QuantSprout

SQL Bootcamp

By Craig Sakuma

Introductions

Craig Sakuma

- Founder of QuantSprout
- General Assembly Instructor for Data Science
- MBA from Wharton
- B.Eng from Northwestern University

Fun Fact

Developed a novelty BBQ product that was featured in USA Today

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Class Introductions

- Name
- What's your job?
- How do you plan to apply skills from today's workshop?
- Fun Fact

Objectives for Class

- Get strong foundation of SQL
- Immediately use skills at work
- Remove barriers/frustration
- Develop skills to be self-sufficient after class
  - Tools and examples for practicing on your own
  - Comfort with SQL to learn on own
  - Ability to troubleshoot problems

Course Structure

- Lectures on topics
  - Interaction is good
  - Feel free to ask questions
  - If there's not enough time to cover questions, we'll put it in a parking lot for after class
- Hands on exercises
  - Pair programming
  - Mix up partners

Schedule

Time	Topic
10:00 – 11:00	Overview of SQL
11:00 – 12:30	Fundamentals of Queries
12:30 – 1:30	Lunch
1:30 – 2:00	Advanced Queries
2:00 – 2:30	Creating Tables
2:30 – 3:45	Joining Tables
3:45 – 4:15	Functions
4:15 – 5:00	Group By

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What is SQL?

- Structured Query Language
  - Programming language
  - Structured data (requires some overhead)
  - Relational Database
  - Allows you to share large sets with many users
  - Scalable data storage

SQL is Searchable

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SQL Types

- PostgreSQL
- SQLite
- MySQL
- Amazon Redshift
- Oracle
- Microsoft SQL Server

Functionality is similar
but syntax can be different

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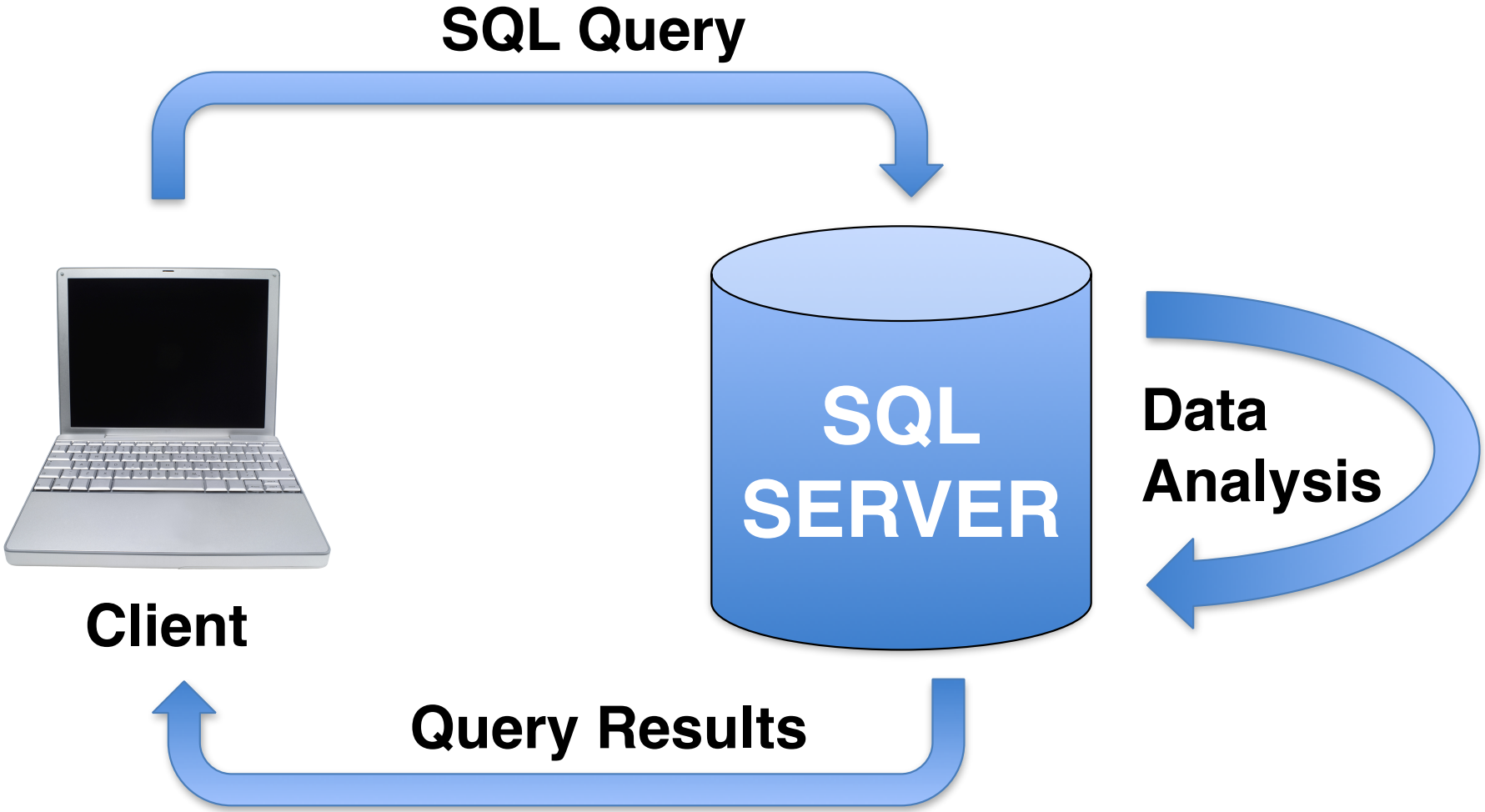
SQL – Behind the Scenes



