

> Did you know?
> As you might have noticed by now, SQL doesn't require you to write the keywords all capitalized, but as a convention, it helps people distinguish SQL keywords from column and tables names, and makes the query easier to read.

Exercise

Using the right constraints, find the information we need from the Movies table for each task below.

> We have the same database "movies" as above

Find the movie with a row id of 6

```
SELECT * FROM movies
WHERE id = 6;
```

OR

```
SELECT * FROM movies WHERE id = 6;
```

Table: Movies

Id	Title	Director	Year	Length_minutes
6	The Incredibles	Brad Bird	2004	116

```
SELECT * FROM movies WHERE id = 6;
```

Find the movies released in the years between 2000 and 2010

```
SELECT * FROM movies WHERE Year BETWEEN 2000 AND 2010;
```

Table: Movies

Id	Title	Director	Year	Length_minutes
4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101
11	Toy Story 3	Lee Unkrich	2010	103

```
SELECT * FROM movies WHERE Year BETWEEN 2000 AND 2010;
```

Find the movies not released in the years between 2000 and 2010

```
SELECT * FROM movies WHERE Year NOT BETWEEN 2000 AND 2010;
```

Table: Movies

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1999	93
12	Cars 2	John Lasseter	2011	120
13	Brave	Brenda Chapman	2012	102
14	Monsters University	Dan Scanlon	2013	110

```
SELECT * FROM movies WHERE Year NOT BETWEEN 2000 AND 2010;
```

Find the first 5 Pixar movies and their release year

```sql
SELECT Title, Year FROM movies WHERE id < 6;
```

OR

```sql
SELECT Title, Year FROM movies LIMIT 5;
```

Table: Movies

Title	Year
Toy Story	1995
A Bug's Life	1998
Toy Story 2	1999
Monsters, Inc.	2001
Finding Nemo	2003

```sql
SELECT Title, Year FROM movies WHERE id < 6;
```

SQL Lesson 3: Queries with constraints (Pt. 2)

When writing WHERE clauses with columns containing text data, SQL supports a number of useful operators to do things like case-insensitive string comparison and wildcard pattern matching. We show a few common text-data specific operators below:

Operator	Condition	Example
=	Case sensitive exact string comparison (**notice the single equals**)	col_name **=** "abc"
!= or <>	Case sensitive exact string inequality comparison	col_name **!=** "abcd"
LIKE	Case insensitive exact string comparison	col_name **LIKE** "ABC"
NOT LIKE	Case insensitive exact string inequality comparison	col_name **NOT LIKE** "ABCD"
%	Used anywhere in a string to match a sequence of zero or more characters (only with LIKE or NOT LIKE)	col_name **LIKE** "%AT%" (matches "AT", "ATTIC", "CAT" or even "BATS")
_	Used anywhere in a string to match a single character (only with LIKE or NOT LIKE)	col_name **LIKE** "AN_" (matches "AND", but not "AN")
IN (…)	String exists in a list	col_name **IN** ("A", "B", "C")
NOT IN (…)	String does not exist in a list	col_name **NOT IN** ("D", "E", "F")

> Did you know?
> All strings must be quoted so that the query parser can distinguish words in the string from SQL keywords.

We should note that while most database implementations are quite efficient when using these operators, full-text search is best left to dedicated libraries like Apache Lucene or Sphinx. These libraries are designed specifically to do full text search, and as a result are more efficient and can support a wider variety of search features including internationalization and advanced queries.

Exercise

Here's the definition of a query with a WHERE clause again, go ahead and try and write some queries with the operators above to limit the results to the information we need in the tasks below.

```
SELECT column, another_column, …
FROM mytable
WHERE condition
    AND/OR another_condition
    AND/OR …;
```

Find all the Toy Story movies

```
SELECT title, director FROM movies WHERE title LIKE "Toy Story";
```

Given code matches only the title that is exactly "Toy Story"

```
SELECT title, director FROM movies WHERE title LIKE "Toy Story%";
```

Matches any title that starts with "Toy Story" — like "Toy Story 2", "Toy Story 3", etc.

Table: Movies

Title	Director
Toy Story	John Lasseter
Toy Story 2	John Lasseter
Toy Story 3	Lee Unkrich

```
SELECT title, director FROM movies WHERE title LIKE "Toy Story%";
-- Matches any title that starts with "Toy Story" — like "Toy Story 2"
    , "Toy Story 3", etc.
```

RESET

Find all the movies directed by John Lasseter

```
SELECT title, director FROM movies WHERE director LIKE "John Lasseter%";
```

Table: Movies

Title	Director
Toy Story	John Lasseter
A Bug's Life	John Lasseter
Toy Story 2	John Lasseter
Cars	John Lasseter
Cars 2	John Lasseter

```
SELECT title, director FROM movies WHERE director LIKE "John
    Lasseter%";
```

RESET

Find all the movies (and director) not directed by John Lasseter

```
SELECT title, director FROM movies WHERE director NOT LIKE "John Lasseter%";
```

Table: Movies

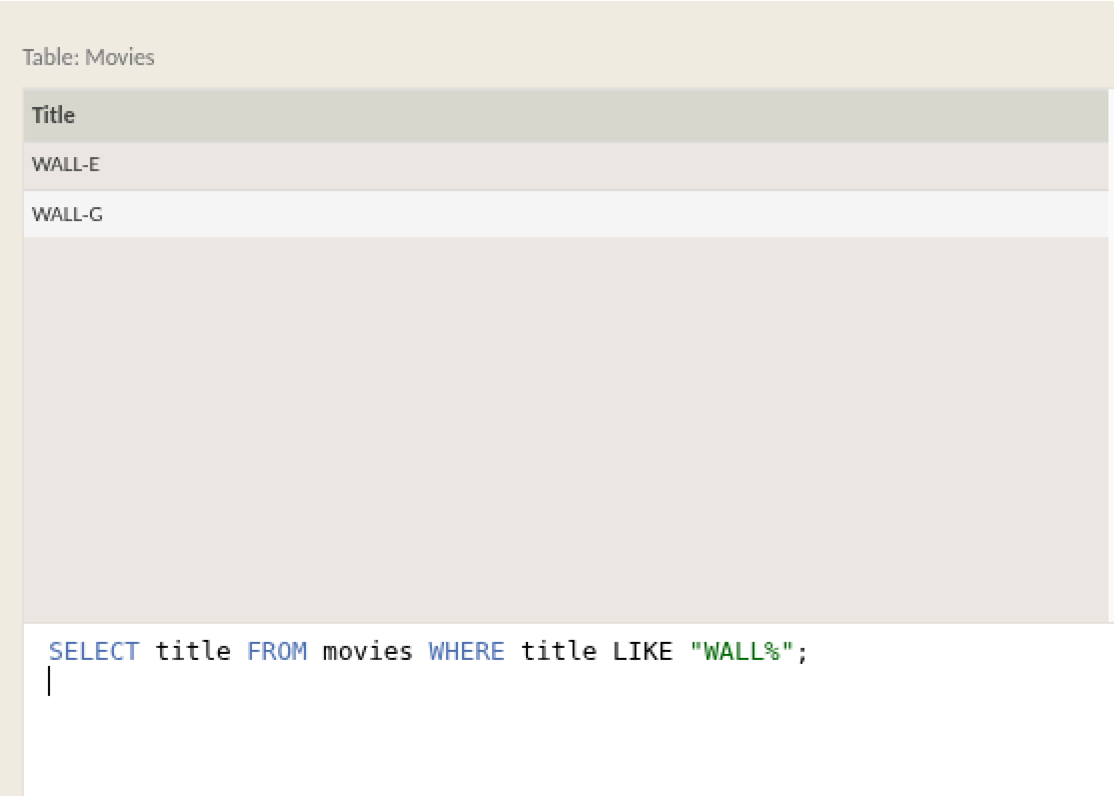
Title	Director
Monsters, Inc.	Pete Docter
Finding Nemo	Andrew Stanton
The Incredibles	Brad Bird
Ratatouille	Brad Bird
WALL-E	Andrew Stanton
Up	Pete Docter
Toy Story 3	Lee Unkrich
Brave	Brenda Chapman
Monsters University	Dan Scanlon
WALL-G	Brenda Chapman

```
SELECT title, director FROM movies WHERE director NOT LIKE "John
    Lasseter%";
```

RESET

Find all the WALL-* movies

```
SELECT title FROM movies WHERE title LIKE "WALL%";
```



SQL Lesson 4: Filtering and sorting Query results

Even though the data in a database may be unique, the results of any particular query may not be – take our Movies table for example, many different movies can be released the same year. In such cases, SQL provides a convenient way to discard rows that have a duplicate column value by using the DISTINCT keyword.

