GENERAL ASSEMBLY

SQL BOOTCAMP


LET'S MEET

ABOUT YOUR PRODUCER!

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Classes & Workshops Lead

ABOUT YOUR INSTRUCTOR!

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DATA SCIENTIST AT KNEWTON

MUSIC COMPOSER
STRATEGY CONSULTANT
ECONOMIC RESEARCHER
MATH TEACHER

AMSTERDAM, NL
BROOKLYN, NY

ABOUT YOU!

Who
are you

What
do you do

Why
are you here


LET'S SET UP

DOWNLOAD REPO TO MACHINE

- Go to https://github.com/rubennaeff/sql_bootcamp
- Click Download ZIP

OR

- git clone https://github.com/rubennaeff/sql_bootcamp.git

EVERYONE ALL SET WITH THE INSTALLATION?

- A MYSQL SERVER
- A MYSQL CLIENT

0. MEET, SETUP, TROUBLESHOOT — DONE!

I. INTRO TO DATABASES & BASIC SQL

II. AGGREGATIONS & GROUP BY

III. RELATIONAL DATABASES & JOIN

IV. CREATE DATABASES & TABLES

INTRO TO DATABASES

Before we start:

Where and how do you store your data?

Before we start:
Where and how do you store your data?

For example, I do my household budgeting in Google Slides.
More examples?

What is ETL?

- **E**xtract data
- **T**ransform data
- **L**oad data

Databases are a **structured** data source optimized for efficient **retrieval and storage**

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structured: we'll have to define some pre-defined organization

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structured: we'll have to define some pre-defined organization

e.g., a table with columns for first name, last name, DOB, address, etc.

Databases are a **structured** data source optimized for efficient **retrieval and storage**

structured: we'll have to define some pre-defined organization

retrieval: the ability to read data our

storage: the ability to write data and save it

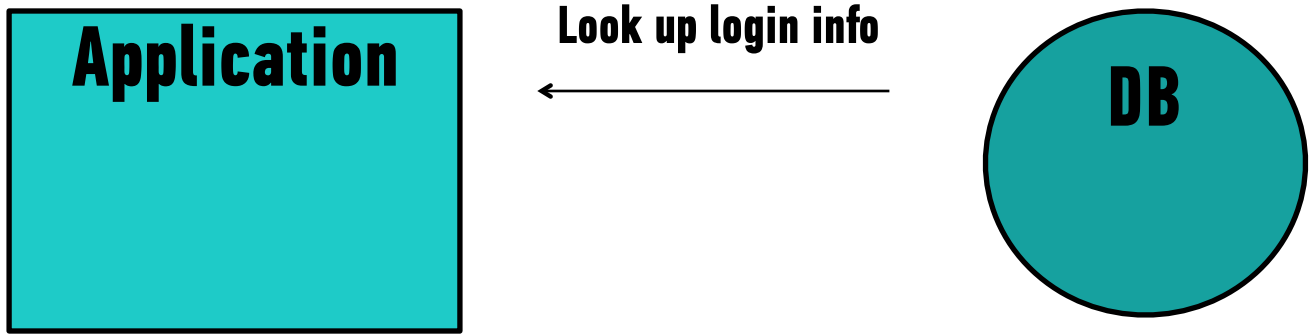
Databases are a **structured** data source optimized for efficient **retrieval and *persistent* storage**

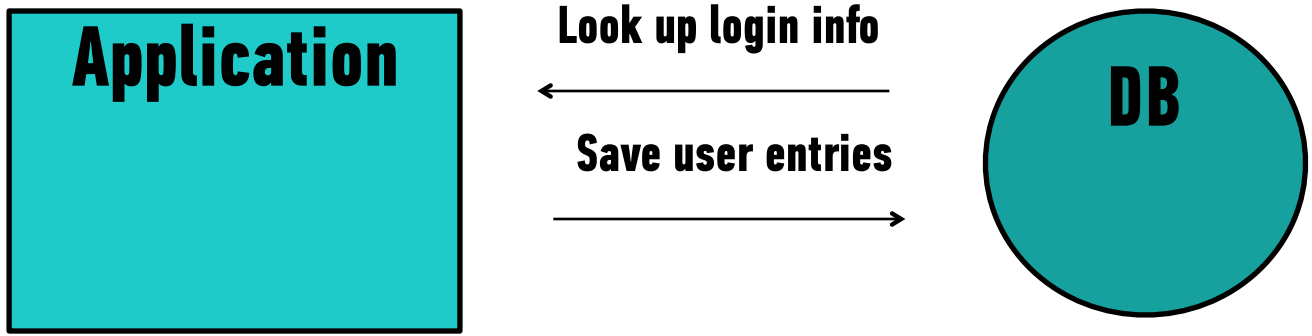
structured: we'll have to define some pre-defined organization

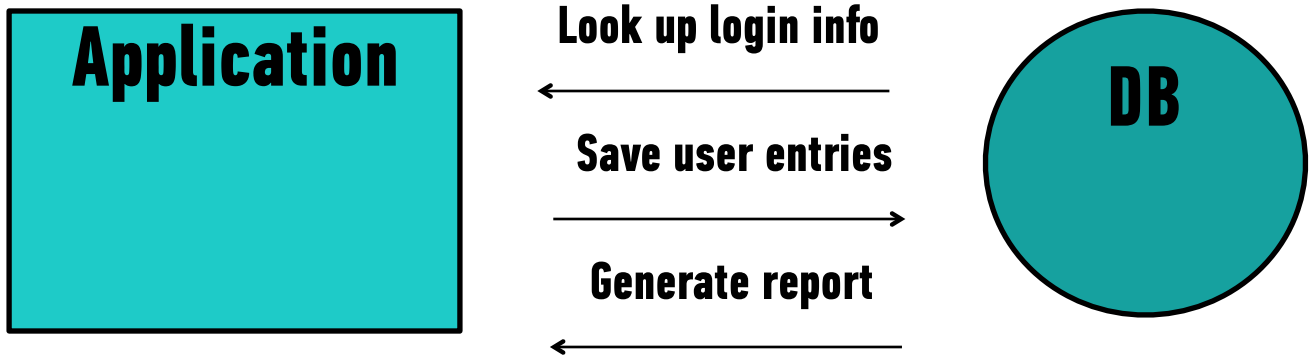
retrieval: the ability to read data our

storage: the ability to write data and save it


Application
DB


Application
Look up login info
DB


Application
Look up login info
Save user entries
DB


Application
Look up login info
Save user entries
Generate report
DB

Thinking about the personal quiz question of earlier,
when is a database useful, and when other storage types?

SQL (STRUCTURED QUERY LANGUAGE)

SQL (Structured Query Language) is a query language designed to extract, transform and load data in relational databases

```
SELECT *
FROM table
```

```
SELECT *
FROM table
```

Select all columns
from this table

```
SELECT col1, col2
FROM table
```

Select some columns
from this table

```
SELECT DISTINCT col1, col2
FROM table
```

Only select unique entries.

```
SELECT *
FROM table
WHERE <condition>
```

SELECT * *SELECT customer, spend*

FROM table *FROM sales*

WHERE <condition> *WHERE spend > 100*

SELECT *
FROM table
WHERE <condition>

SELECT customer, spend, city
FROM sales
WHERE spend > 100
AND city = 'NYC'

SELECT *
FROM table
WHERE <condition>

SELECT customer, spend, city
FROM sales
WHERE spend > 100
AND NOT city = 'NYC'

SELECT *
FROM table
WHERE <condition>

SELECT customer, spend, city
FROM sales
WHERE spend > 100
AND city != 'NYC'

```
SELECT *
FROM table
WHERE <condition>
```

```
SELECT customer, spend, city
FROM sales
WHERE spend > 100
    AND city = 'NYC'
    OR city = 'Amsterdam'
```

```
SELECT *
FROM table
WHERE <condition>
```

```
SELECT customer, spend, city
FROM sales
WHERE spend > 100
    AND city IN ('NYC' , 'Amsterdam')
```

SELECT *
FROM table
WHERE <condition>

SELECT customer, spend, city
FROM sales
WHERE spend > 100
AND city NOT IN ('London', 'Paris')

SELECT *
FROM table
WHERE <condition>

SELECT customer, spend, date
FROM sales
WHERE spend > 100
AND date LIKE '2016-07-%'

```
SELECT *
FROM table
WHERE <condition>
```

```
SELECT customer, spend, date
FROM sales
WHERE spend > 100
    AND date LIKE '20__-06-16'
```

```
SELECT *
FROM table
WHERE <condition>
```

```
SELECT customer, spend, date
FROM sales
WHERE spend > 100
    AND customer LIKE '[abc]%'
```

```
SELECT *
FROM table
WHERE <condition>
ORDER BY <column>
```

SELECT *	*SELECT customer, spend*
FROM table	*FROM sales*
WHERE <condition>	*WHERE spend > 100*
ORDER BY <column>	*ORDER BY spend*

SELECT *	*SELECT customer, spend*
FROM table	*FROM sales*
WHERE <condition>	*WHERE spend > 100*
ORDER BY <column>	*ORDER BY spend*

What do you think will happen now?

```
SELECT *
FROM table
WHERE <condition>
ORDER BY <column> DESC
```

```
SELECT *
FROM table
WHERE <condition>
ORDER BY <column> [DESC | ASC]
```

```
SELECT *
FROM table
WHERE <condition>
ORDER BY <column> [DESC | ASC]
LIMIT <number>
```

```
SELECT *
FROM table
WHERE <condition>
ORDER BY <column> [DESC | ASC]
LIMIT <number>
```

Let's practice! **github.com/rubennaeff/sql_bootcamp**

AGGREGATIONS AND GROUP BY

So far, we have just retrieved information from a single table.