However, SQLite operates locally

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Tables

- Data containers
- Organized by rows and columns

CustomerId	FirstName	LastName	City
16	Frank	Harris	Mountain View
17	Jack	Smith	Redmond
18	Michelle	Brooks	New York
19	Tim	Goyer	Cupertino
20	Dan	Miller	Mountain View
21	Kathy	Chase	Reno
22	Heather	Leacock	Orlando
23	John	Gordon	Boston
24	Frank	Ralston	Chicago
25	Victor	Stevens	Madison

Tables Are Like Spreadsheets

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Tables

Data Fields
(like columns)

Database Records
(like rows)

CustomerId	FirstName	LastName	City
16	Frank	Harris	Mountain View
17	Jack	Smith	Redmond
18	Michelle	Brooks	New York
19	Tim	Goyer	Cupertino
20	Dan	Miller	Mountain View
21	Kathy	Chase	Reno
22	Heather	Leacock	Orlando
23	John	Gordon	Boston
24	Frank	Ralston	Chicago
25	Victor	Stevens	Madison

- Fields have Data Types
- Primary Keys (unique identifier)
- Foreign Keys (identifier for linking to other tables)
- Fields frequently are both Primary and Foreign Keys

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Data Types

- Text
  - char(***n***)
  - varchar(***n***)
  - nvarchar(***n***)
  - text
- Numbers
  - integers
  - floats
- Boolean (True/False)
- Temporal
  - Dates
  - Times

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Sample Database – sql_bootcamp.db

11 Data Tables

- Album
- Artist
- Customer
- Employee
- Genre
- Invoice
- InvoiceLine
- MediaType
- Playlist
- PlaylistTrack
- Track

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Note: Database example come from ChinookDatabase 1.4

Syntax for Slides

Brackets are placeholders

Example (for change directory):

cd *<directory name>*

Applied for changing to directory ‘SQL’:

cd SQL

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SQL Code vs. SQLite Commands

SQLite Commands

- Start with a period like .quit
- Specific only to SQLite and not other versions of SQL
- Used for opening databases, reading files, changing settings
- Doesn’t require a semi-colon at end of statement

SQL Code

- Universal code used for all versions of SQL
- Code requires a semi-colon at end of statement because SQL commands can be written across multiple lines

Launch SQLite3

Mac Users:

- Create a folder on your desktop called SQL
- Move the sql_bootcamp.db file into the new folder
- Launch your terminal
- Change directories to your SQL folder by entering “cd Desktop/SQL”
- Enter “sqlite3”

Windows Users:

- Move the sql_bootcamp.db file into same folder as sqlite3 executable file
- Double click your sqlite3 executable file

```
SQLite version 3.8.4.1 2014-03-11 15:27:36
Enter ".help" for usage hints.
Connected to a transient in-memory database.
Use ".open FILENAME" to reopen on a persistent database.
sqlite>
```

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SQLite3 – Open a Database

Open a database:

.open sql_bootcamp.db

View the database schema:

.schema

Explore the Data Tables and Identify Foreign Keys

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Query Types

- SELECT
  - Creates view of records from database
- INSERT
  - Inserts new records into a table
- UPDATE
  - Updates existing records into a table
- DELETE
  - Removes records

CHANGES DATA IN TABLES

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Simplest Query

You Only Need Two Things for a Query:

What You Want to Get

SELECT *<field>*

FROM *<table name>*;

Where to Get it From

Semi-colon is used to mark the end of a query

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Basic Query Structure

- SELECT (values you want to view)
- FROM (data source – table name)
- WHERE (conditions for results)
- ; (delimiter for end of query)