Select query with unique results

```
SELECT DISTINCT column, another_column, …
FROM mytable
WHERE condition(s);
```

Since the DISTINCT keyword will blindly remove duplicate rows, we will learn in a future lesson how to discard duplicates based on specific columns using grouping and the GROUP BY clause.

Ordering results

Unlike our neatly ordered table in the last few lessons, most data in real databases are added in no particular column order. As a result, it can be difficult to read through and understand the results of a query as the size of a table increases to thousands or even millions rows.

To help with this, SQL provides a way to sort your results by a given column in ascending or descending order using the ORDER BY clause.

Select query with ordered results

```
SELECT column, another_column, …
FROM mytable
WHERE condition(s)
ORDER BY column ASC/DESC;
```

When an ORDER BY clause is specified, each row is sorted alpha-numerically based on the specified column's value. In some databases, you can also specify a collation to better sort data containing international text.

Limiting results to a subset

Another clause which is commonly used with the ORDER BY clause are the LIMIT and OFFSET clauses, which are a useful optimization to indicate to the database the subset of the results you care about.
The LIMIT will reduce the number of rows to return, and the optional OFFSET will specify where to begin counting the number rows from.

Select query with limited rows

```
SELECT column, another_column, …
FROM mytable
WHERE condition(s)
ORDER BY column ASC/DESC
LIMIT num_limit OFFSET num_offset;
```

If you think about websites like Reddit or Pinterest, the front page is a list of links sorted by popularity and time, and each subsequent page can be represented by sets of links at different offsets in the database. Using these clauses, the database can then execute queries faster and more efficiently by processing and returning only the requested content.

> Did you know?
> If you are curious about when the LIMIT and OFFSET are applied relative to the other parts of a query, they are generally done last after the other clauses have been applied. We'll touch more on this in Lesson 12: Order of execution after introducting a few more parts of the query.

Exercise

There are a few concepts in this lesson, but all are pretty straight-forward to apply. To spice things up, we've gone and scrambled the Movies table for you in the exercise to better mimic what kind of data you might see in real life. Try and use the necessary keywords and clauses introduced above in your queries.

List all directors of Pixar movies (alphabetically), without duplicates

```
SELECT DISTINCT director FROM movies ORDER BY director ASC;
```

Table: Movies

Director
Andrew Stanton
Brad Bird
Brenda Chapman
Dan Scanlon
John Lasseter
Lee Unkrich
Pete Docter

```
SELECT DISTINCT director FROM movies ORDER BY director ASC;
```

List the last four Pixar movies released (ordered from most recent to least)

```
SELECT title, year FROM movies ORDER BY year DESC LIMIT 4;
```

Table: Movies

Title	Year
Monsters University	2013
Brave	2012
Cars 2	2011
Toy Story 3	2010

```
SELECT title, year FROM movies ORDER BY year DESC LIMIT 4;
```

List the first five Pixar movies sorted alphabetically

```
SELECT title FROM movies ORDER BY title ASC LIMIT 5;
```

Table: Movies

Title
A Bug's Life
Brave
Cars
Cars 2
Finding Nemo

```
SELECT title FROM movies ORDER BY title ASC LIMIT 5;
```

List the next five Pixar movies sorted alphabetically

```
SELECT title FROM movies ORDER BY title ASC LIMIT 5 OFFSET 5;
```

SQL Review: Simple SELECT Queries (With Different DataBase)

We've done a good job getting to this point! Now that we've gotten a taste of how to write a basic query, we need to practice writing queries that solve actual problems.

```
SELECT column, another_column, …
FROM mytable
WHERE condition(s)
ORDER BY column ASC/DESC
LIMIT num_limit OFFSET num_offset;
```

Exercise

In the exercise below, you will be working with a different table. This table instead contains information about a few of the most populous cities of North America[1] including their population and geo-spatial location in the world.

> Did you know?
> Positive latitudes correspond to the northern hemisphere, and positive longitudes correspond to

> the eastern hemisphere. Since North America is north of the equator and west of the prime meridian, all of the cities in the list have positive latitudes and negative longitudes.

Try and write some queries to find the information requested in the tasks below. You may have to use a different combination of clauses in your query for each task. Once you're done, continue onto the next lesson to learn about queries that span multiple tables.

New Data Base

Table: North_american_cities

City	Country	Population	Latitude	Longitude
Guadalajara	Mexico	1500800	20.659699	-103.349609
Toronto	Canada	2795060	43.653226	-79.383184
Houston	United States	2195914	29.760427	-95.369803
New York	United States	8405837	40.712784	-74.005941
Philadelphia	United States	1553165	39.952584	-75.165222
Havana	Cuba	2106146	23.05407	-82.345189
Mexico City	Mexico	8555500	19.432608	-99.133208
Phoenix	United States	1513367	33.448377	-112.074037
Los Angeles	United States	3884307	34.052234	-118.243685
Ecatepec de Morelos	Mexico	1742000	19.601841	-99.050674

```
SELECT * FROM north_american_cities;
```

List all the Canadian cities and their populations

```
SELECT city, population FROM north_american_cities WHERE country = 'Canada';
```

Table: North_american_cities

City	Population
Toronto	2795060
Montreal	1717767

```sql
SELECT city, population FROM north_american_cities WHERE country =
    'Canada';
```

Order all the cities in the United States by their latitude from north to south

First know the north, south, east and west from latitude and longitude

Coordinate	Range	Meaning
Latitude	-90 to +90	Measures **North/South** of the equator
Longitude	-180 to +180	Measures **East/West** of the Prime Meridian

```sql
SELECT city FROM north_american_cities WHERE country LIKE "united%" ORDER BY latitude D
```

Table: North_american_cities

City
Chicago
New York
Philadelphia
Los Angeles
Phoenix
Houston

```
SELECT city FROM north_american_cities WHERE country LIKE "united%"
    ORDER BY latitude DESC;
```

List all the cities west of Chicago, ordered from west to east

As we have to go west to east so we see longitude and also we have given as specific city so we are comparing all other cities with the longitude of that particular city.

```
SELECT city, longitude FROM north_american_cities
WHERE longitude < -87.629798
ORDER BY longitude ASC;
```

Table: North_american_cities

City	Longitude
Los Angeles	-118.243685
Phoenix	-112.074037
Guadalajara	-103.349609
Mexico City	-99.133208
Ecatepec de Morelos	-99.050674
Houston	-95.369803

```
SELECT city, longitude FROM north_american_cities
WHERE longitude < -87.629798
ORDER BY longitude ASC;
```

List the two largest cities in Mexico (by population)

```
SELECT city, population FROM north_american_cities WHERE country = "Mexico" ORDER BY po
```