Often, we'd like to gain statistics about the data,
rather than the raw entries themselves.

```
SELECT *
FROM table
```

Select all columns
from this table

```
SELECT Count(*)
FROM table
```

Count all rows (containing all columns) from this table

```
SELECT Count(*)
FROM table
```

Count all rows (containing all columns) from this table

Same as:

```
SELECT Count(col1)
FROM table
```

Count all rows (containing 1st column) from this table

```
SELECT class, name, gender, age
FROM students
```

Print class, name, gender and age of each student.

```
SELECT DISTINCT class
FROM students
```

Only print the (unique) class names.

```
SELECT Count(DISTINCT class)
FROM students
```

Count the number of (unique) classes.

```
SELECT Avg(age)
FROM students
```

Print average age of all students.

```
SELECT Avg(age) AS “Average age”
FROM students
```

Write “Average Age” as column header, instead of “Avg(age)”

```
SELECT Avg(age) AS “Average age”
FROM students
```

Can we also print average age by gender?

```
SELECT gender, Avg(age) AS “Average age”
FROM students
GROUP BY gender
```

Can we also print average age by gender? Yes!

```
SELECT gender, Avg(age) AS “Average age”
FROM students
GROUP BY gender
```

There are usually a few common built-in operations:
SUM, AVG, MIN, MAX, COUNT

```
SELECT class, gender, Avg(age) AS “Average age”
FROM students
GROUP BY class, gender
```

We can also group by multiple columns.

```
SELECT class, gender, Avg(age) AS “Average age”
FROM students
GROUP BY 1, 2
```

Note the convenient shorthand notation!

```
SELECT class, gender, Avg(age) AS “Average age”
FROM students
GROUP BY 1, 2
ORDER BY 3
```

Note the convenient shorthand notation!

```
SELECT class, Avg(age) AS “Average age”
FROM students
GROUP BY class
```

Suppose we’d like to only display classes where the average age is at least 18 years.

```
SELECT class, Avg(age) AS “Average age”
FROM students
GROUP BY class
WHERE Avg(age) >= 18
```

Suppose we’d like to only display classes where the average age is at least 18 years.

```
SELECT class, Avg(age) AS “Average age”
FROM students
GROUP BY class
WHERE Avg(age) >= 18
```

Suppose we’d like to only display classes where the average age is at least 18 years.

NOTE

The WHERE clause only accepts column names, and not aggregates.

It comes ***before*** the GROUP BY clause.

```
SELECT class, Avg(age) AS “Average age”
FROM students
GROUP BY class
HAVING Avg(age) >= 18
```

Suppose we’d like to only display classes where the average age is at least 18 years.

NOTE

The HAVING clause accepts aggregates.

It comes ***after*** the GROUP BY clause.

```
SELECT class, Avg(age) AS “Average age”
FROM students
GROUP BY class
HAVING “Average age” >= 18
```

Suppose we’d like to only display classes where the average age is at least 18 years.

NOTE

Make sure you refer to the actual column name, and not write a string value.

```
SELECT class, Avg(age) AS “Average_age”
FROM students
GROUP BY class
HAVING Average_age >= 18
```

Suppose we’d like to only display classes where the average age is at least 18 years.

```
SELECT <columns>
FROM <table>
GROUP BY <columns>
HAVING <condition on aggregates>
```

General SQL structure

```
SELECT <columns>
FROM <table>
WHERE <condition>
GROUP BY <columns>
HAVING <condition on aggregates>
ORDER BY <columns>
LIMIT <number>
```

General SQL structure (putting it all together)

SELECT <columns>
FROM <table>
WHERE <condition>
GROUP BY <columns>
HAVING <condition on aggregates>
ORDER BY <columns>
LIMIT <number>

General SQL structure (putting it all together)

Let's practice s'more!

RELATIONAL DATABASES

A **relational database** is organized in the following manner:

- A database has **tables** which represent individual entities or objects
- Tables have a predefined **schema** - rules that tell it what columns exist and what they look like

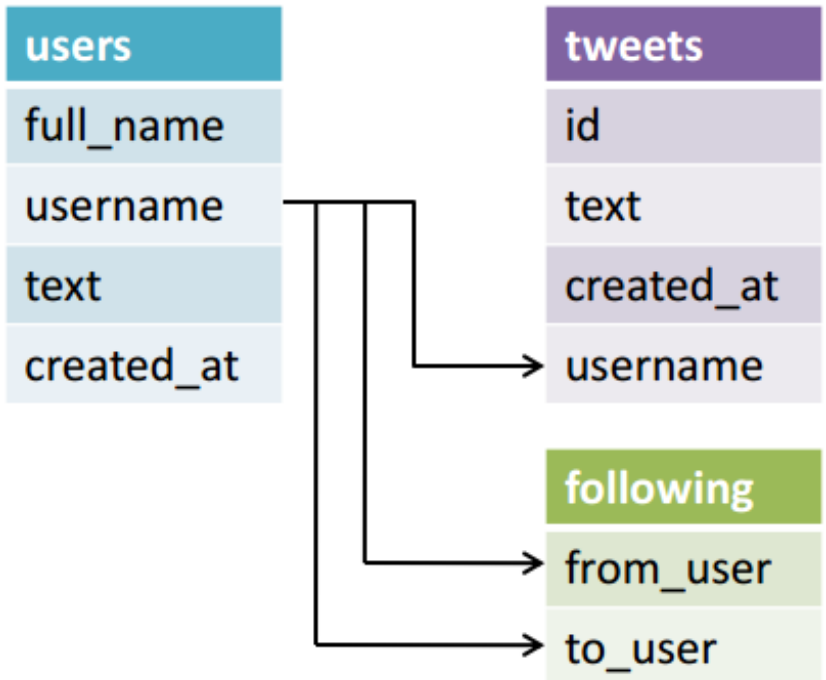
A **relational database** is organized in the following manner:

- table

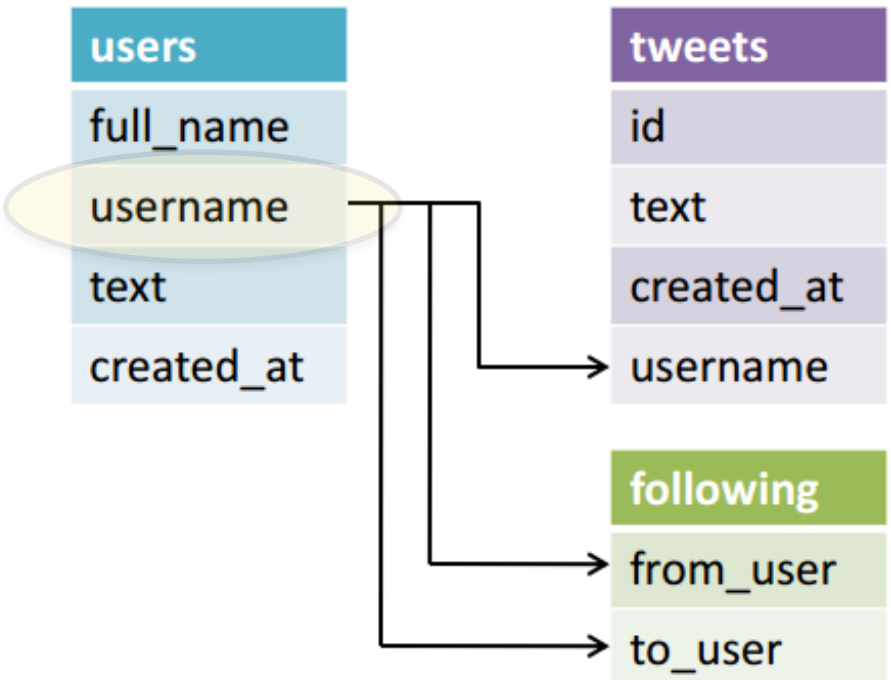
id	first_name	last_name	date_of_birth
312	Joe	Smith	1980-12-24
1532	Michelle	Anderson	1973-03-12

- schema

```
id              bigint
first_name      char(36)
last_name       char(36)
date_of_birth   timestamp
```


users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user

Each table should have a **primary key** column,
i.e., a unique identifier for that row


users
full_name
username
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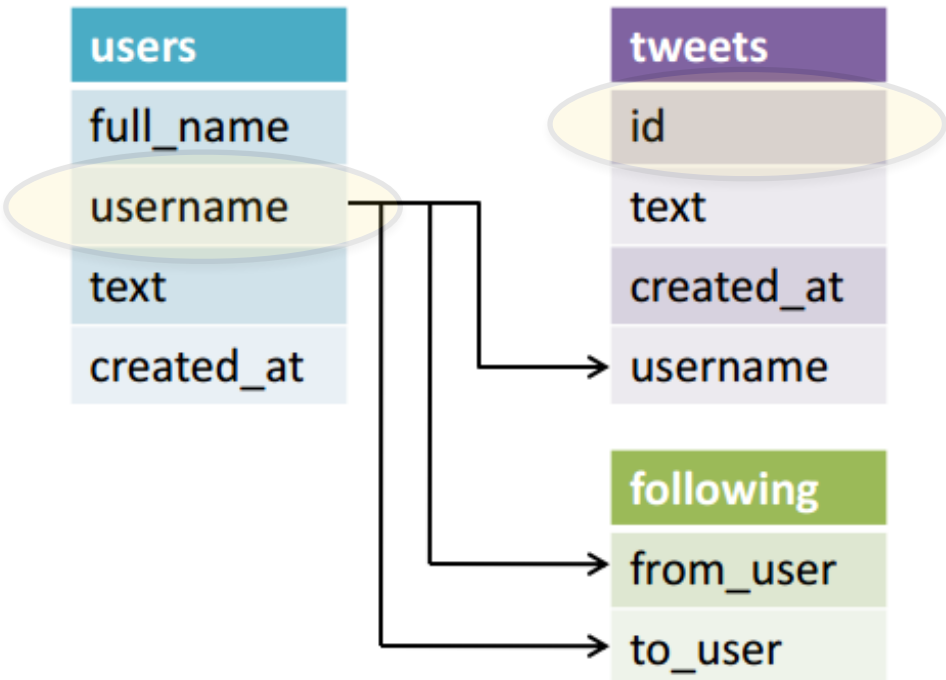
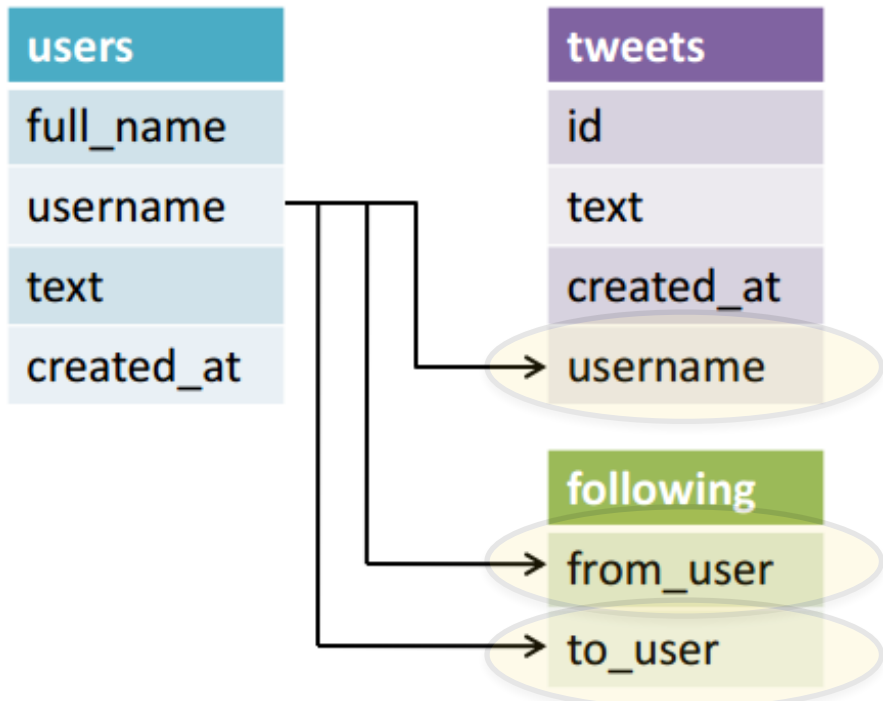
id
text
created_at
username
following
from_user
to_user