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Common Basic Queries

SELECT ***<field 1>*, *<field 2>***

FROM ***<table name>***

WHERE ***<field 1>*** **= 'value';**

Select multiple fields

Create conditions for query

You Can Create Multiple Conditions with AND /OR

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Queries with Limits

SELECT * ← Wildcard for Selecting All Fields

FROM ***<table name>***

WHERE ***<field 1>*** **= 5**

LIMIT 10; ← Limit Results to 10 Records

Avoid Long Queries that Slow Down the Server
…And Keep Your Database Admin Happy

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Why Use a Text Editor

- Save your queries for future reference
- Easier to edit when you make mistakes (especially when you have large queries)
- Include multiple queries in single file
- Comment out queries you don’t want to execute

Create SQL File with Sublime Text

1. Open your text editor

2. Create a file with the following text:

```
SELECT  *
FROM  Album
LIMIT  10;
```

3. Save file as **class_exercises.sql** in same folder as sql_bootcamp.db (Note: you'll probably have to expand save as window)

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SQLite3 – Read SQL File

Execute SQL from file

.read *<filename>*

Try it yourself:

.read class_exercises.sql

```
sqlite> .read basic_query.sql
1|For Those About To Rock We Salute You|1
2|Balls to the Wall|2
3|Restless and Wild|2
4|Let There Be Rock|1
5|Big Ones|3
6|Jagged Little Pill|4
7|Facelift|5
8|Warner 25 Anos|6
9|Plays Metallica By Four Cellos|7
10|Audioslave|8
```

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SQLite3 Settings

View Column Headers

.header on

Organize Data in Columns:

.mode column

(Note: default mode is list)

Makes Viewing Results
Easier to Read

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SQLite3 – Comment

Write comments that aren't executed as code

-- *<single line of text>*

/* <multiple lines of text>

<multiple lines of text> */

Use for documenting code

Comment out code that you don't want to run

sublime text shortcut: command + /

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Instructions for Exercises

- Pair programming
  - Using only one computer
  - Take turns typing
  - Collaborate on solutions
- Resources
  - Stackoverflow / Google
  - Don’t be afraid to ask for help

Exercise #1

1. What are the genres in the database?

2. What are the customer names that are from California?
   (Hint: text strings need to be in single quotes)

Bonus: Explore data samples from the rest of the tables in the database

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SELECT Options

- SELECT COUNT(*)
  Counts the records in the database
- SELECT DISTINCT firstname
  Selects unique first names
  (Note: if multiple fields are provided it will select distinct combinations of those fields)
- SELECT COUNT(DISTINCT firstname)
  Counts the number of unique first names

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WHERE Clauses

- Combine multiple conditions with AND / OR

```
SELECT *
FROM customers
WHERE state='CA' OR state='WA' OR state='OR';

WHERE country!='USA' AND country!='Canada';
```

Apply Any Equality condition: >, >=, <, <=, =, !=

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WHERE Clauses

- IS NULL / IS NOT NULL
  WHERE genreid IS NULL

- IN (‘item1’,’item2’, etc….)
  WHERE state IN (‘NY’, ’PA’, ‘MD’, ‘DE’)

- BETWEEN ***<start>*** AND ***<end>***
  WHERE milliseconds BETWEEN 180000 AND 240000

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Best Practices

- CAPITALIZE SQL COMMANDS
- Use Indentation to Improve Readability:

Option #1

```
SELECT
    albumid,
    title
FROM
    album
```

Option #2

```
SELECT albumid, title
FROM album
WHERE albumid =1
```

- Error Tracking
  - Create a text file to keep notes on your errors
- Save Class Examples as Files

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Exercise #2

1. How many songs are longer than 10 minutes?
2. How many invoices were there between January 1, 2010 and February 1, 2010 (hint: dates are in single quotes and use google to find format)?
3. How many tracks have a NULL composer?
4. How many distinct album titles are there? How many distinct album IDs? Why would these have different counts?

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ORDER BY

- Sorts data
  - ASC for ascending
  - DESC for descending
- Can have multiple fields
  - First field listed takes precedence
- Example:

```
SELECT *
FROM track
ORDER BY genreid ASC, milliseconds DESC
```

LIKE / NOT LIKE

Value		Pattern	Result
• 'abc'	LIKE	'abc'	TRUE
• 'abc'	LIKE	'c'	FALSE
• 'abc'	LIKE	'a%'	TRUE
• 'abc'	LIKE	'_b_'	TRUE

Example:

WHERE email LIKE ‘%@%._ _ _’

LIKE is not case sensitive

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Exercise #3

1. What are the 5 longest songs?
2. R.E.M. has collaborated with a couple artists, can you find which artists they've collaborated with?
   (Hint: Use the Artist Table)
3. How many 'Love' songs are there?
   (Hint: Use the Track Name)

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Table Commands

- CREATE TABLE
  - Creates new table
  - Requires fields to be defined by data type
- DROP TABLE
  - Deletes table from database
- ALTER TABLE
  - Change database column name
  - Add or remove columns
  - Change table name