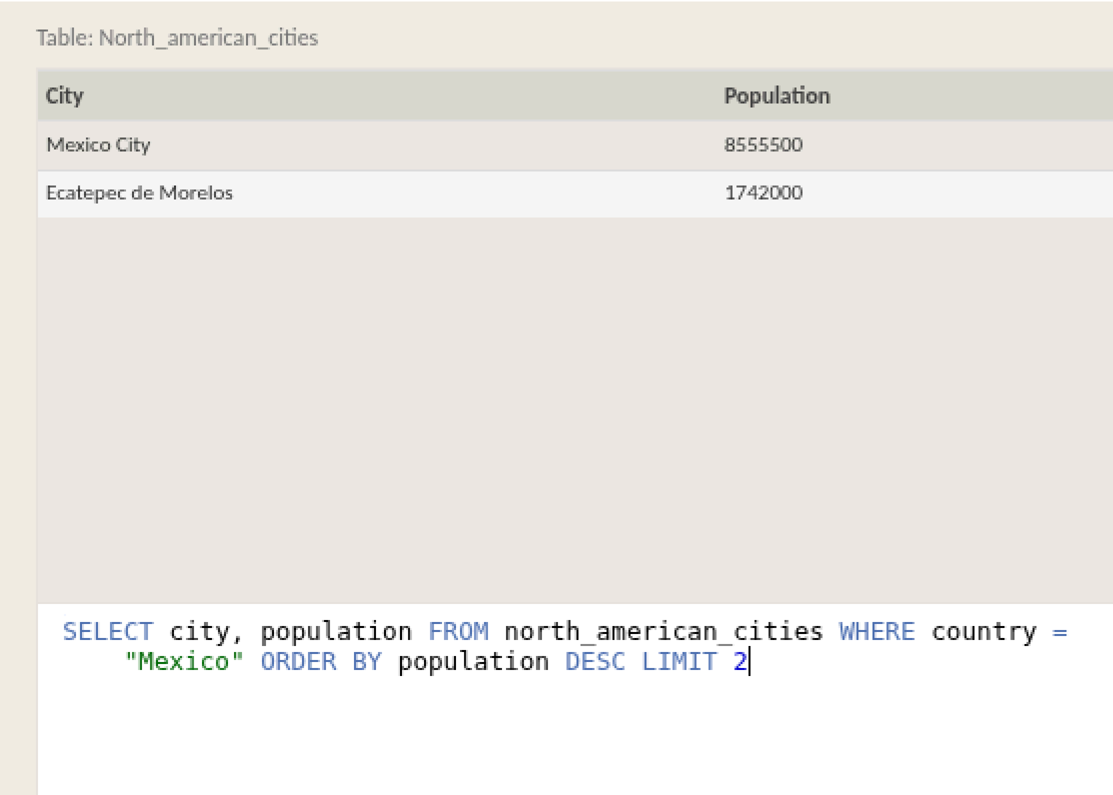


Table: North_american_cities

City	Population
Mexico City	8555500
Ecatepec de Morelos	1742000

```
SELECT city, population FROM north_american_cities WHERE country =
    "Mexico" ORDER BY population DESC LIMIT 2
```

List the third and fourth largest cities (by population) in the United States and their population

As we have to list two cities in the united states which are third and fourth largest, so we arrange in descending order by population then we have to display two rows so we set LIMIT to 2 and also we have to display only third and fourth row so we set OFFSET to 2 i.e. it displays by skipping first two rows and displaying 3 and 4 row.

```
SELECT city, population FROM north_american_cities WHERE country LIKE "united%" ORDER B
```

Table: North_american_cities

City	Population
Chicago	2718782
Houston	2195914

```
SELECT city, population FROM north_american_cities WHERE country LIKE
    "united%" ORDER BY population DESC LIMIT 2 OFFSET 2;
```

SQL Lesson 6: Multi-table queries with JOINs

Up to now, we've been working with a single table, but entity data in the real world is often broken down into pieces and stored across multiple orthogonal tables using a process known as normalization[1].

Database normalization

Database normalization is useful because it minimizes duplicate data in any single table, and allows for data in the database to grow independently of each other (ie. Types of car engines can grow independent of each type of car). As a trade-off, queries get slightly more complex since they have to be able to find data from different parts of the database, and performance issues can arise when working with many large tables.

In order to answer questions about an entity that has data spanning multiple tables in a normalized database, we need to learn how to write a query that can combine all that data and pull out exactly the information we need.

Multi-table queries with JOINs

Tables that share information about a single entity need to have a primary key that identifies that entity uniquely across the database. One common primary key type is an auto-incrementing integer (because they are space efficient), but it can also be a string, hashed value, so long as it is unique.

Using the JOIN clause in a query, we can combine row data across two separate tables using this unique key. The first of the joins that we will introduce is the INNER JOIN.

Select query with INNER JOIN on multiple tables

```
SELECT column, another_table_column, …
FROM mytable
INNER JOIN another_table
    ON mytable.id = another_table.id
WHERE condition(s)
ORDER BY column, … ASC/DESC
LIMIT num_limit OFFSET num_offset;
```

The INNER JOIN is a process that matches rows from the first table and the second table which have the same key (as defined by the ON constraint) to create a result row with the combined columns from both tables. After the tables are joined, the other clauses we learned previously are then applied.

> Did you know?
> You might see queries where the INNER JOIN is written simply as a JOIN. These two are equivalent, but we will continue to refer to these joins as inner-joins because they make the query easier to read once you start using other types of joins, which will be introduced in the following lesson.

Exercise

We've added a new table to the Pixar database so that you can try practicing some joins. The BoxOffice table stores information about the ratings and sales of each particular Pixar movie, and the Movie_id column in that table corresponds with the Id column in the Movies table 1-to-1. Try and solve the tasks below using the INNER JOIN introduced above.

DataBases

Table: Movies (Read-Only)

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1999	93
4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116

Table: Boxoffice (Read-Only)

Movie_id	Rating	Domestic_sales	International_sales
5	8.2	380843261	555900000
14	7.4	268492764	475066843
8	8	206445654	417277164
12	6.4	191452396	368400000
3	7.9	245852179	239163000
6	8	261441092	370001000

Find the domestic and international sales for each movie

```
SELECT Title, domestic_sales, international_sales FROM movies
INNER JOIN boxoffice
ON movies.id = boxoffice.movie_id;
```

Query Results

Title	Domestic_sales	International_sales
Finding Nemo	380843261	555900000
Monsters University	268492764	475066843
Ratatouille	206445654	417277164
Cars 2	191452396	368400000
Toy Story 2	245852179	239163000
The Incredibles	261441092	370001000
WALL-E	223808164	297503696
Toy Story 3	415004880	648167031
Toy Story	191796233	170162503
Cars	244082982	217900167


```
SELECT Title, domestic_sales, international_sales FROM movies
INNER JOIN boxoffice
ON movies.id = boxoffice.movie_id;
```


Show the sales numbers for each movie that did better internationally rather than domestically

```
SELECT Title, domestic_sales, international_sales FROM movies
INNER JOIN boxoffice
ON movies.id = boxoffice.movie_id
WHERE international_sales > domestic_sales;
```

Query Results

Title	Domestic_sales	International_sales
Finding Nemo	380843261	555900000
Monsters University	268492764	475066843
Ratatouille	206445654	417277164
Cars 2	191452396	368400000
The Incredibles	261441092	370001000
WALL-E	223808164	297503696
Toy Story 3	415004880	648167031
Up	293004164	438338580
A Bug's Life	162798565	200600000
Brave	237283207	301700000

```
SELECT Title, domestic_sales, international_sales FROM movies
INNER JOIN boxoffice
ON movies.id = boxoffice.movie_id
WHERE international_sales > domestic_sales;
```

List all the movies by their ratings in descending order

```
SELECT Title, rating FROM movies
INNER JOIN boxoffice
ON movies.id = boxoffice.movie_id
ORDER BY rating DESC;
```

Query Results

Title	Rating
WALL-E	8.5
Toy Story 3	8.4
Toy Story	8.3
Up	8.3
Finding Nemo	8.2
Monsters, Inc.	8.1
Ratatouille	8
The Incredibles	8
Toy Story 2	7.9
Monsters University	7.4

```
SELECT Title, rating FROM movies
INNER JOIN boxoffice
ON movies.id = boxoffice.movie_id
ORDER BY rating DESC;
```

SQL Lesson 7: OUTER JOINs

Depending on how you want to analyze the data, the INNER JOIN we used last lesson might not be sufficient because the resulting table only contains data that belongs in both of the tables.

If the two tables have asymmetric data, which can easily happen when data is entered in different stages, then we would have to use a LEFT JOIN, RIGHT JOIN or FULL JOIN instead to ensure that the data you need is not left out of the results.

Select query with LEFT/RIGHT/FULL JOINs on multiple tables

```
SELECT column, another_column, …
FROM mytable
INNER/LEFT/RIGHT/FULL JOIN another_table
    ON mytable.id = another_table.matching_id
WHERE condition(s)
ORDER BY column, … ASC/DESC
LIMIT num_limit OFFSET num_offset;
```

Like the INNER JOIN these three new joins have to specify which column to join the data on.
When joining table A to table B, a LEFT JOIN simply includes rows from A regardless of whether a matching row is found in B. The RIGHT JOIN is the same, but reversed, keeping rows in B regardless of whether a match is found in A. Finally, a FULL JOIN simply means that rows from both tables are kept, regardless of whether a matching row exists in the other table.

When using any of these new joins, you will likely have to write additional logic to deal with NULLs in the result and constraints (more on this in the next lesson).

> Did you know?
> You might see queries with these joins written as LEFT OUTER JOIN, RIGHT OUTER JOIN, or FULL OUTER JOIN, but the OUTER keyword is really kept for SQL-92 compatibility and these queries are simply equivalent to LEFT JOIN, RIGHT JOIN, and FULL JOIN respectively.