users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user

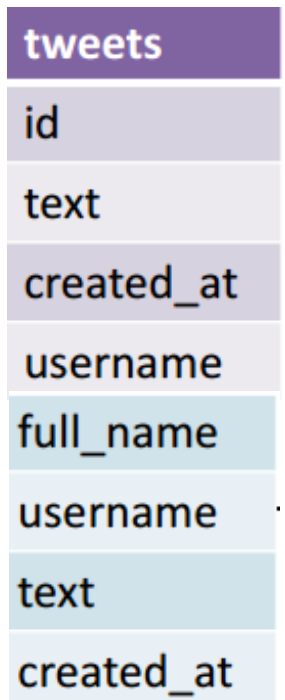
Each table should have a **primary key** column,
i.e., a unique identifier for that row

Additionally, each table can have a **foreign key** column,
i.e., an id that links this to table to another


users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user

We could have had a table structure as follow:

Why is this different?



We could have had a table structure as follow:

Why is this different?

We would repeat the user information on each row.

This is called **denormalization**

tweets
id
text
created_at
username
full_name
username
text
created_at

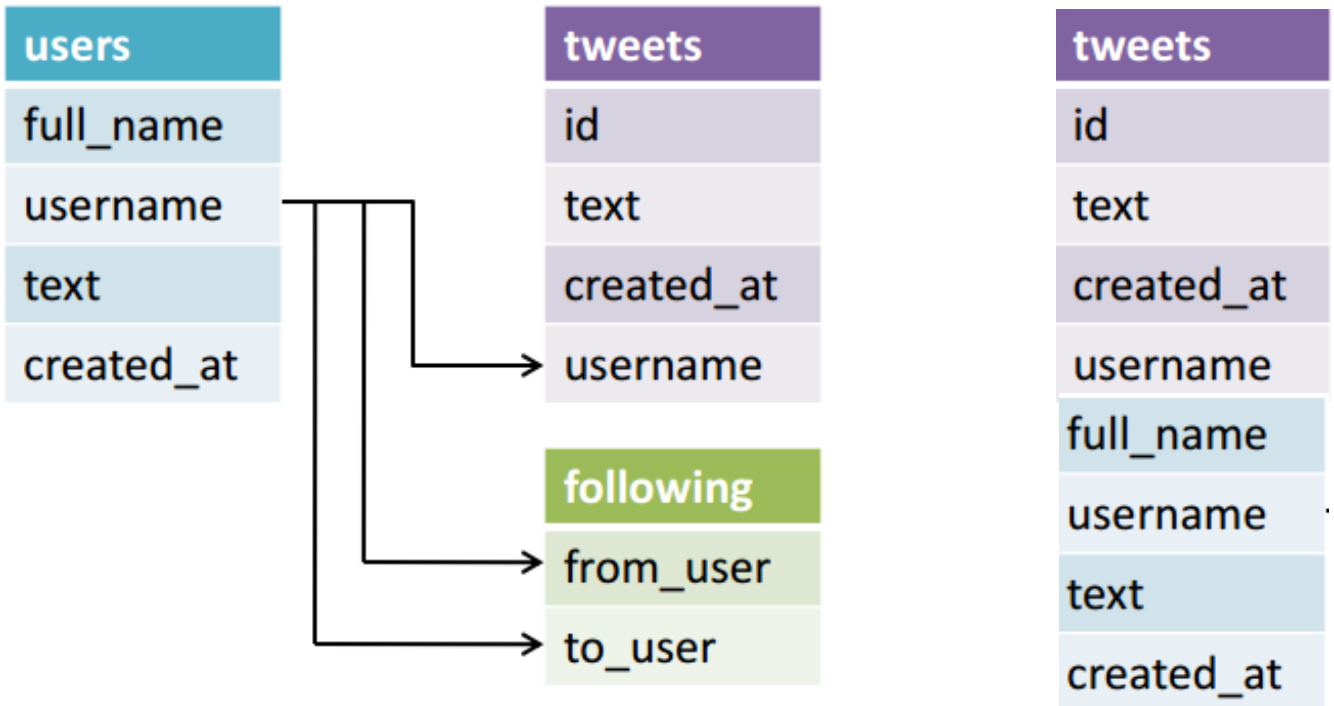
Normalized Data:

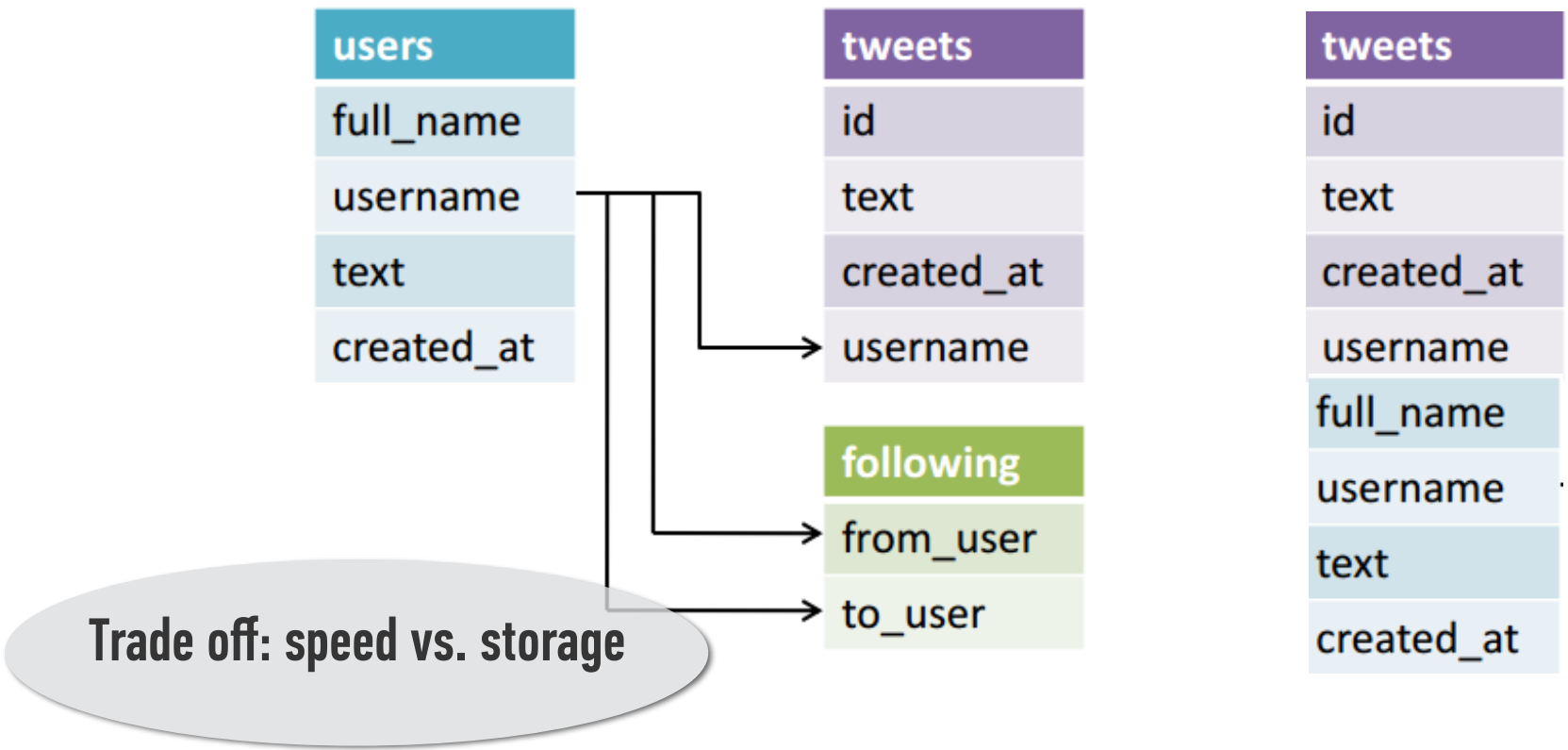
Many tables to reduce redundant or repeated data in a table

Denormalized Data:

Wide data, fields are often repeated

but removes the need to join together multiple tables


users
full_name
username
text
created_at
tweets
id
text
created_at
username
following
from_user
to_user
tweets
id
text
created_at
username
full_name
username
text
created_at


users
full_name
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text
created_at
tweets
id
text
created_at
username
following
from_user
to_user
tweets
id
text
created_at
username
full_name
username
text
created_at
Trade off: speed vs. storage

Q: How do we commonly evaluate databases?