Create Table

Creating new tables requires definitions for fields and data types:

```
CREATE TABLE <table name> (
    <field name1>   <data type1>,
    <field name2>   <data type2>,
    etc…
);
```

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Create Table Example

```
CREATE TABLE favorite_songs (
    id INTEGER,
    title VARCHAR(128),
    seconds INTEGER
);
```

Commit Changes

Many database require confirmation after changes are made

- Create, Alter or Drop Tables
- Insert, Update or Delete Values

Enter “COMMIT;” after changes are made

However, SQLite automatically commits

Insert Query

Use Insert Queries to add records to your tables

INSERT INTO ***<table name>***
(***<field 1>***, ***<field 2>***)
VALUES (***<value 1>***, ***<value 2>***);

Insert Query Example

```
INSERT INTO favorite_songs
(id, title, seconds)
VALUES (0, ‘Call Me Maybe’, 193);
```

Drop Table

Use DROP TABLE to completely remove a table:

DROP TABLE ***<table name>***;

DROP TABLE favorite_songs;

What are JOINS?

- Technique for merging data together from multiple tables
- Tables must have a shared Foreign Key to be joined together
- Similar to vlookup formula in Excel
- Multiple JOINS can be created to merge data from more than one table
- Data from JOINS only exist in memory during the transaction of the query

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How JOINS Work

- Data is merged between two tables at a time
- Cartesian product is created between two tables (fancy for every possible combination of records)
- Results are filtered based on a condition where Foreign Keys equal each other
- All fields from both tables are included in JOINS

JOIN Simulation

Location Table

Name	State
Tim	CA
Bob	NY
Jen	AZ

Age Table

Name	Years
Tim	30
Jen	20

JOIN ON location.name = age.name

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Create Every Combination

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30
Tim	CA	Jen	20
Bob	NY	Tim	30
Bob	NY	Jen	20
Jen	AZ	Tim	30
Jen	AZ	Jen	20

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Filter for location.name = age.name

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30
~~Tim~~	~~CA~~	~~Jen~~	~~20~~
~~Bob~~	~~NY~~	~~Tim~~	~~30~~
~~Bob~~	~~NY~~	~~Jen~~	~~20~~
~~Jen~~	~~AZ~~	~~Tim~~	~~30~~
Jen	AZ	Jen	20

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Results of Query

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30
Jen	AZ	Jen	20

SQL Code for Example:

```
SELECT *
FROM location
JOIN age
ON location.name = age.name;
```

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JOIN Syntax

SELECT ***<field>***

FROM ***<table 1>***

JOIN ***<table 2>***

ON ***<table1 foreign key>*** = ***<table2 foreign key>***

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JOIN Example

```
SELECT *
FROM track
JOIN mediatype
    ON track.mediatypeId =
        mediatype.mediatypeId
LIMIT 10;
```

Need to use table name with field name since the same field can be in multiple tables

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Multiple Joins

- Joins are executed one by one in the order they are written
- Output of first join is used in subsequent join
- Each join adds extra work for the server to execute (slows down query performance)
- Foreign keys must be shared between the table being joined and the previous tables that were joined

Multiple Joins - Example

```
SELECT COUNT(*)
FROM track
JOIN album
    ON track.albumid = album.albumid
JOIN artist
    ON album.artistid = artist.artistid
WHERE artist.name LIKE ‘a%’;
```