Exercise

In this exercise, you are going to be working with a new table which stores fictional data about Employees in the film studio and their assigned office Buildings. Some of the buildings are new, so they don't have any employees in them yet, but we need to find some information about them regardless.

Since our browser SQL database is somewhat limited, only the LEFT JOIN is supported in the exercise below.

Data Base

Table: Buildings (Read-Only)

Building_name	Capacity
1e	24
1w	32
2e	16
2w	20

Table: Employees (Read-Only)

Role	Name	Building	Years_employed
Engineer	Becky A.	1e	4
Engineer	Dan B.	1e	2
Engineer	Sharon F.	1e	6
Engineer	Dan M.	1e	4
Engineer	Malcom S.	1e	1
Artist	Tylar S.	2w	2

Find the list of all buildings that have employees

```
SELECT DISTINCT building FROM employees;
```

Query Results

Building
1e
2w

```
SELECT DISTINCT building FROM employees;
```

Find the list of all buildings and their capacity

```
SELECT building_name, capacity FROM buildings;
```

Query Results

Building_name	Capacity
1e	24
1w	32
2e	16
2w	20

```
SELECT building_name, capacity FROM buildings;
```

List all buildings and the distinct employee roles in each building (including empty buildings) ✓

```
SELECT DISTINCT building_name, role
FROM buildings
  LEFT JOIN employees
    ON building_name = building;
```

Query Results

Building_name	Role
1e	Engineer
1e	Manager
1w	
2e	
2w	Artist
2w	Manager


```
SELECT DISTINCT building_name, role
FROM buildings
  LEFT JOIN employees
    ON building_name = building;
```

SQL Lesson 8: A short note on NULLs

As promised in the last lesson, we are going to quickly talk about NULL values in an SQL database. It's always good to reduce the possibility of NULL values in databases because they require special attention when constructing queries, constraints (certain functions behave differently with null values) and when processing the results.

An alternative to NULL values in your database is to have data-type appropriate default values, like 0 for numerical data, empty strings for text data, etc. But if your database needs to store incomplete data, then NULL values can be appropriate if the default values will skew later analysis (for example, when taking averages of numerical data).

Sometimes, it's also not possible to avoid NULL values, as we saw in the last lesson when outer-joining two tables with asymmetric data. In these cases, you can test a column for NULL values in a WHERE clause by using either the IS NULL or IS NOT NULL constraint.

Select query with constraints on NULL values

```
SELECT column, another_column, …
FROM mytable
WHERE column IS/IS NOT NULL
AND/OR another_condition
AND/OR …;
```

Exercise

This exercise will be a sort of review of the last few lessons. We're using the same Employees and Buildings table from the last lesson, but we've hired a few more people, who haven't yet been assigned a building.

Find the name and role of all employees who have not been assigned to a building

```
SELECT name, role FROM employees
WHERE building IS NULL;
```

Query Results

Name	Role
Yancy I.	Engineer
Oliver P.	Artist

```
SELECT name, role FROM employees
WHERE building IS NULL;
```

Find the names of the buildings that hold no employees

```
SELECT DISTINCT building_name
FROM buildings
  LEFT JOIN employees
    ON building_name = building
WHERE role IS NULL;
```

Query Results

Building_name
1w
2e


```
SELECT DISTINCT building_name
FROM buildings
  LEFT JOIN employees
    ON building_name = building
WHERE role IS NULL;
```

SQL Lesson 9: Queries with expressions

In addition to querying and referencing raw column data with SQL, you can also use expressions to write more complex logic on column values in a query. These expressions can use mathematical and string functions along with basic arithmetic to transform values when the query is executed, as shown in this physics example.

Example query with expressions

```
SELECT particle_speed / 2.0 AS half_particle_speed
FROM physics_data
WHERE ABS(particle_position) * 10.0 > 500;
```

Each database has its own supported set of mathematical, string, and date functions that can be used in a query, which you can find in their own respective docs.

The use of expressions can save time and extra post-processing of the result data, but can also make the query harder to read, so we recommend that when expressions are used in the SELECT part of the query, that they are also given a descriptive alias using the AS keyword.

Select query with expression aliases

```
SELECT col_expression AS expr_description, …
FROM mytable;
```

In addition to expressions, regular columns and even tables can also have aliases to make them easier to reference in the output and as a part of simplifying more complex queries.

Example query with both column and table name aliases

```
SELECT column AS better_column_name, …
FROM a_long_widgets_table_name AS mywidgets
INNER JOIN widget_sales
  ON mywidgets.id = widget_sales.widget_id;
```

Exercise

You are going to have to use expressions to transform the BoxOffice data into something easier to understand for the tasks below.

List all movies and their combined sales in millions of dollars

```
SELECT title, (domestic_sales + international_sales) / 1000000 AS combined_sales FROM m
INNER JOIN boxoffice
ON id = movie_id;
```

OR

```
SELECT
    movies.title,
    (boxoffice.domestic_sales + boxoffice.international_sales) / 1000000 AS combined_sa
FROM
    movies
INNER JOIN
    boxoffice
ON
    movies.id = boxoffice.movie_id;
```

Query Results

Title	Combined_sales
Finding Nemo	936.743261
Monsters University	743.559607
Ratatouille	623.722818
Cars 2	559.852396
Toy Story 2	485.015179
The Incredibles	631.442092
WALL-E	521.31186
Toy Story 3	1063.171911
Toy Story	361.958736
Cars	461.983149

```
SELECT movies.title, (domestic_sales + international_sales) / 1000000
    AS combined_sales FROM movies
INNER JOIN boxoffice
ON id = movie_id;
```

List all movies and their ratings in percent

The Float One

```
SELECT title, (rating / 10) * 100 AS rating_percent FROM movies
INNER JOIN boxoffice
ON id = movie_id;
```

Query Results

Title	Rating_percent
Finding Nemo	82
Monsters University	74
Ratatouille	80
Cars 2	64
Toy Story 2	79
The Incredibles	80
WALL-E	85
Toy Story 3	84.00000000000001
Toy Story	83
Cars	72


```
SELECT title, (rating / 10) * 100 AS rating_percent FROM movies
INNER JOIN boxoffice
ON id = movie_id;
```


The Integer One

```
SELECT title, rating * 10 AS rating_percent
FROM movies
  JOIN boxoffice
    ON movies.id = boxoffice.movie_id;
```

Query Results

Title	Rating_percent
Finding Nemo	82
Monsters University	74
Ratatouille	80
Cars 2	64
Toy Story 2	79
The Incredibles	80
WALL-E	85
Toy Story 3	84
Toy Story	83
Cars	72

```
SELECT title, rating * 10 AS rating_percent
FROM movies
  JOIN boxoffice
    ON movies.id = boxoffice.movie_id;
```

List all movies that were released on even number years

```
SELECT title FROM movies WHERE (year % 2) = 0;
```

Query Results

Title
A Bug's Life
The Incredibles
Cars
WALL-E
Toy Story 3
Brave

```
SELECT title FROM movies WHERE (year % 2) = 0;
```

SQL Lesson 10: Queries with aggregates (Pt. 1)

In addition to the simple expressions that we introduced last lesson, SQL also supports the use of aggregate expressions (or functions) that allow you to summarize information about a group of rows of data. With the Pixar database that you've been using, aggregate functions can be used to answer questions like, "How many movies has Pixar produced?", or "What is the highest grossing Pixar film each year?".

Select query with aggregate functions over all rows

```
SELECT AGG_FUNC(column_or_expression) AS aggregate_description, …
FROM mytable
WHERE constraint_expression;
```

Without a specified grouping, each aggregate function is going to run on the whole set of result rows and return a single value. And like normal expressions, giving your aggregate functions an alias ensures that the results will be easier to read and process.

Common aggregate functions

Here are some common aggregate functions that we are going to use in our examples:

Function	Description
COUNT(*), COUNT(*column*)	A common function used to counts the number of rows in the group if no column name is specified. Otherwise, count the number of rows in the group with non-NULL values in the specified column.
MIN(*column*)	Finds the smallest numerical value in the specified column for all rows in the group.
MAX(*column*)	Finds the largest numerical value in the specified column for all rows in the group.
AVG(*column*)	Finds the average numerical value in the specified column for all rows in the group.
SUM(*column*)	Finds the sum of all numerical values in the specified column for the rows in the group.