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- *read-speed vs. write speed*

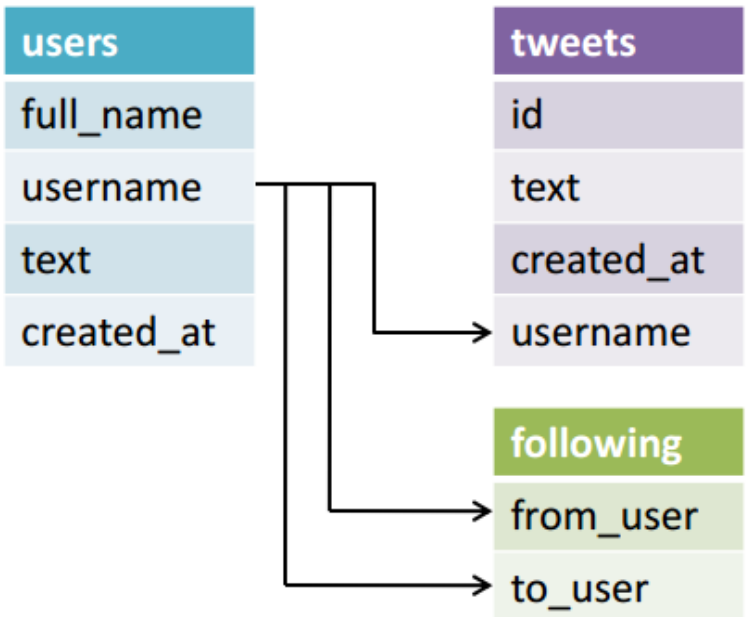
Q: How do we commonly evaluate databases?

- *read-speed vs. write speed*
- *space considerations*

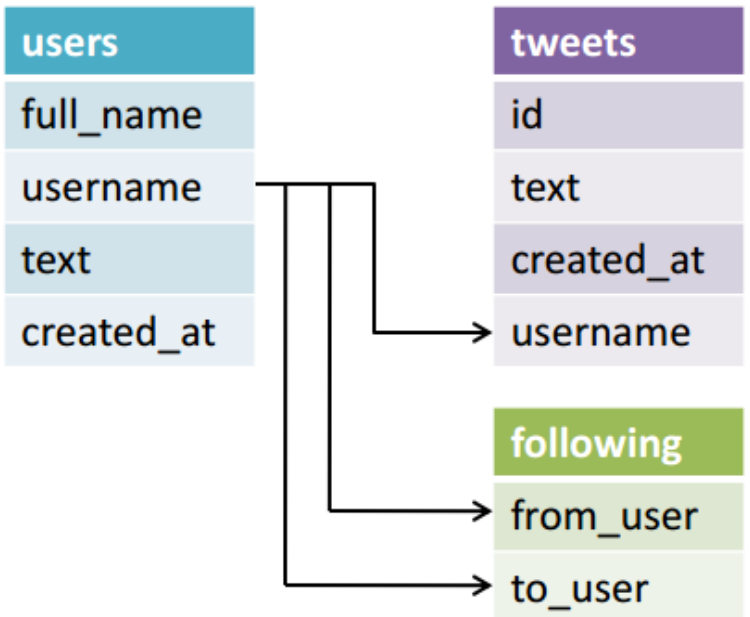
Q: How do we commonly evaluate databases?

- *read-speed vs. write speed*
- *space considerations*
- *(...and many other criteria)*

Q: Why are normalized tables (possibly) slower to read?



Q: Why are normalized tables (possibly) slower to read?



We'll have to get data from multiple tables to answer some questions

Q: Why are denormalized tables (possibly) slower to write?

tweets
id
text
created_at
username
full_name
username
text
created_at

Q: Why are denormalized tables (possibly) slower to write?

tweets
id
text
created_at
username
full_name
username
text
created_at

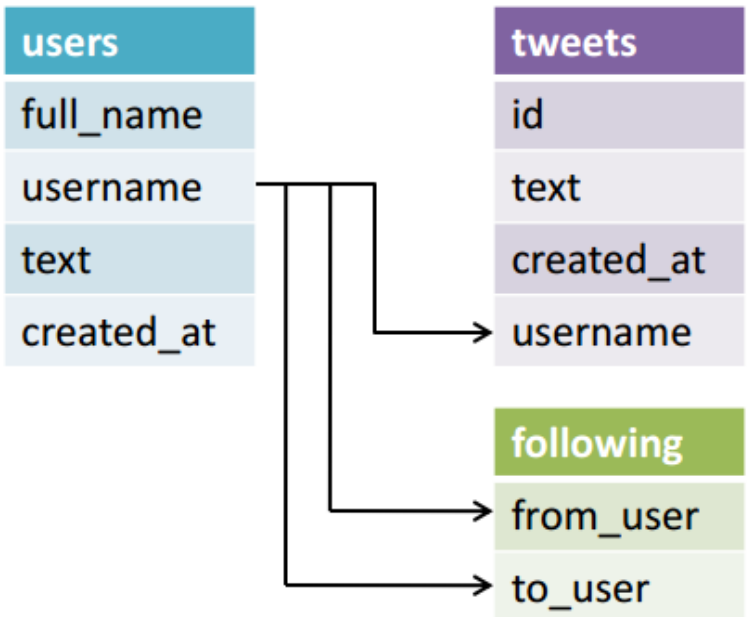
We'll have to write more data each time we store something

Databases are either relational or non-relational

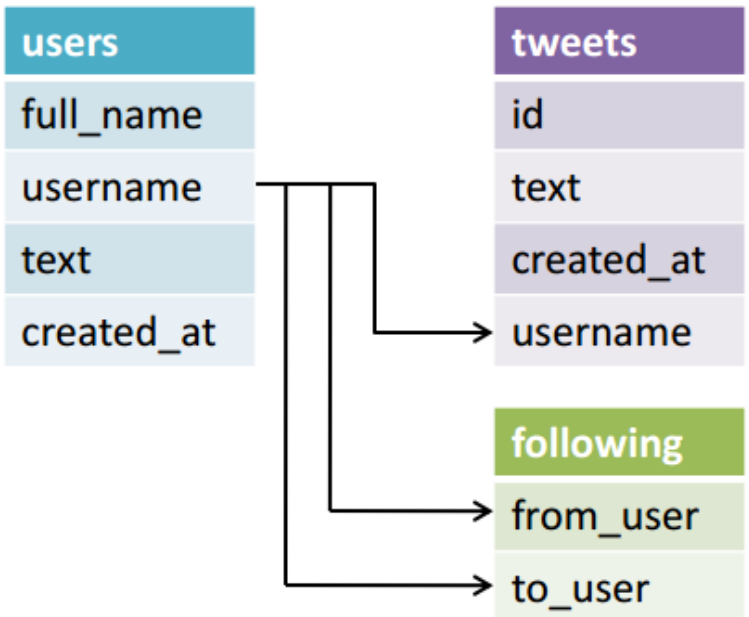
- Relational: SQL (MySQL, PostgreSQL, ...)
- Non-relational: NoSQL (MongoDB, Cassandra, ...)

SQL: THE JOIN COMMAND

Create a table with all the users' full names and their tweets

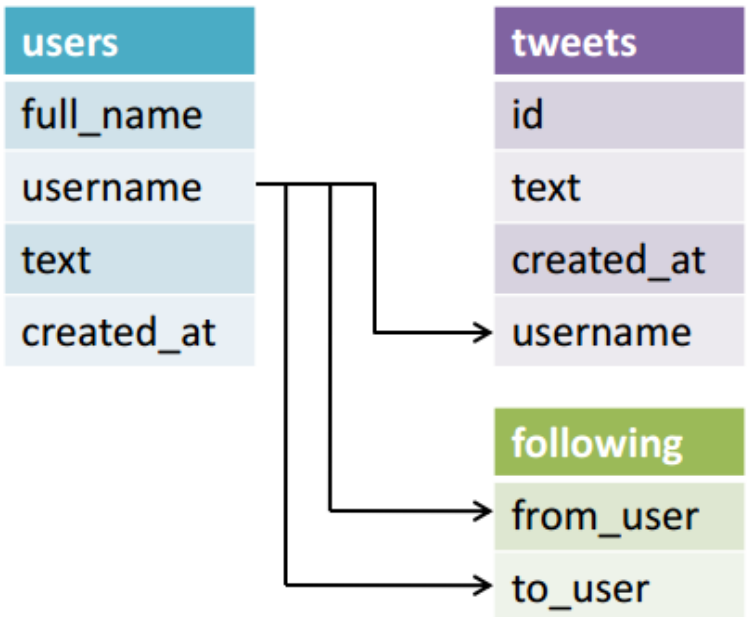


Create a table with all the users' full names and their tweets



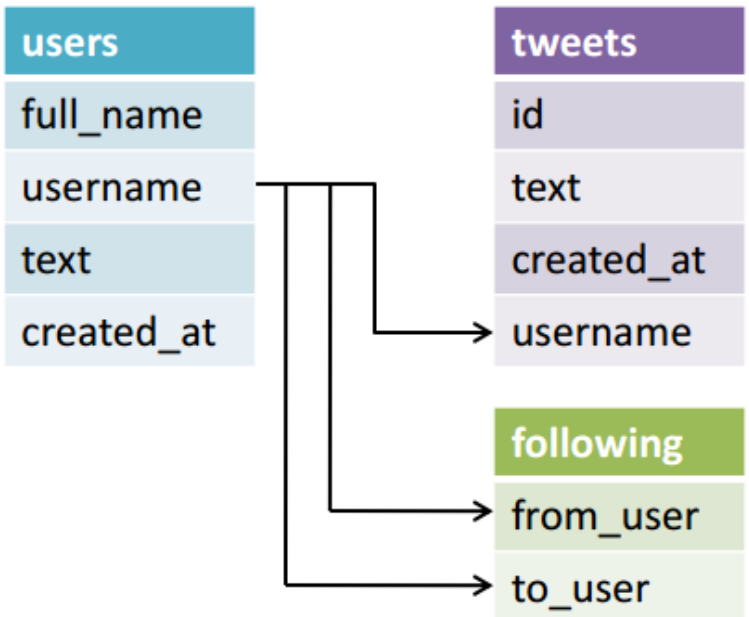
full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight