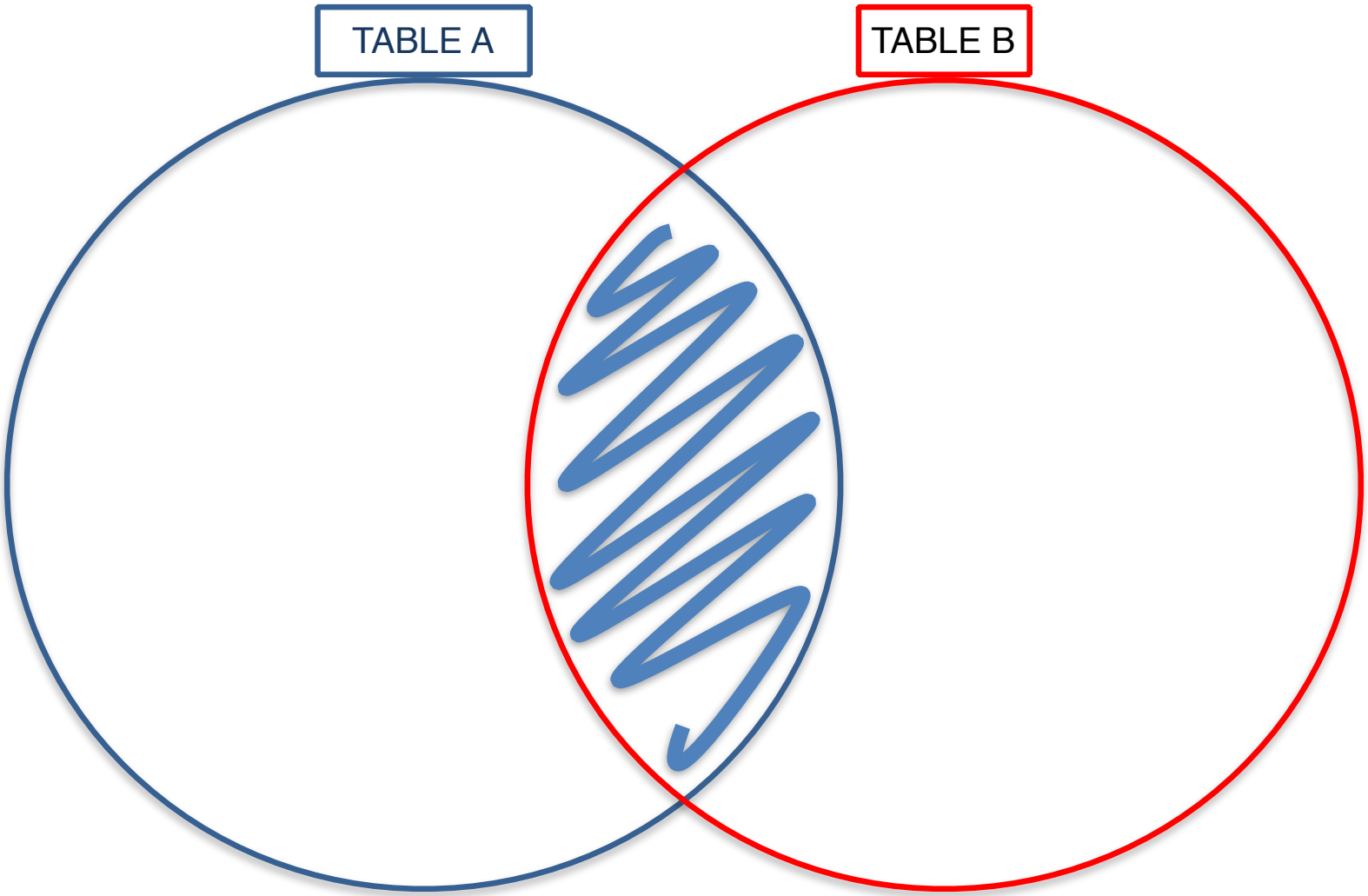
Order of Query Clauses

```
SELECT *
FROM track
JOIN genre
    ON track.genreId = genre.genreid
WHERE genre.name = ‘Rock’
ORDER BY track.name
LIMIT 10;
```

Exercise #5

1. How many tracks are rock or alternative?
2. How many tracks are performed by R.E.M. excluding collaborators?
3. How many tracks are performed by R.E.M. with collaborators?
4. What other interesting queries can you create that join 2 tables?

INNER JOIN



This is the default type for ‘JOIN’