Grouped aggregate functions

In addition to aggregating across all the rows, you can instead apply the aggregate functions to individual groups of data within that group (ie. box office sales for Comedies vs Action movies). This would then create as many results as there are unique groups defined as by the GROUP BY clause.

Select query with aggregate functions over groups

```
SELECT AGG_FUNC(column_or_expression) AS aggregate_description, …
FROM mytable
WHERE constraint_expression
GROUP BY column;
```

The GROUP BY clause works by grouping rows that have the same value in the column specified.

Exercise

For this exercise, we are going to work with our Employees table. Notice how the rows in this table have shared data, which will give us an opportunity to use aggregate functions to summarize some high-level metrics about the teams. Go ahead and give it a shot.

DataBase

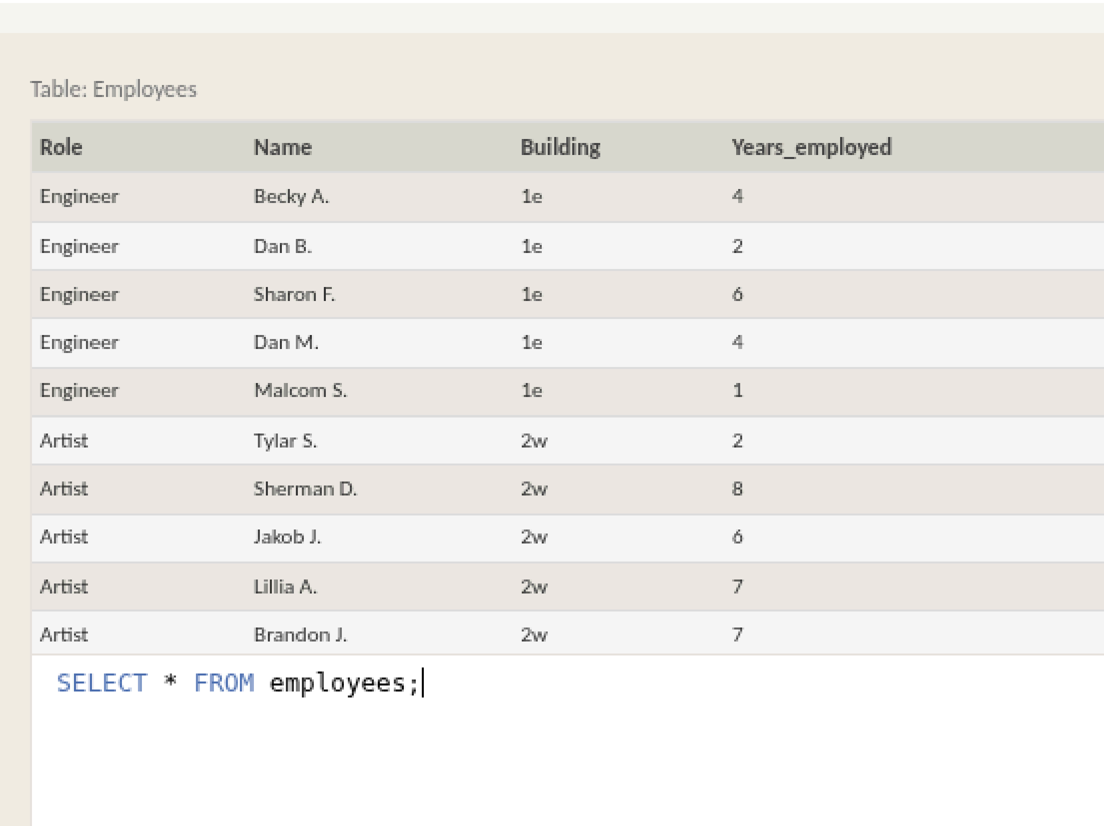


Table: Employees

Role	Name	Building	Years_employed
Engineer	Becky A.	1e	4
Engineer	Dan B.	1e	2
Engineer	Sharon F.	1e	6
Engineer	Dan M.	1e	4
Engineer	Malcom S.	1e	1
Artist	Tylar S.	2w	2
Artist	Sherman D.	2w	8
Artist	Jakob J.	2w	6
Artist	Lillia A.	2w	7
Artist	Brandon J.	2w	7

```
SELECT * FROM employees;
```

Find the longest time that an employee has been at the studio

```
SELECT MAX(years_employed) FROM employees;
```

Table: Employees

MAX(Years_employed)
9

```
SELECT MAX(years_employed) FROM employees;
```

RES

For each role, find the average number of years employed by employees in that role

```
SELECT role, AVG(years_employed) as Average_years_employed
FROM employees
GROUP BY role;
```

Table: Employees

Role	Average_years_employed
Artist	6
Engineer	3.4
Manager	6

```
SELECT role, AVG(years_employed) as Average_years_employed
FROM employees
GROUP BY role;
```

RES

Find the total number of employee years worked in each building

```sql
SELECT building, SUM(years_employed) as Total_years_employed
FROM employees
GROUP BY building;
```

Table: Employees

Building	Total_years_employed
1e	29
2w	36

```sql
SELECT building, SUM(years_employed) as Total_years_employed
FROM employees
GROUP BY building;
```

RES

SQL Lesson 11: Queries with aggregates (Pt. 2)

Our queries are getting fairly complex, but we have nearly introduced all the important parts of a SELECT query. One thing that you might have noticed is that if the GROUP BY clause is executed after the WHERE clause (which filters the rows which are to be grouped), then how exactly do we filter the grouped rows?

Luckily, SQL allows us to do this by adding an additional HAVING clause which is used specifically with the GROUP BY clause to allow us to filter grouped rows from the result set.

Select query with HAVING constraint

```sql
SELECT group_by_column, AGG_FUNC(column_expression) AS aggregate_result_alias, …
FROM mytable
WHERE condition
GROUP BY column
HAVING group_condition;
```

The HAVING clause constraints are written the same way as the WHERE clause constraints, and are applied to the grouped rows. With our examples, this might not seem like a particularly useful construct, but if you imagine data with millions of rows with different properties, being able to apply additional constraints is often necessary to quickly make sense of the data.

> Did you know?
> If you aren't using the `GROUP BY` clause, a simple `WHERE` clause will suffice.

Exercise

For this exercise, you are going to dive deeper into Employee data at the film studio. Think about the different clauses you want to apply for each task.

Find the number of Artists in the studio (without a HAVING clause)

```sql
SELECT COUNT(role) FROM employees
where role LIKE "Artist%";
```

Table: Employees

COUNT(Role)
5

```
SELECT COUNT(role) FROM employees
where role LIKE "Artist%";
```

RES

Find the number of Employees of each role in the studio

```
SELECT role, COUNT(name) FROM employees
GROUP BY role;
```

Table: Employees

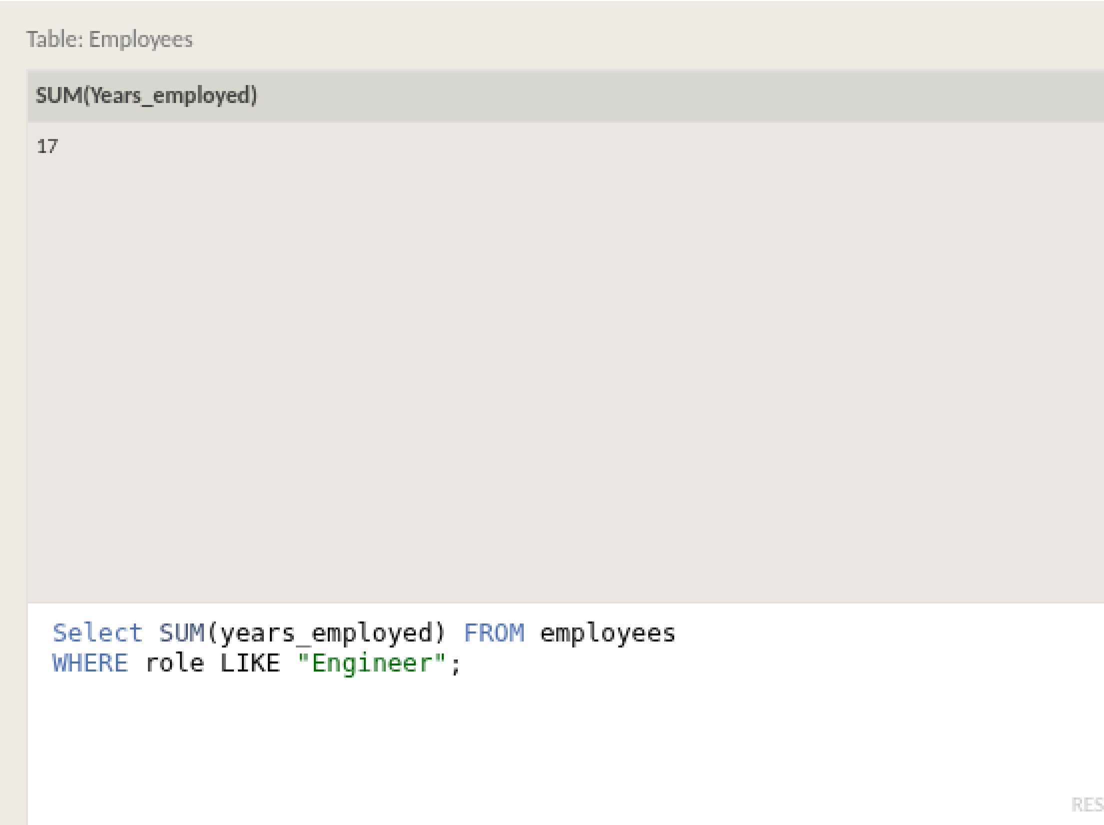
Role	COUNT(Name)
Artist	5
Engineer	5
Manager	3

```
SELECT role, COUNT(name) FROM employees
GROUP BY role;
```