Create a table with all the users' full names and their tweets



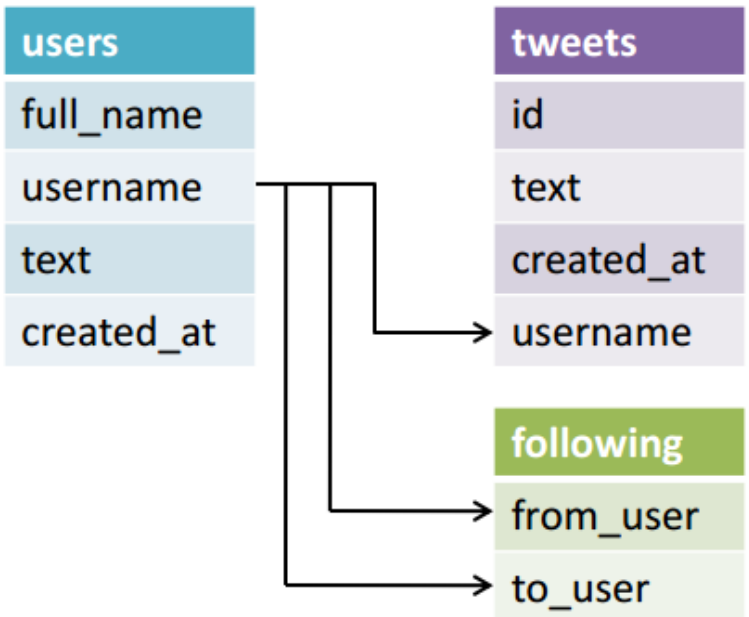

```
SELECT
  users.full_name,
  tweets.text
```

Create a table with all the users' full names and their tweets



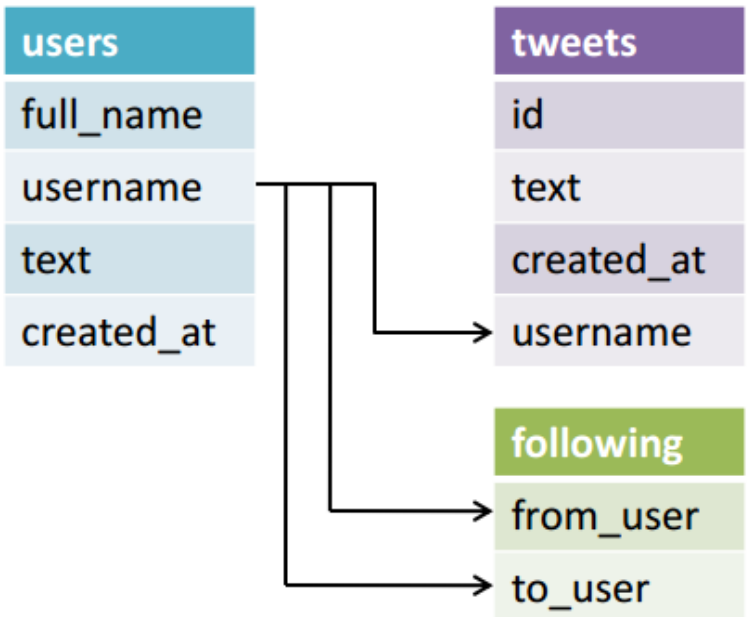

```
SELECT
  users.full_name,
  tweets.text
FROM users
```

Create a table with all the users' full names and their tweets



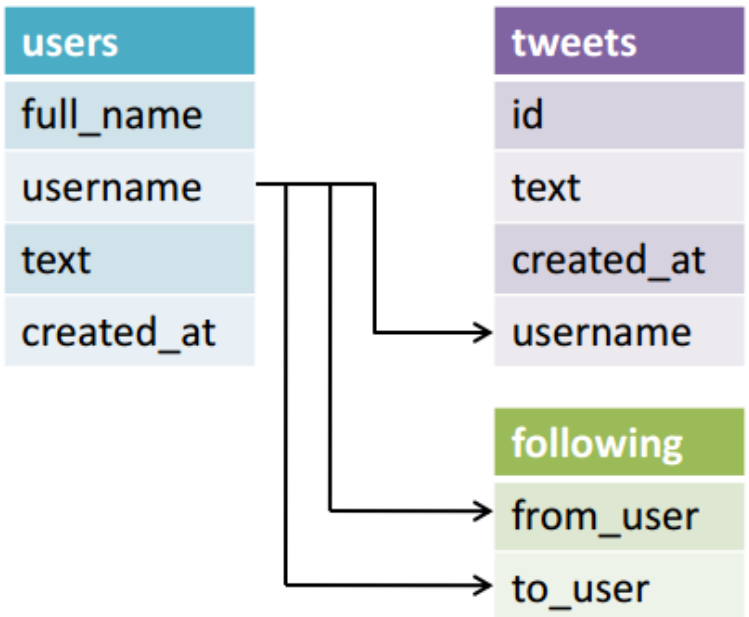

```
SELECT
  users.full_name,
  tweets.text
FROM users
JOIN tweets
```

Create a table with all the users' full names and their tweets




```
SELECT
  users.full_name,
  tweets.text
FROM users
JOIN tweets
ON users.username = tweets.username
```

Create a table with all the users' full names and their tweets




```
SELECT
  full_name,
  text
FROM users
JOIN tweets
ON users.username = tweets.username
```

General SQL structure

```
SELECT <columns>
FROM <table>
JOIN <otherTable>
ON <table.key> = <otherTable.key>
```

General SQL structure

```
SELECT <columns>
FROM <table>
JOIN <otherTable>
ON <table.key> = <otherTable.key>
JOIN <yetAnotherTable>
ON <otherTable.key> = <yetAnotherTable.key>
```

NOTE

You can combine as many **JOIN**s as you want!

General SQL structure

```
SELECT <columns>
FROM <table>
JOIN <otherTable>
ON <table.key> = <otherTable.key>
WHERE <condition>
GROUP BY <columns>
HAVING <condition>
ORDER BY <columns>
LIMIT <number>
```

General SQL structure

```
SELECT <columns>
FROM <table>
JOIN <otherTable>
ON <table.key> = <otherTable.key>
WHERE <condition>
GROUP BY <columns>
HAVING <condition>
ORDER BY <columns>
LIMIT <number>
```

NOTE

This is basically the ***only query*** you need to know to successfully extract data from databases.

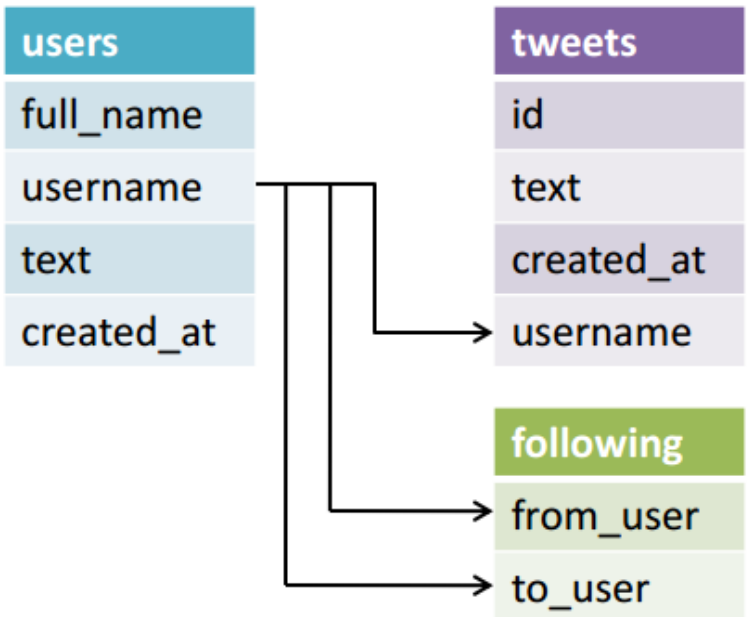
```
SELECT <columns>
FROM <table>
JOIN <otherTable>
ON <table.key> = <otherTable.key>
WHERE <condition>
GROUP BY <columns>
HAVING <condition>
ORDER BY <columns>
LIMIT <number>
```

General SQL structure

Let's practice s'more!