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INNER JOIN Example

Location Table

Name	State
Tim	CA
Bob	NY

Age Table

Name	Years
Tim	30
Jen	20

Result

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30

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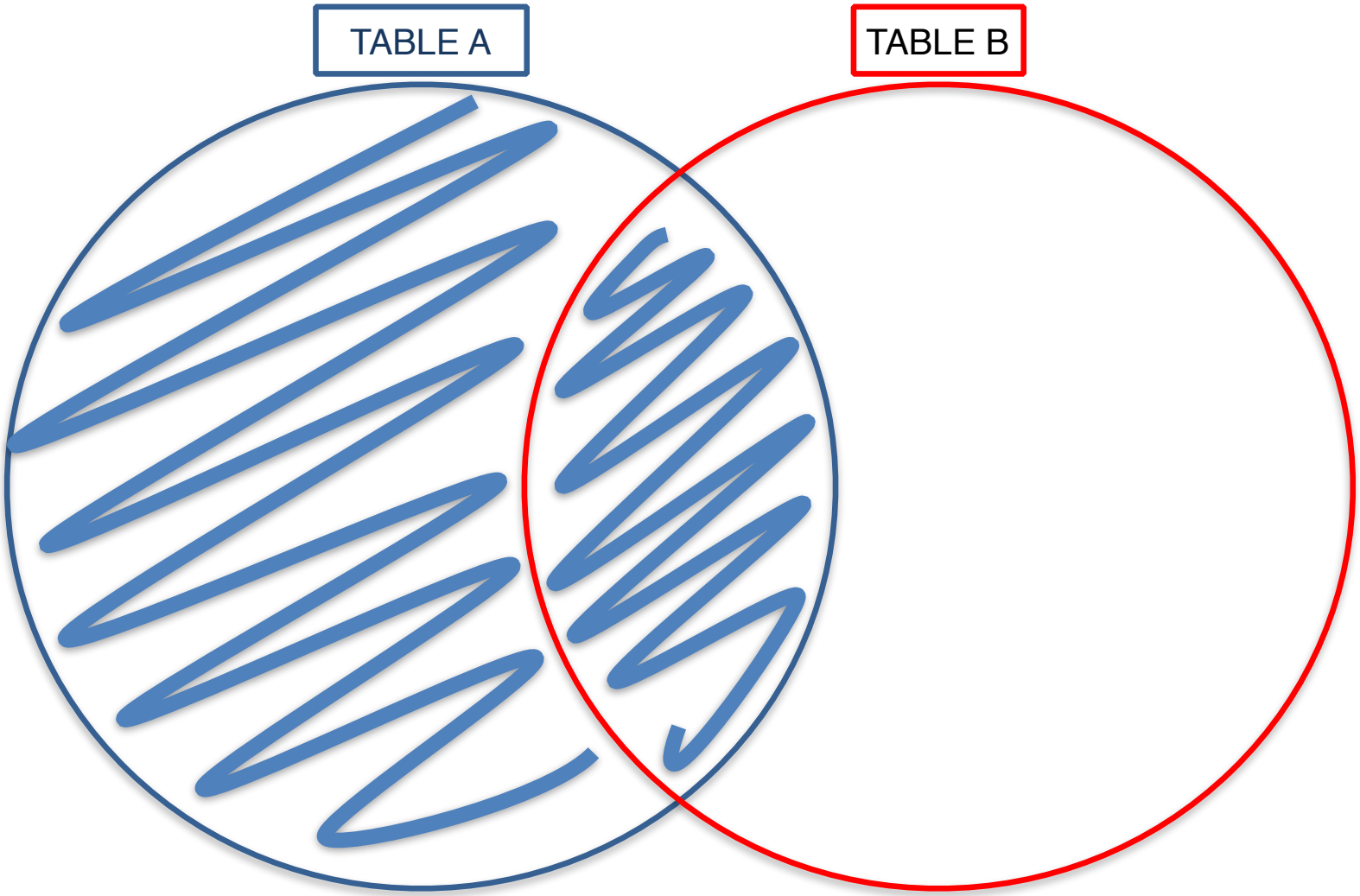
LEFT JOIN



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LEFT JOIN Example

Location Table

Name	State
Tim	CA
Bob	NY

Age Table

Name	Years
Tim	30
Jen	20

Result

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30
Bob	NY		

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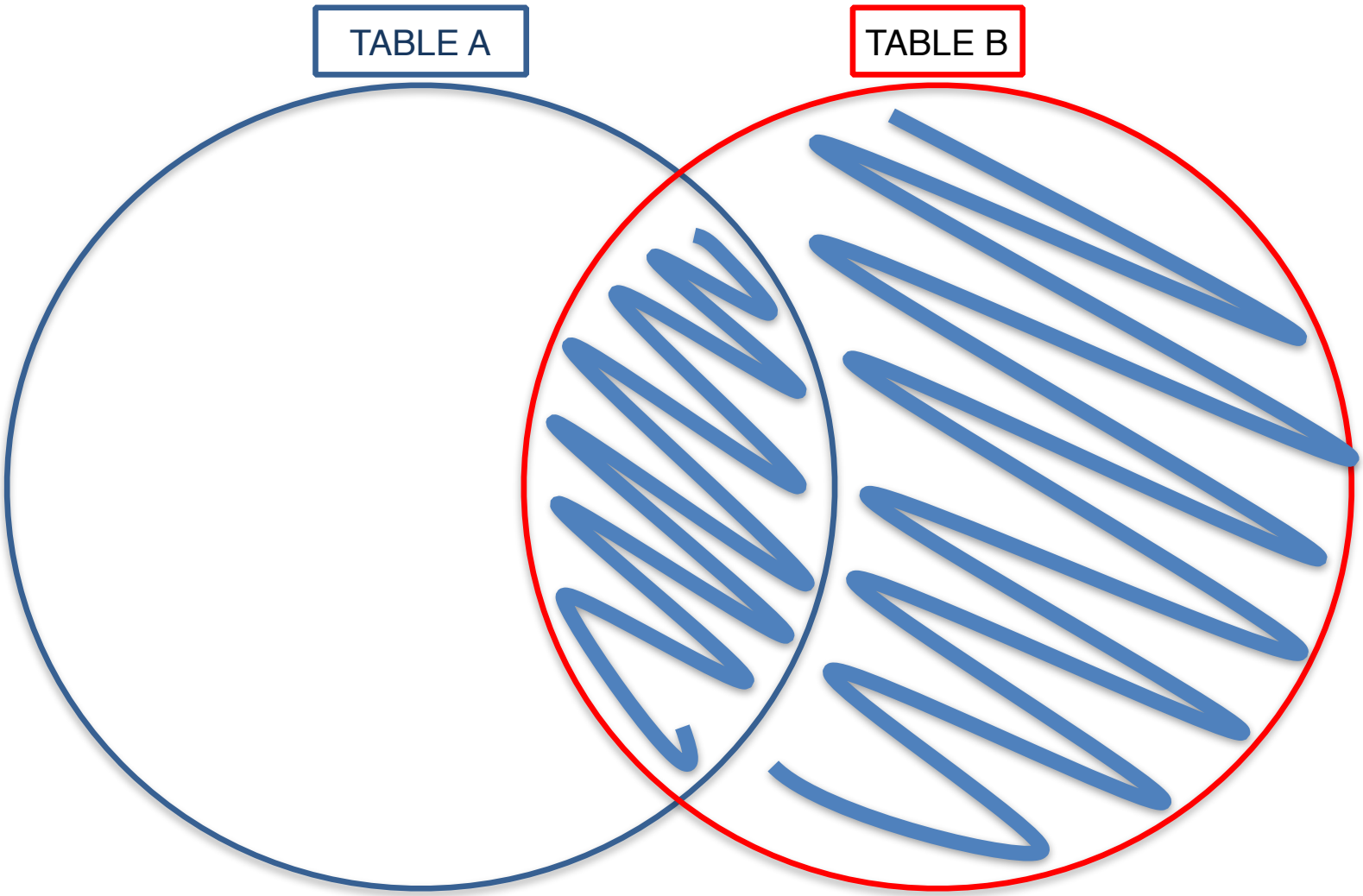
RIGHT JOIN