RES

Find the total number of years employed by all Engineers

```
Select SUM(years_employed) FROM employees
WHERE role LIKE "Engineer";
```



SQL Lesson 12: Order of execution of a Query

Now that we have an idea of all the parts of a query, we can now talk about how they all fit together in the context of a complete query.

Complete SELECT query

```
SELECT DISTINCT column, AGG_FUNC(column_or_expression), …
FROM mytable
    JOIN another_table
      ON mytable.column = another_table.column
    WHERE constraint_expression
    GROUP BY column
    HAVING constraint_expression
    ORDER BY column ASC/DESC
    LIMIT count OFFSET COUNT;
```

Each query begins with finding the data that we need in a database, and then filtering that data down into something that can be processed and understood as quickly as possible. Because each part of the query is executed sequentially, it's important to understand the order of execution so that you know what results are accessible where.

Query order of execution

1. FROM and JOINs

The FROM clause, and subsequent JOINs are first executed to determine the total working set of data that is being queried. This includes subqueries in this clause, and can cause temporary tables to be created under the hood containing all the columns and rows of the tables being joined.

2. WHERE

Once we have the total working set of data, the first-pass WHERE constraints are applied to the individual rows, and rows that do not satisfy the constraint are discarded. Each of the constraints can only access columns directly from the tables requested in the FROM clause. Aliases in the SELECT part of the query are not accessible in most databases since they may include expressions dependent on parts of the query that have not yet executed.

3. GROUP BY

The remaining rows after the WHERE constraints are applied are then grouped based on common values in the column specified in the GROUP BY clause. As a result of the grouping, there will only be as many rows as there are unique values in that column. Implicitly, this means that you should only need to use this when you have aggregate functions in your query.

4. HAVING

If the query has a GROUP BY clause, then the constraints in the HAVING clause are then applied to the grouped rows, discard the grouped rows that don't satisfy the constraint. Like the WHERE clause, aliases are also not accessible from this step in most databases.

5. SELECT

Any expressions in the SELECT part of the query are finally computed.

6. DISTINCT

Of the remaining rows, rows with duplicate values in the column marked as DISTINCT will be discarded.

7. ORDER BY

If an order is specified by the ORDER BY clause, the rows are then sorted by the specified data in either ascending or descending order. Since all the expressions in the SELECT part of the query have been computed, you can reference aliases in this clause.

8. LIMIT / OFFSET

Finally, the rows that fall outside the range specified by the LIMIT and OFFSET are discarded, leaving the final set of rows to be returned from the query.

Conclusion

Not every query needs to have all the parts we listed above, but a part of why SQL is so flexible is that it allows developers and data analysts to quickly manipulate data without having to write additional code, all just by using the above clauses.

Exercise

Here ends our lessons on SELECT queries, congrats of making it this far! This exercise will try and test your understanding of queries, so don't be discouraged if you find them challenging. Just try your best.

Find the number of movies each director has directed

```
SELECT director,COUNT(title) FROM movies
GROUP BY director;
```

Query Results

Director	COUNT(Title)
Andrew Stanton	2
Brad Bird	2
Brenda Chapman	1
Dan Scanlon	1
John Lasseter	5
Lee Unkrich	1
Pete Docter	2


```
SELECT director,COUNT(title) FROM movies
GROUP BY director;
```


RESET

Find the total domestic and international sales that can be attributed to each director

```
SELECT director, SUM(domestic_sales + international_sales) as Cumulative_sales_from_al
FROM movies
    INNER JOIN boxoffice
        ON movies.id = boxoffice.movie_id
GROUP BY director;
```

Query Results

Director	Cumulative_sales_from_all_movies
Andrew Stanton	1458055121
Brad Bird	1255164910
Brenda Chapman	538983207
Dan Scanlon	743559607
John Lasseter	2232208025
Lee Unkrich	1063171911
Pete Docter	1294159000

```
SELECT director, SUM(domestic_sales + international_sales) as
    Cumulative_sales_from_all_movies
FROM movies
    INNER JOIN boxoffice
        ON movies.id = boxoffice.movie_id
GROUP BY director;
```

SQL Lesson 13: Inserting rows

We've spent quite a few lessons on how to query for data in a database, so it's time to start learning a bit about SQL schemas and how to add new data.

What is a Schema?

We previously described a table in a database as a two-dimensional set of rows and columns, with the columns being the properties and the rows being instances of the entity in the table. In SQL, the database schema is what describes the structure of each table, and the datatypes that each column of the table can contain.

> Example: Correlated subquery
>
> For example, in our Movies table, the values in the Year column must be an Integer, and the values in the Title column must be a String.

This fixed structure is what allows a database to be efficient, and consistent despite storing millions or even billions of rows.

Inserting new data

When inserting data into a database, we need to use an INSERT statement, which declares which table to write into, the columns of data that we are filling, and one or more rows of data to insert. In general, each row of data you insert should contain values for every corresponding column in the table. You can insert multiple rows at a time by just listing them sequentially.

Insert statement with values for all columns

```
INSERT INTO mytable
VALUES (value_or_expr, another_value_or_expr, …),
       (value_or_expr_2, another_value_or_expr_2, …),
       …;
In some cases, if you have incomplete data and the table contains columns that support

Insert statement with specific columns
INSERT INTO mytable
(column, another_column, …)
VALUES (value_or_expr, another_value_or_expr, …),
      (value_or_expr_2, another_value_or_expr_2, …),
      …;
```

In these cases, the number of values need to match the number of columns specified. Despite this being a more verbose statement to write, inserting values this way has the benefit of being forward compatible. For example, if you add a new column to the table with a default value, no hardcoded INSERT statements will have to change as a result to accommodate that change.

In addition, you can use mathematical and string expressions with the values that you are inserting. This can be useful to ensure that all data inserted is formatted a certain way.

Example Insert statement with expressions

```
INSERT INTO boxoffice
(movie_id, rating, sales_in_millions)
VALUES (1, 9.9, 283742034 / 1000000);
```

Exercise

In this exercise, we are going to play studio executive and add a few movies to the Movies to our portfolio. In this table, the Id is an auto-incrementing integer, so you can try inserting a row with only the other columns defined.

Since the following lessons will modify the database, you'll have to manually run each query once they are ready to go.

Add the studio's new production, Toy Story 4 to the list of movies (you can use any director)

```
INSERT INTO movies
(title,director,year,length_minutes)
VALUES ("Toy Story 4","Pete Docter",2025,45);
```

Query Results

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1999	93
15	Toy Story 4	Pete Docter	2025	45

```
INSERT INTO movies
(title,director,year,length_minutes)
VALUES ("Toy Story 4","Pete Docter",2025,45);
```

RUN QUERY RESE

Toy Story 4 has been released to critical acclaim! It had a rating of 8.7, and made 340 million domestically and 270 million internationally. Add the record to the BoxOffice table

```
INSERT INTO boxoffice VALUES (4, 8.7, 340000000, 270000000);
```

Table: Boxoffice (Read-Only)

Movie_id	Rating	Domestic_sales	International_sales
3	7.9	245852179	239163000
1	8.3	191796233	170162503
2	7.2	162798565	200600000
4	8.7	340000000	270000000
4	8.7	340000000	270000000

SQL Lesson 14: Updating rows

In addition to adding new data, a common task is to update existing data, which can be done using an UPDATE statement. Similar to the INSERT statement, you have to specify exactly which table, columns, and rows to update. In addition, the data you are updating has to match the data type of the columns in the table schema.