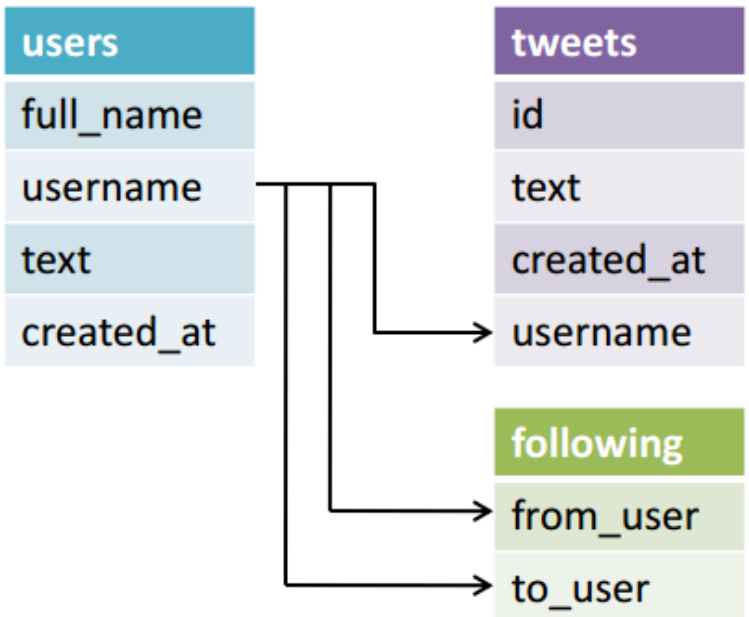
SQL: MORE JOINS
LEFT, RIGHT, INNER, OUTER

Create a table with all the users' full names and their tweets



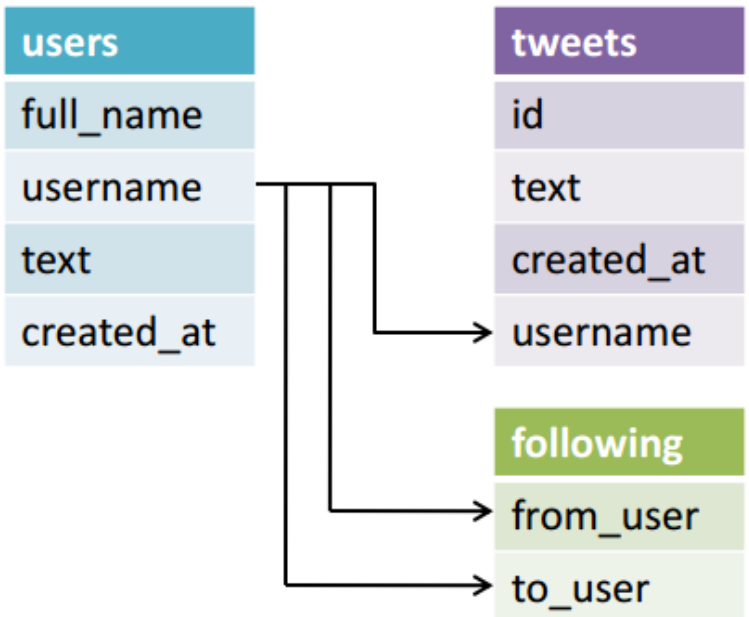

```
SELECT
  full_name,
  text
FROM users
JOIN tweets
ON users.username = tweets.username
```

Create a table with all the users' full names and their tweets



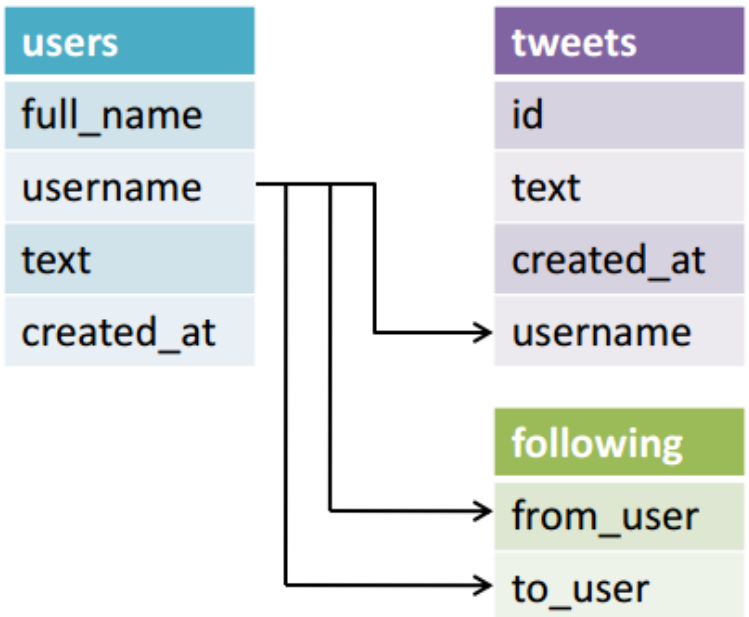
Will users who never tweeted appear in the list?

Create a table with all the users' full names and their tweets



Will users who never tweeted appear in the list? No.

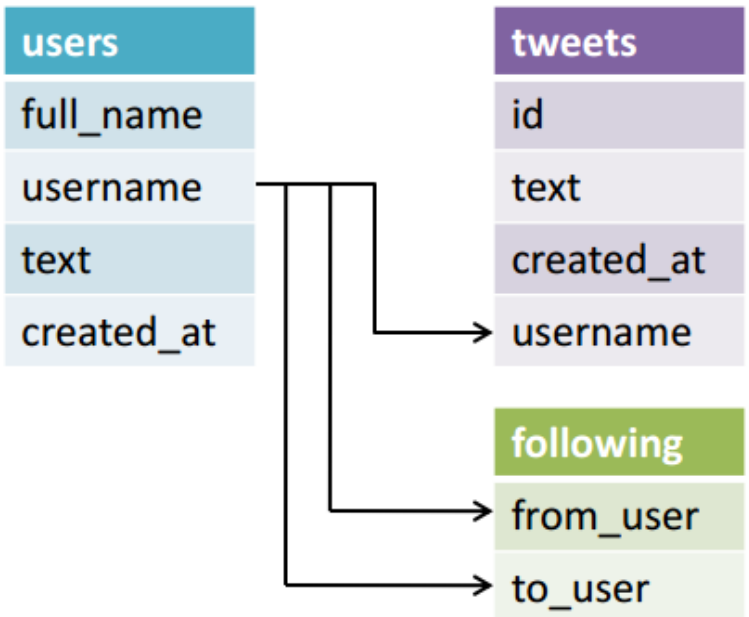
Create a table with all the users' full names and their tweets



Will users who never tweeted appear in the list? No.

Will tweets from deleted accounts still appear in the list?

Create a table with all the users' full names and their tweets



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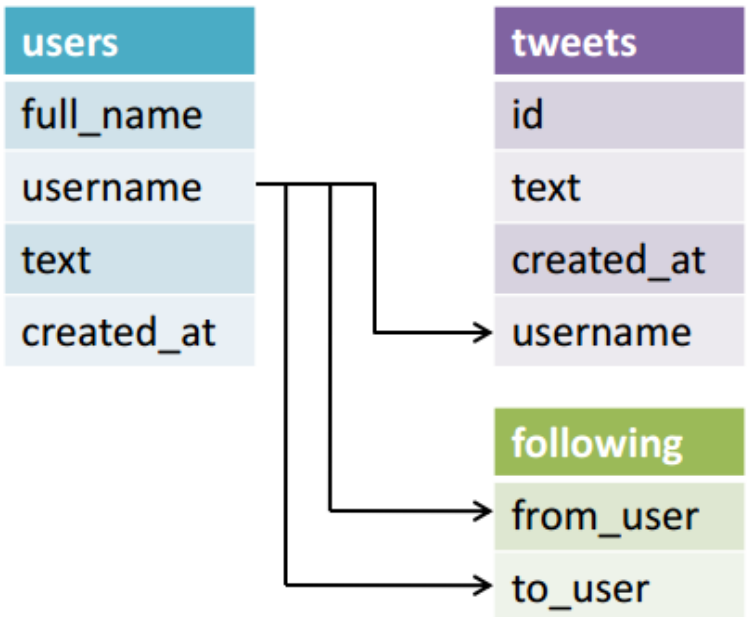


Will users who never tweeted appear in the list? No.

Will tweets from deleted accounts still appear in the list? No.

What if we still want them?

JOIN *will only include entries that occur in both tables.*

```
SELECT
  full_name,
  text
FROM users
JOIN tweets
ON users.username = tweets.username
```

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight

JOIN *will only include entries that occur in both tables.*

This is also called an **INNER JOIN**.

```
SELECT
  full_name,
  text
FROM users
INNER JOIN tweets
ON users.username = tweets.username
```

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight

LEFT JOIN *will always include all entries from the left table, even if there are no matches in the other table.*

```
SELECT
  full_name,
  text
FROM users
LEFT JOIN tweets
ON users.username = tweets.username
```

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight
Jim Rogers	

RIGHT JOIN *will always include all entries from the right table, even if there are no matches in the other table.*

```
SELECT
  full_name,
  text
FROM users
RIGHT JOIN tweets
ON users.username = tweets.username
```

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight
	OK, deleting my account

FULL OUTER JOIN *will always include all entries from both tables, even if there are no matches in the other table.*

```
SELECT
  full_name,
  text
FROM users
FULL OUTER JOIN tweets
ON users.username = tweets.username
```

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight
Jim Rogers	
	OK, deleting my account

The holes in the resulting table are called **NULL**s.

NULL indicates missing data.

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight
Jim Rogers	
	OK, deleting my account

The holes in the resulting table are called **NULL**s.

NULL indicates missing data.

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight
Jim Rogers	NULL
NULL	OK, deleting my account

The holes in the resulting table are called **NULL**s.

NULL indicates missing data.

Note that **NULL** is not the same as zero or an empty string "", it really means that there is no data.

full_name	tweet
Joe Smith	Hello, world!
Joe Smith	Just tweetin'
Michelle Ng	I am eating pizza tonight
Jim Rogers	NULL
NULL	OK, deleting my account

For example, to print a list of users without tweets, we'd write

```
SELECT full_name
FROM users
FULL OUTER JOIN tweets
ON users.username = tweets.username
WHERE tweets.text IS NULL
```

full_name
Jim Rogers

For example, to print a list of users without tweets, we'd write

```
SELECT full_name
FROM users
FULL OUTER JOIN tweets
ON users.username = tweets.username
WHERE tweets.text IS NULL
```

full_name
Jim Rogers

NOTE

It is common to write **IS NULL**, rather than **= NULL**, to emphasize that there is no value at all (which hence cannot be equal to anything).