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RIGHT JOIN Example

Location Table

Name	State
Tim	CA
Bob	NY

Age Table

Name	Years
Tim	30
Jen	20

Result

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30
		Jen	20

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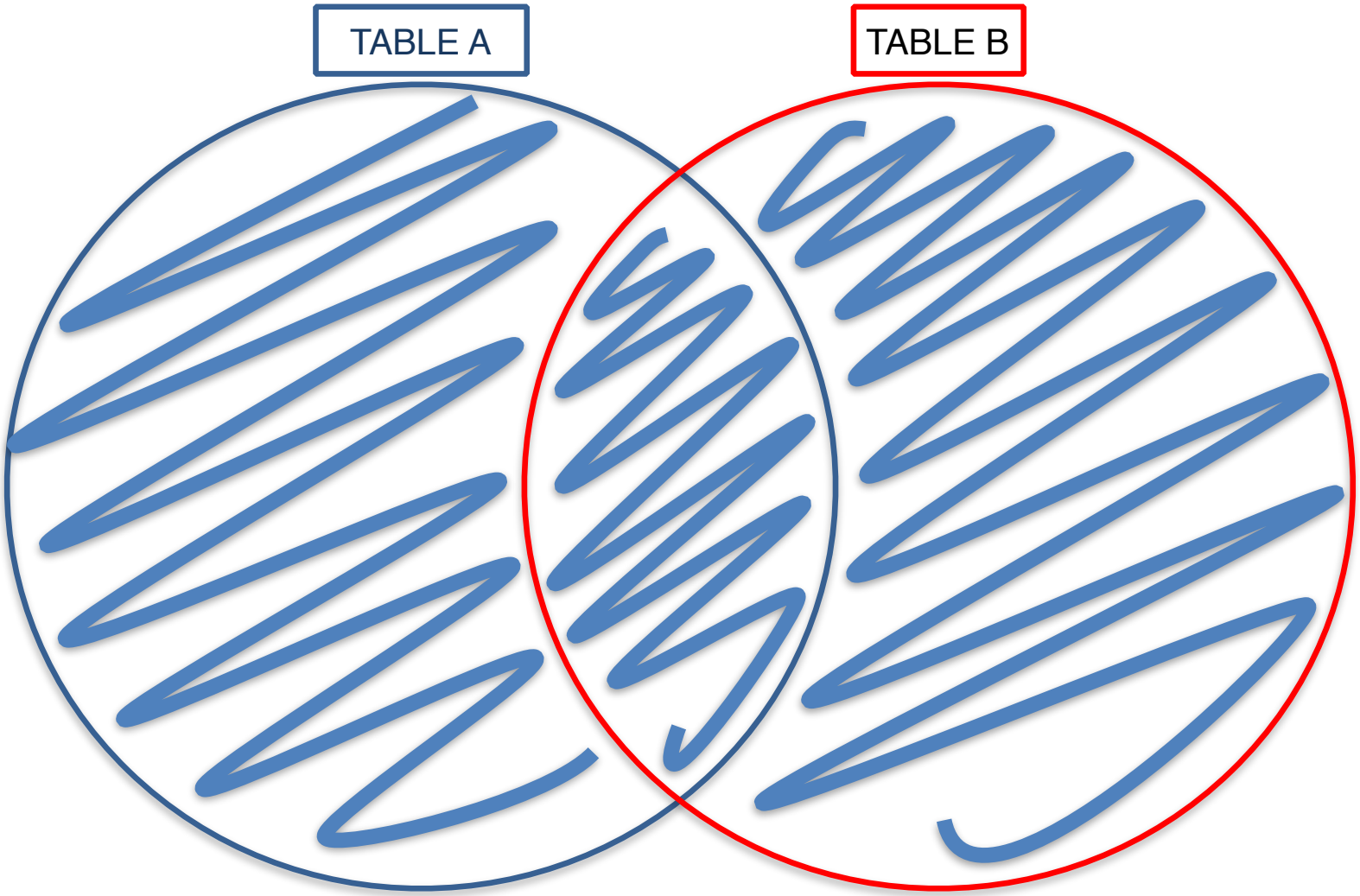
OUTER / FULL JOIN