Update statement with values

```
UPDATE mytable
SET column = value_or_expr,
    other_column = another_value_or_expr,
    …
WHERE condition;
```

The statement works by taking multiple column/value pairs, and applying those changes to each and every row that satisfies the constraint in the WHERE clause.

Taking care

Most people working with SQL will make mistakes updating data at one point or another. Whether it's updating the wrong set of rows in a production database, or accidentally leaving out the WHERE clause (which causes the update to apply to all rows), you need to be extra careful when constructing UPDATE statements.

One helpful tip is to always write the constraint first and test it in a SELECT query to make sure you are updating the right rows, and only then writing the column/value pairs to update.

Exercise

It looks like some of the information in our Movies database might be incorrect, so go ahead and fix them through the exercises below.

The director for A Bug's Life is incorrect, it was actually directed by John Lasseter

```
UPDATE movies
SET director = "John Lasseter"
WHERE title LIKE "A Bug's Life";
```

Table: Movies

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1899	93
4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101

```
UPDATE movies
SET director = "John Lasseter"
WHERE title LIKE "A Bug's Life";
```

The year that Toy Story 2 was released is incorrect, it was actually released in 1999

```
UPDATE movies
SET year = 1999
WHERE title LIKE "Toy Story 2";
```

Table: Movies

Id	Title	Director	Year	Length_minutes
1	Toy Story	John Lasseter	1995	81
2	A Bug's Life	John Lasseter	1998	95
3	Toy Story 2	John Lasseter	1999	93
4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101

```
UPDATE movies
SET year = 1999
WHERE title LIKE "Toy Story 2";
```

Both the title and director for Toy Story 8 is incorrect! The title should be "Toy Story 3" and it was directed by Lee Unkrich

```
UPDATE movies
SET title = "Toy Story 3",
    director = "Lee Unkrich"
WHERE title LIKE "Toy Story 8";
```

Table: Movies

4	Monsters, Inc.	Pete Docter	2001	92
5	Finding Nemo	Andrew Stanton	2003	107
6	The Incredibles	Brad Bird	2004	116
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101
11	Toy Story 3	Lee Unkrich	2010	103
12	Cars 2	John Lasseter	2011	120
13	Brave	Brenda Chapman	2012	102
14	Monsters University	Dan Scanlon	2013	110

```
UPDATE movies
SET title = "Toy Story 3",
    director = "Lee Unkrich"
WHERE title LIKE "Toy Story 8";
```

SQL Lesson 15: Deleting rows

When you need to delete data from a table in the database, you can use a DELETE statement, which describes the table to act on, and the rows of the table to delete through the WHERE clause.

Delete statement with condition

```
DELETE FROM mytable
WHERE condition;
```

If you decide to leave out the WHERE constraint, then all rows are removed, which is a quick and easy way to clear out a table completely (if intentional).

Taking extra care

Like the UPDATE statement from last lesson, it's recommended that you run the constraint in a SELECT query first to ensure that you are removing the right rows. Without a proper backup or test database, it is downright easy to irrevocably remove data, so always read your DELETE statements twice and execute once.

Exercise

The database needs to be cleaned up a little bit, so try and delete a few rows in the tasks below.

This database is getting too big, lets remove all movies that were released before 2005

```
DELETE FROM movies
    WHERE year < 2005;
```

Id	Title	Director	Year	Length_minutes
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
9	WALL-E	Andrew Stanton	2008	104
10	Up	Pete Docter	2009	101
11	Toy Story 3	Lee Unkrich	2010	103
12	Cars 2	John Lasseter	2011	120
13	Brave	Brenda Chapman	2012	102
14	Monsters University	Dan Scanlon	2013	110

```
DELETE FROM movies
    WHERE year < 2005;
```

RUN QUERY RESE

Andrew Stanton has also left the studio, so please remove all movies directed by him

```
DELETE FROM movies
    WHERE director LIKE "Andrew Stanton";
```

Id	Title	Director	Year	Length_minutes
7	Cars	John Lasseter	2006	117
8	Ratatouille	Brad Bird	2007	115
10	Up	Pete Docter	2009	101
11	Toy Story 3	Lee Unkrich	2010	103
12	Cars 2	John Lasseter	2011	120
13	Brave	Brenda Chapman	2012	102
14	Monsters University	Dan Scanlon	2013	110

```
DELETE FROM movies
    WHERE director LIKE "Andrew Stanton";
```

RUN QUERY RESE

SQL Lesson 16: Creating tables

When you have new entities and relationships to store in your database, you can create a new database table using the CREATE TABLE statement.

Create table statement w/ optional table constraint and default value

```
CREATE TABLE IF NOT EXISTS mytable (
    column DataType TableConstraint DEFAULT default_value,
    another_column DataType TableConstraint DEFAULT default_value,
    …
);
```

The structure of the new table is defined by its table schema, which defines a series of columns. Each column has a name, the type of data allowed in that column, an optional table constraint on values being inserted, and an optional default value.

If there already exists a table with the same name, the SQL implementation will usually throw an error, so to suppress the error and skip creating a table if one exists, you can use the IF NOT EXISTS clause.

Table data types

Different databases support different data types, but the common types support numeric, string, and other miscellaneous things like dates, booleans, or even binary data. Here are some examples that you might use in real code.

Data type	Description
INTEGER , BOOLEAN	The integer datatypes can store whole integer values like the count of a number or an age. In some implementations, the boolean value is just represented as an integer value of just 0 or 1.
FLOAT , DOUBLE , REAL	The floating point datatypes can store more precise numerical data like measurements or fractional values. Different types can be used depending on the floating point precision required for that value.
CHARACTER(num_chars) , VARCHAR(num_chars) , TEXT	The text based datatypes can store strings and text in all sorts of locales. The distinction between the various types generally amount to underlaying efficiency of the database when working with these columns. Both the CHARACTER and VARCHAR (variable character) types are specified with the max number of characters that they can store (longer values may be truncated), so can be more efficient to store and query with big tables.
DATE , DATETIME	SQL can also store date and time stamps to keep track of time series and event data. They can be tricky to work with especially when manipulating data across timezones.
BLOB	Finally, SQL can store binary data in blobs right in the database. These values are often opaque to the database, so you usually have to store them with the right metadata to requery them.

Table constraints

We aren't going to dive too deep into table constraints in this lesson, but each column can have additional table constraints on it which limit what values can be inserted into that column. This is not a comprehensive list, but will show a few common constraints that you might find useful.

Constraint	Description
PRIMARY KEY	This means that the values in this column are unique, and each value can be used to identify a single row in this table.
AUTOINCREMENT	For integer values, this means that the value is automatically filled in and incremented with each row insertion. Not supported in all databases.
UNIQUE	This means that the values in this column have to be unique, so you can't insert another row with the same value in this column as another row in the table. Differs from the `PRIMARY KEY` in that it doesn't have to be a key for a row in the table.
NOT NULL	This means that the inserted value can not be `NULL`.
CHECK (expression)	This allows you to run a more complex expression to test whether the values inserted are valid. For example, you can check that values are positive, or greater than a specific size, or start with a certain prefix, etc.
FOREIGN KEY	This is a consistency check which ensures that each value in this column corresponds to another value in a column in another table. For example, if there are two tables, one listing all Employees by ID, and another listing their payroll information, the `FOREIGN KEY` can ensure that every row in the payroll table corresponds to a valid employee in the master Employee list.

An example

Here's an example schema for the Movies table that we've been using in the lessons up to now.

Movies table schema

```
CREATE TABLE movies (
    id INTEGER PRIMARY KEY,
    title TEXT,
    director TEXT,
    year INTEGER,
    length_minutes INTEGER
);
```

Exercise

In this exercise, you'll need to create a new table for us to insert some new rows into.