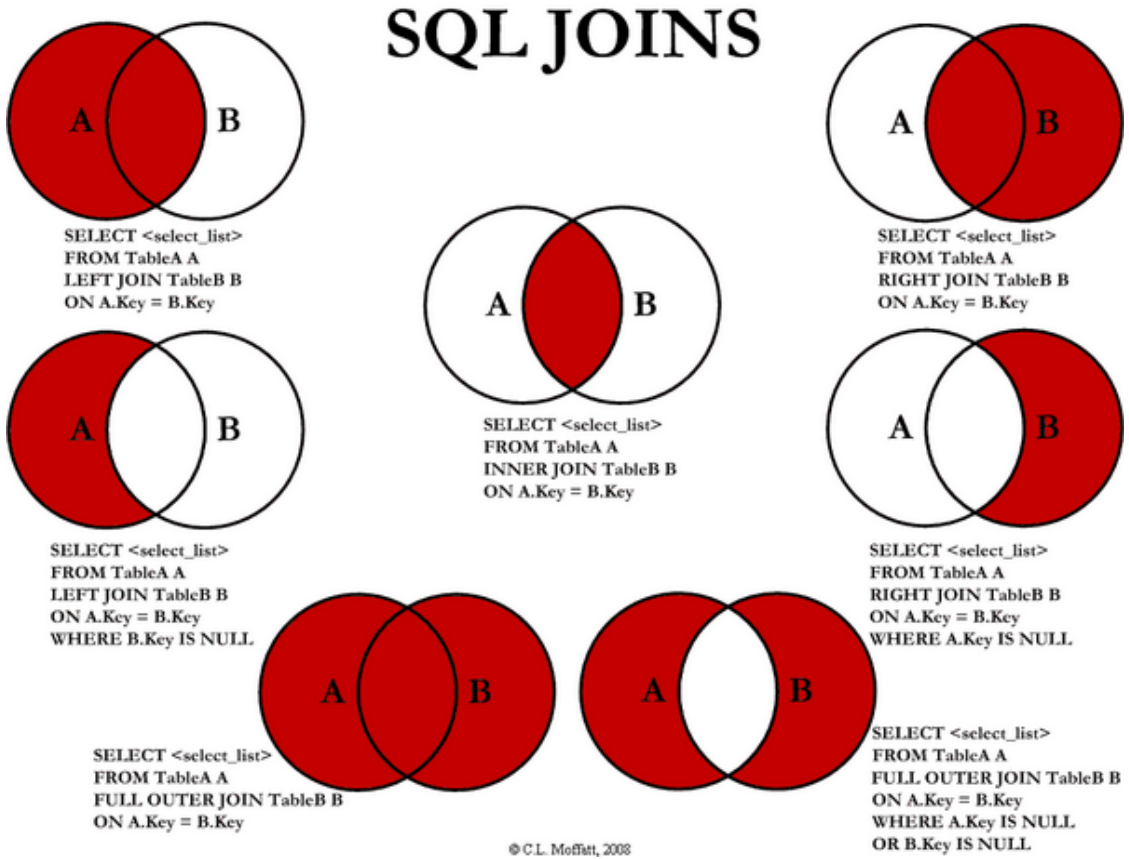


Image by CodeProject

General SQL structure

```
SELECT <columns>
FROM <table>
[INNER|LEFT|RIGHT|FULL OUTER] JOIN <otherTable>
ON <table.key> = <otherTable.key>
```

General SQL structure

```
SELECT <columns>
FROM <table>
[INNER|LEFT|RIGHT|FULL OUTER] JOIN <otherTable>
ON <table.key> = <otherTable.key>
WHERE <condition>
GROUP BY <columns>
HAVING <condition>
ORDER BY <columns> [DESC|ASC]
LIMIT <number>
```

VARIOUS FUNCTIONS

```
SELECT 1+1
SELECT NOW()
SELECT "test"
```

```
SELECT CONCAT(first_name, ' ', last_name) AS full_name
FROM users
```

```
SELECT CONCAT(first_name, ' ', last_name) AS full_name
FROM users
```

could also be written as

```
SELECT first_name + ' ‘ + last_name AS full_name
FROM users
```

```
SELECT CONCAT(first_name, ' ', last_name) AS full_name
FROM users

SELECT LENGTH(first_name) AS name_length
FROM users
```

```
SELECT CONCAT(first_name, ' ', last_name) AS full_name
FROM users

SELECT LENGTH(first_name) AS name_length
FROM users

SELECT LOCATE('a', first_name) AS first_a_location
FROM users
```

```
SELECT
    first_name,
    last_name,
    CASE WHEN last_name < 'n' THEN 'A' ELSE 'B' END AS position
FROM users
```

```
SELECT
    first_name,
    last_name,
    IF (last_name < 'n', 'A', 'B') AS position
FROM users
```

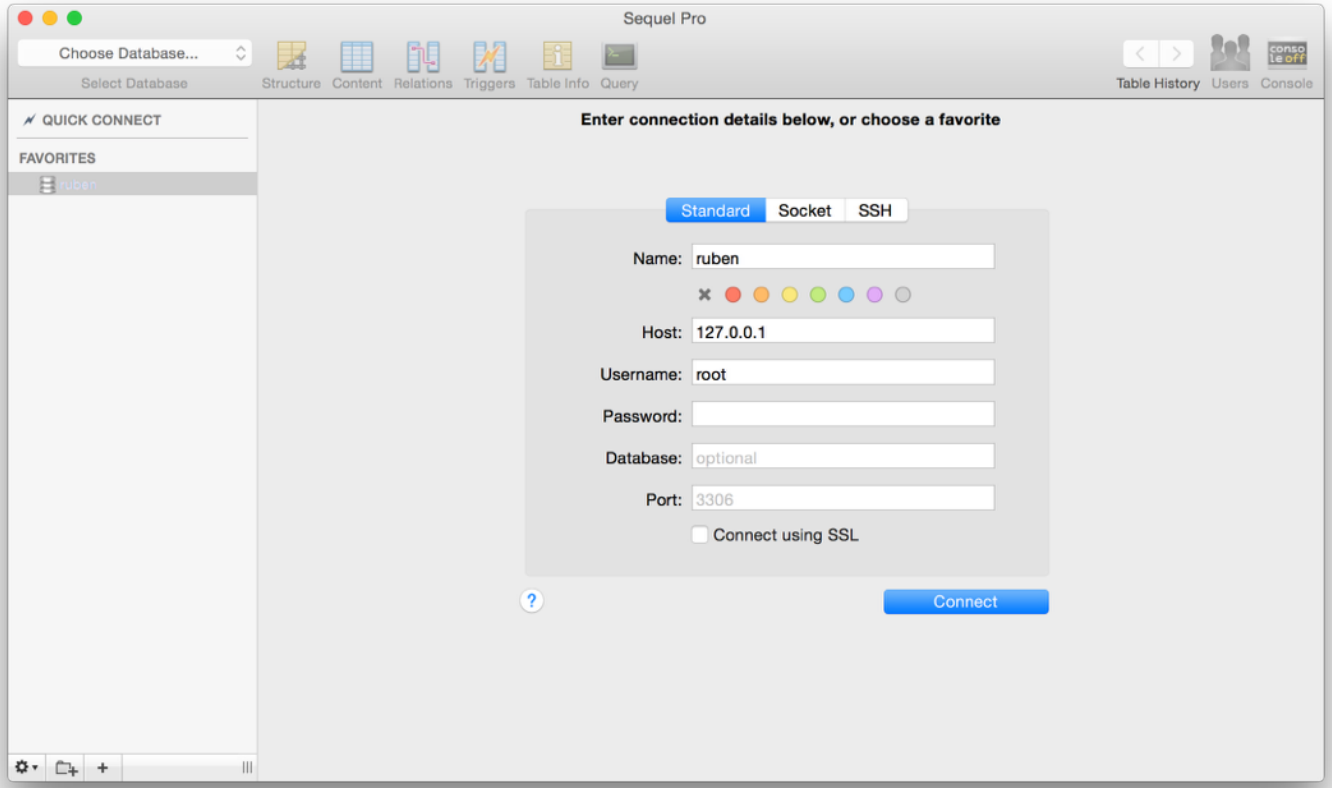
```
SELECT *
FROM users
WHERE first_name IN (
    SELECT DISTINCT first_name
    FROM presidents
)
```

```
SELECT col1, col2        Select some columns
FROM table               from this table
```

```
SELECT col1, col2          -- Select two columns
FROM table                 -- from this table

SELECT col1                -- Select two columns
FROM table                 -- from this table
UNION                      -- but list them a one column,
SELECT col2                -- underneath each other
FROM table
```

CREATING DATABASES & TABLES


Sequel Pro
Choose Database...
Select Database
Structure
Content
Relations
Triggers
Table Info
Query
Table History
Users
Console
QUICK CONNECT
FAVORITES
ruben
Enter connection details below, or choose a favorite
Standard
Socket
SSH
Name: ruben
Host: 127.0.0.1
Username: root
Password:
Database: optional
Port: 3306
Connect using SSL
Connect

CREATE DATABASE GA

CREATE DATABASE GA

DROP DATABASE GA

DROP DATABASE IF EXISTS GA

```
DROP DATABASE IF EXISTS GA;
CREATE DATABASE GA
```

SHOW DATABASES

USE GA

```
CREATE TABLE users (
    user_id INT NOT NULL AUTO_INCREMENT,
    first_name VARCHAR(20) NOT NULL,
    last_name VARCHAR(30) NOT NULL,
    age INT NOT NULL,
    PRIMARY KEY (user_id) )
```

```
CREATE TABLE users (
    user_id INT NOT NULL AUTO_INCREMENT,
    first_name VARCHAR(20) NOT NULL,
    last_name VARCHAR(30) NOT NULL,
    age INT NOT NULL,
    PRIMARY KEY (user_id) )
```

AUTO_INCREMENT starts at 1 and goes up with every record

```
CREATE TABLE users (
    user_id INT NOT NULL AUTO_INCREMENT,
    first_name VARCHAR(20) NOT NULL,
    last_name VARCHAR(30) NOT NULL,
    age INT NOT NULL,
    PRIMARY KEY (user_id) )
```

PRIMARY KEYs are indexed by default, must be unique, and cannot be NULL.