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FULL JOIN Example

Location Table

Name	State
Tim	CA
Bob	NY

Age Table

Name	Years
Tim	30
Jen	20

Result

Location.Name	Location.State	Age.Name	Age.Years
Tim	CA	Tim	30
Bob	NY		
		Jen	20

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Aggregation Functions

- SELECT SUM(amount)
- SELECT MAX(release_year)
- SELECT MIN(length)
- SELECT AVG(price)

You can select multiple functions in same SELECT clause

Aliases

- Fields can be renamed:
  SELECT milliseconds/1000.0 AS seconds

- Tables can be given aliases:
  SELECT t.name, t.milliseconds, g.name
  FROM track t
  JOIN genre g
  ON t.genreid = g.genreid;

Exercise #6

1. What was the sales total for January 2010?

2. What is the average length of a song by R.E.M.? (Convert results to minutes)

Group By

- Technique for Aggregating Data
- Usually requires aggregation function in SELECT statement
- Similar to Pivot Tables

Group Example

Name	City
Bob	SF
Terry	SF
Joe	LA
Tina	NYC
Jen	NYC
John	NYC

What would you do if you wanted to Group by City?

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Group By

SF	LA	NYC
Bob	Joe	Tina
Terry		Jen
		John

Now how would you describe the amount for each City?

<u>Aggregation Functions:</u>
Sum, Count, Max, Minimum, Average

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GROUP BY Syntax

SELECT ***<group by field>***,
<aggregation function> (***<field>***)
FROM ***<table name>***
GROUP BY ***<group by field>***;

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GROUP BY Example

```
SELECT composer, COUNT(*)
FROM track
GROUP BY composer;
```

HAVING

- Feature for only GROUP BY
- Similar to WHERE clause
- Provides ability to apply conditions to the aggregation functions
- Example:

```
SELECT composer, COUNT(*)
FROM track
GROUP BY composer
HAVING COUNT(*) > 20;
```

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GROUP BY Example

- For example:

```
SELECT composer, COUNT(*)
FROM track t
JOIN genre g
    ON t.genreid = g.genreid
WHERE g.name LIKE ‘%alternative%’
GROUP BY composer
HAVING COUNT(*) >20
ORDER BY COUNT(*) DESC
LIMIT 10;
```

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Exercise #7

1. Which Artists have the most Tracks?
2. Which Albums have the longest playing time?

Bonus: How does the answer for #2 change if you limited the results to music?

ADDITIONAL TECHNIQUES

SUBQUERIES

- Use results of one query as an input to another query
- Powerful, but can also add complexity
  - Less intuitive to read
  - Harder to trouble shoot when errors occur
- Build and test the subquery first
- Use WITH AS to create an alias for the subquery

EXTRACT from Date

- Components of Dates can be Extracted
  - day, month, year
  - hour, minute, second
- SELECT EXTRACT(month from InvoiceDate) FROM Invoice;

CASE STATEMENTS

- Similar to IF statements in Excel
- Create new values from existing data
- For example:
  - You have customer age data
  - Customers behave in age segments (e.g., kids, teens, adults, seniors)
  - CASE statements can be used to create categories for age ranges

Resources for Future Reference

- W3 Schools SQL Tutorials
  www.w3schools.com/sql

- Tutorials Point
  tutorialspoint.com/sql

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yelp.com/biz/quantsprout-san-francisco