Create a new table named Database with the following columns

- Name A string (text) describing the name of the database
- Version A number (floating point) of the latest version of this database
- Download_count An integer count of the number of times this database was downloaded

This table has no constraints.

```
CREATE TABLE Database(
Name TEXT,
Version FLOAT,
Download_count INTEGER
);
```

SQL Lesson 17: Altering tables

As your data changes over time, SQL provides a way for you to update your corresponding tables and database schemas by using the ALTER TABLE statement to add, remove, or modify columns and table constraints.

Adding columns

The syntax for adding a new column is similar to the syntax when creating new rows in the CREATE TABLE statement. You need to specify the data type of the column along with any potential table constraints and default values to be applied to both existing and new rows. In some databases like MySQL, you can even specify where to insert the new column using the FIRST or AFTER clauses, though this is not a standard feature.

> Altering table to add new column(s)

```
ALTER TABLE mytable
ADD column DataType OptionalTableConstraint
    DEFAULT default_value;
```

Removing columns

Dropping columns is as easy as specifying the column to drop, however, some databases (including SQLite) don't support this feature. Instead you may have to create a new table and migrate the data over.

> Altering table to remove column(s)

```
ALTER TABLE mytable
DROP column_to_be_deleted;
```

Renaming the table

If you need to rename the table itself, you can also do that using the RENAME TO clause of the statement.

> Altering table name

```
ALTER TABLE mytable
RENAME TO new_table_name;
```

Other changes

Each database implementation supports different methods of altering their tables, so it's always best to consult your database docs before proceeding: MySQL, Postgres, SQLite, Microsoft SQL Server.

Exercise

Our exercises use an implementation that only support adding new columns, so give that a try below.

Add a column named Aspect_ratio with a FLOAT data type to store the aspect-ratio each movie was released in

```
ALTER TABLE movies
    ADD Aspect_ratio FLOAT;
```

Table: Movies

Id	Title	Director	Year	Length_minutes	Aspect_ratio
1	Toy Story	John Lasseter	1995	81	
2	A Bug's Life	John Lasseter	1998	95	
3	Toy Story 2	John Lasseter	1999	93	
4	Monsters, Inc.	Pete Docter	2001	92	
5	Finding Nemo	Andrew Stanton	2003	107	
6	The Incredibles	Brad Bird	2004	116	
7	Cars	John Lasseter	2006	117	
8	Ratatouille	Brad Bird	2007	115	
9	WALL-E	Andrew Stanton	2008	104	
10	Up	Pete Docter	2009	101	

```
ALTER TABLE movies
    ADD Aspect_ratio FLOAT;
```

Add another column named Language with a TEXT data type to store the language that the movie was released in. Ensure that the default for this language is English

```
ALTER TABLE movies
    ADD Language TEXT DEFAULT "English";
```

Table: Movies

Id	Title	Director	Year	Length_minutes	Aspect_ratio	Language
1	Toy Story	John Lasseter	1995	81		English
2	A Bug's Life	John Lasseter	1998	95		English
3	Toy Story 2	John Lasseter	1999	93		English
4	Monsters, Inc.	Pete Docter	2001	92		English
5	Finding Nemo	Andrew Stanton	2003	107		English
6	The Incredibles	Brad Bird	2004	116		English
7	Cars	John Lasseter	2006	117		English
8	Ratatouille	Brad Bird	2007	115		English
9	WALL-E	Andrew Stanton	2008	104		English
10	Up	Pete Docter	2009	101		English

```
ALTER TABLE movies
    ADD Language TEXT DEFAULT "English";
```

SQL Lesson 18: Dropping tables

In some rare cases, you may want to remove an entire table including all of its data and metadata, and to do so, you can use the DROP TABLE statement, which differs from the DELETE statement in that it also removes the table schema from the database entirely.

Drop table statement

```
DROP TABLE IF EXISTS mytable;
```

Like the CREATE TABLE statement, the database may throw an error if the specified table does not exist, and to suppress that error, you can use the IF EXISTS clause.

In addition, if you have another table that is dependent on columns in table you are removing (for example, with a FOREIGN KEY dependency) then you will have to either update all dependent tables first to remove the dependent rows or to remove those tables entirely.

Exercise

We've reached the end of our exercises, so lets clean up by removing all the tables we've worked with.

We've sadly reached the end of our lessons, lets clean up by removing the Movies table

```
DROP TABLE IF EXISTS movies;
```

And drop the BoxOffice table as well

```
DROP TABLE IF EXISTS boxoffice;
```

SQL Lesson 19: Subqueries

You might have noticed that even with a complete query, there are many questions that we can't answer about our data without additional post, or pre, processing. In these cases, you can either make multiple queries and process the data yourself, or you can build a more complex query using SQL subqueries.

Example: General subquery

Lets say your company has a list of all Sales Associates, with data on the revenue that each Associate brings in, and their individual salary. Times are tight, and you now want to find out which of your Associates are costing the company more than the average revenue brought per Associate.

First, you would need to calculate the average revenue all the Associates are generating:

```
SELECT AVG(revenue_generated)
FROM sales_associates;
```

And then using that result, we can then compare the costs of each of the Associates against that value. To use it as a subquery, we can just write it straight into the WHERE clause of the query:

```
SELECT *
FROM sales_associates
WHERE salary >
   (SELECT AVG(revenue_generated)
    FROM sales_associates);
```

As the constraint is executed, each Associate's salary will be tested against the value queried from the inner subquery.

A subquery can be referenced anywhere a normal table can be referenced. Inside a FROM clause, you can JOIN subqueries with other tables, inside a WHERE or HAVING constraint, you can test expressions against the results of the subquery, and even in expressions in the SELECT clause, which allow you to return data directly from the subquery. They are generally executed in the same logical order as the part of the query that they appear in, as described in the last lesson.

Because subqueries can be nested, each subquery must be fully enclosed in parentheses in order to establish proper hierarchy. Subqueries can otherwise reference any tables in the database, and make use of the constructs of a normal query (though some implementations don't allow subqueries to use LIMIT or OFFSET).

Correlated subqueries

A more powerful type of subquery is the correlated subquery in which the inner query references, and is dependent on, a column or alias from the outer query. Unlike the subqueries above, each of these inner queries need to be run for each of the rows in the outer query, since the inner query is dependent on the current outer query row.

Example: Correlated subquery

Instead of the list of just Sales Associates above, imagine if you have a general list of Employees, their departments (engineering, sales, etc.), revenue, and salary. This time, you are now looking across the company to find the employees who perform worse than average in their department.

For each employee, you would need to calculate their cost relative to the average revenue generated by all people in their department. To take the average for the department, the subquery will need to know what department each employee is in:

```
SELECT *
FROM employees
WHERE salary >
   (SELECT AVG(revenue_generated)
    FROM employees AS dept_employees
    WHERE dept_employees.department = employees.department);

These kinds of complex queries can be powerful, but also difficult to read and understa

## Existence tests

When we introduced WHERE constraints in Lesson 2: Queries with constraints, the IN oper

Select query with subquery constraint

```sql
SELECT *, …
FROM mytable
WHERE column
    IN/NOT IN (SELECT another_column
               FROM another_table);
```

When doing this, notice that the inner subquery must select for a column value or expression to produce a list that the outer column value can be tested against. This type of constraint is powerful when the constraints are based on current data.
```

SQL Lesson 20: Unions, Intersections & Exceptions

When working with multiple tables, the UNION and UNION ALL operator allows you to append the results of one query to another assuming that they have the same column count, order and data type. If you use the UNION without the ALL, duplicate rows between the tables will be removed from the result.

Select query with set operators

```
SELECT column, another_column
   FROM mytable
UNION / UNION ALL / INTERSECT / EXCEPT
SELECT other_column, yet_another_column
   FROM another_table
ORDER BY column DESC
LIMIT n;
```

In the order of operations as defined in Lesson 12: Order of execution, the UNION happens before the ORDER BY and LIMIT. It's not common to use UNIONs, but if you have data in different tables that can't be joined and processed, it can be an alternative to making multiple queries on the database.

Similar to the UNION, the INTERSECT operator will ensure that only rows that are identical in both result sets are returned, and the EXCEPT operator will ensure that only rows in the first result set that aren't in the second are returned. This means that the EXCEPT operator is query order-sensitive, like the LEFT JOIN and RIGHT JOIN.

Both INTERSECT and EXCEPT also discard duplicate rows after their respective operations, though some databases also support INTERSECT ALL and EXCEPT ALL to allow duplicates to be retained and returned.