BIT	0 or 1
INT	Any whole number
DECIMAL	Any number
DATETIME	A date and time
DATE	Just the date part of a datetime
CHAR(length)	Has a fixed length
VARCHAR(length)	Has a max length
...	and many more

SHOW TABLES

DESCRIBE users

```
DESCRIBE users


SELECT *
FROM INFORMATION_SCHEMA.COLUMNS
WHERE TABLE_NAME = 'users'
```

```
ALTER TABLE users
ADD employer_id INT
```

```
ALTER TABLE users
ADD employer_id INT

ALTER TABLE table_name
ALTER COLUMN employer_id DECIMAL        or: MODIFY
```

```
ALTER TABLE users
ADD employer_id INT

ALTER TABLE table_name
ALTER COLUMN employer_id DECIMAL        or: MODIFY

ALTER TABLE table_name
DROP COLUMN column_name
```

```
INSERT INTO users (first_name, last_name, age)
VALUES
    ("Bob", "Bobson", 20),
    ("Betty", "Bettyberg", 42)
```

```
DELETE FROM users
WHERE user_id = 2
```

```
DELETE FROM users
WHERE user_id = 2

UPDATE users
SET first_name = 'Bobby'
WHERE user_id = 1
```

DROP TABLE users

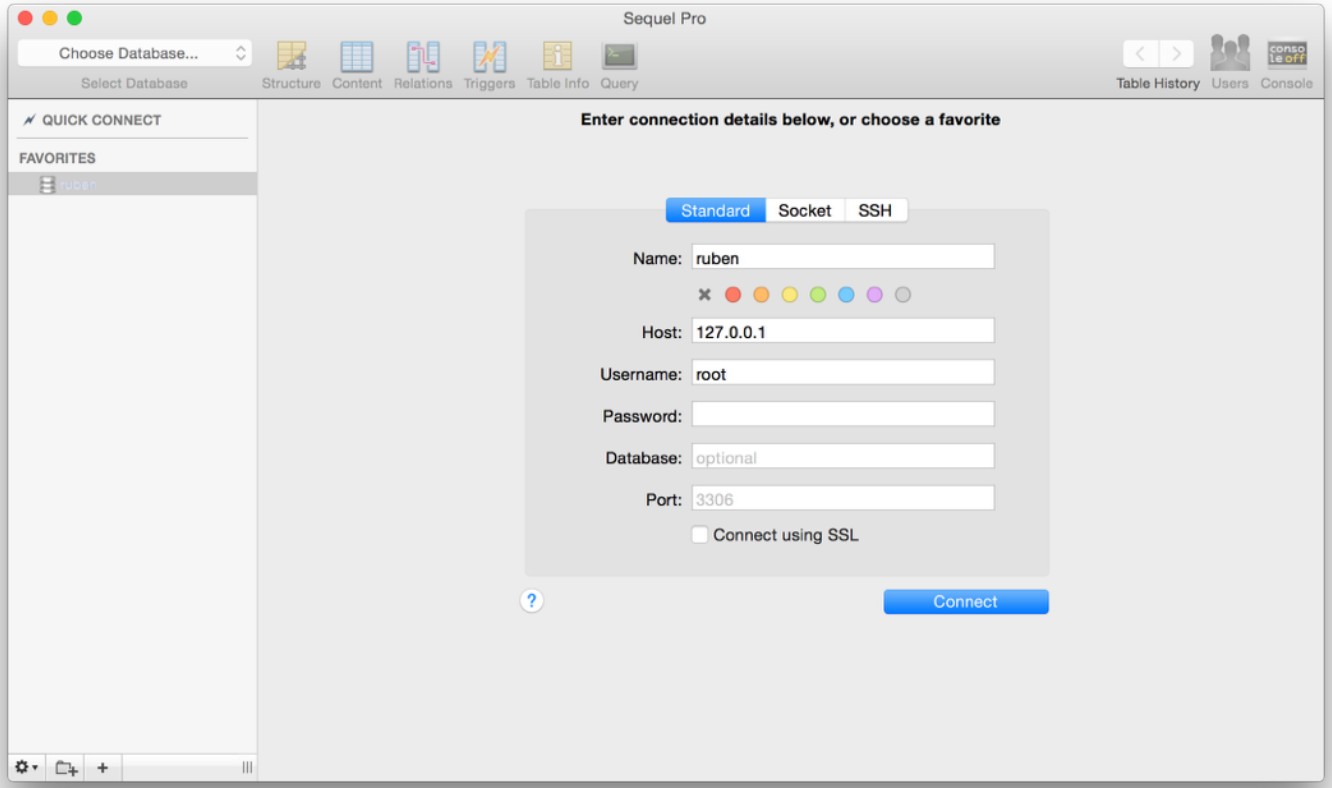
DROP TABLE IF EXISTS users

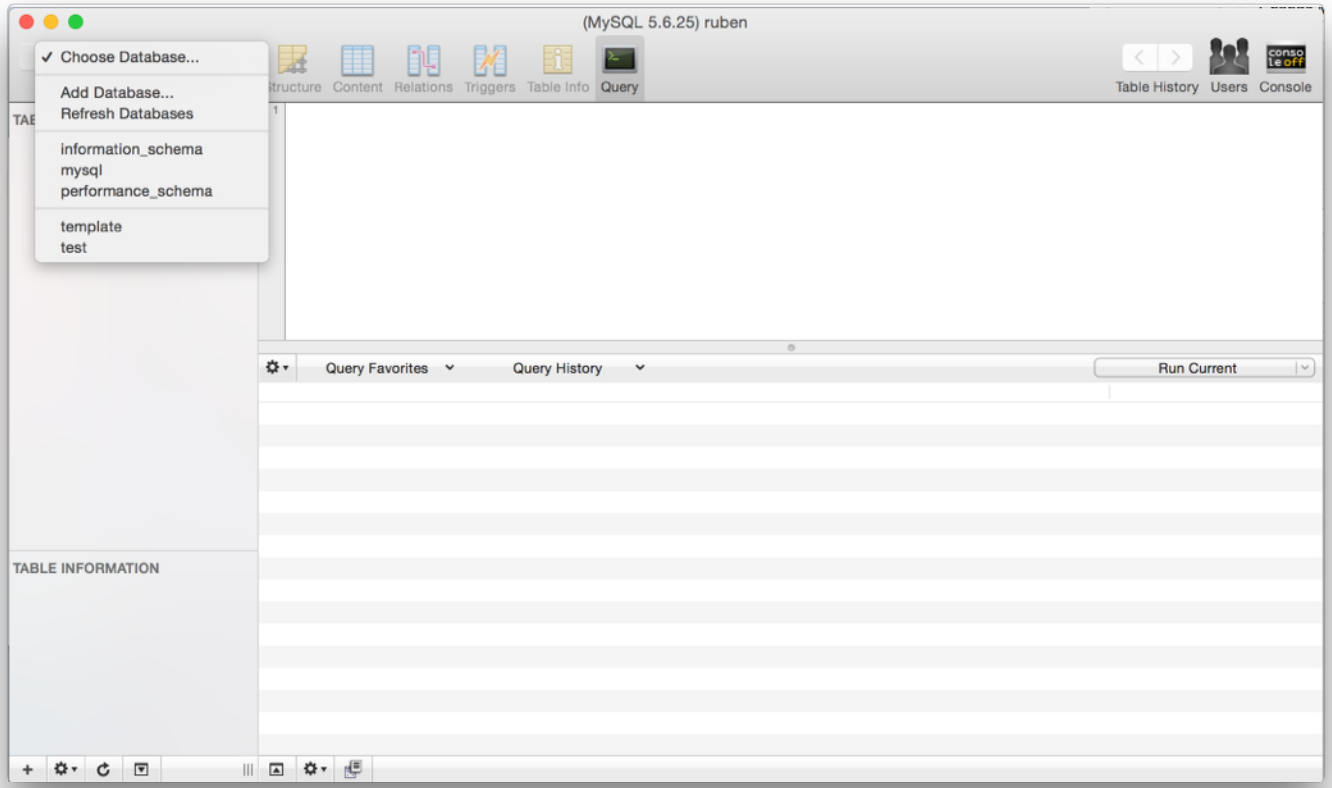
DROP TABLE users

DROP TABLE IF EXISTS users

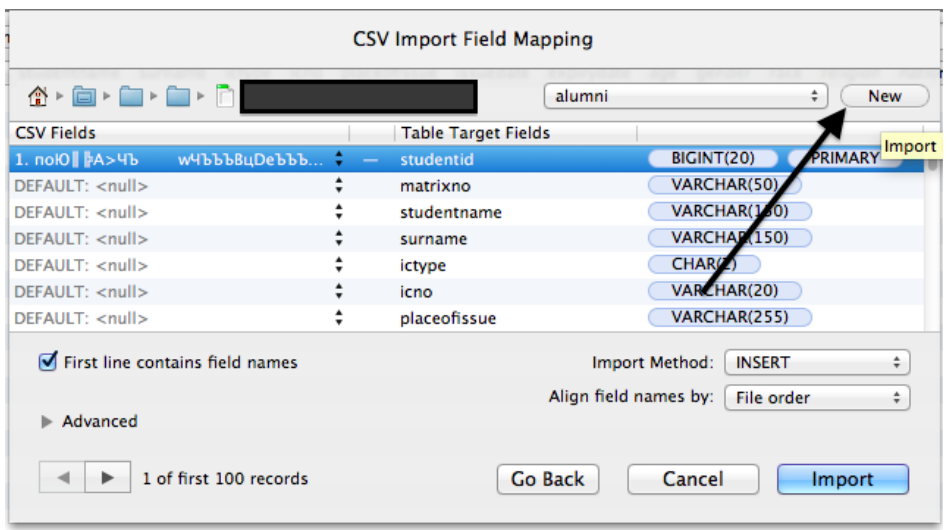
Let's practice!

USING A FANCY CLIENT
SEQUELPRO & SQLYOG


Sequel Pro
Choose Database...
Select Database
Structure
Content
Relations
Triggers
Table Info
Query
Table History
Users
Console
QUICK CONNECT
FAVORITES
ruben
Enter connection details below, or choose a favorite
Standard
Socket
SSH
Name: ruben
Host: 127.0.0.1
Username: root
Password:
Database: optional
Port: 3306
Connect using SSL
Connect


(MySQL 5.6.25) ruben
Choose Database...
Add Database...
Refresh Databases
information_schema
mysql
performance_schema
template
test
Content
Relations
Triggers
Table Info
Query
Table History
Users
Console
Query Favorites
Query History
Run Current
TABLE INFORMATION

- Click **File | Import** and select a data file to import
- Check or uncheck box **First line contains field names**
- Click **New** if the file is a new table (not part of an existing one)



THANK YOU