

Software Engineering in the Arts and Humanities

SQL

September 30, 2019

This Time

- Databases
- SQL



File Home Insert Draw Page Layout Formulas Data Review View Help Search

Paste

Clipboard

Font

Alignment

Number

Conditional Formatting

Format as Table

Cell Styles

Styles

Cells

Editing

Ideas

Ideas

E6 *fx*

| | A | B | C | D | E | F | G |
|----|----------|-------------|----------|---|---|---|---|
| 1 | origin | destination | duration | | | | |
| 2 | New York | London | 415 | | | | |
| 3 | Shanghai | Paris | 760 | | | | |
| 4 | Istanbul | Tokyo | 700 | | | | |
| 5 | New York | Paris | 435 | | | | |
| 6 | Moscow | Paris | 245 | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |

flights





File Home Insert Draw Page Layout Formulas Data Review View Help Search

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|----|----------|-------------|----------|---|---|---|---|
| 1 | origin | destination | duration | | | | |
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| 6 | Moscow | Paris | 245 | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |

flights



File Home Insert Draw Page Layout Formulas Data Review View Help Search

Clipboard: Paste, Font, Alignment, Number, Styles: Conditional Formatting, Format as Table, Cell Styles, Cells, Editing, Ideas

E6 fx

| | A | B | C | D | E | F | G |
|----|----------|-------------|----------|---|---|---|---|
| 1 | origin | destination | duration | | | | |
| 2 | New York | London | 415 | | | | |
| 3 | Shanghai | Paris | 760 | | | | |
| 4 | Istanbul | Tokyo | 700 | | | | |
| 5 | New York | Paris | 435 | | | | |
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| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |

flights



File Home Insert Draw Page Layout Formulas Data Review View Help Search

Paste
Clipboard

A
Font

Alignment

%
Number

Conditional Formatting
 Format as Table
 Cell Styles
Styles

Cells

Editing

Ideas
Ideas

E6 *fx*

| | A | B | C | D | E | F | G |
|----|----------|-------------|----------|---|---|---|---|
| 1 | origin | destination | duration | | | | |
| 2 | New York | London | 415 | | | | |
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| 4 | Istanbul | Tokyo | 700 | | | | |
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| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |

flights



| origin | destination | duration |
|-----------------|--------------------|-----------------|
| New York | London | 415 |
| Shanghai | Paris | 760 |
| Istanbul | Tokyo | 700 |
| New York | Paris | 435 |
| Moscow | Paris | 245 |

SQL

SQLite

SQLite

SQLite

sqlite3

```
npm install sqlite3
```

DB Browser

SQLite Type Affinities

- INTEGER
- REAL
- TEXT
- BLOB
- NUMERIC

SQLite Type Affinities

- INTEGER
 - INT, TINYINT, BIGINT...
- REAL
 - FLOAT, REAL, DOUBLE...
- TEXT
 - CHAR, VARCHAR, TEXT...
- BLOB
- NUMERIC
 - DECIMAL, BOOLEAN, DATETIME...

CRUD

Create
Retrieve
Uppdate
Delete

Create
Retrieve
Update
Delete

Create a Table

```
CREATE TABLE <table> (  
    <colname1> <coltype1> (<attributes>),  
    <colname2> <coltype2> (<attributes>),  
    <colname3> <coltype3> (<attributes>),  
    ...  
);
```

| origin | destination | duration |
|-----------------|--------------------|-----------------|
| New York | London | 415 |
| Shanghai | Paris | 760 |
| Istanbul | Tokyo | 700 |
| New York | Paris | 435 |
| Moscow | Paris | 245 |

| origin | destination | duration |
|-----------------|--------------------|-----------------|
| New York | London | 415 |
| Shanghai | Paris | 760 |
| Istanbul | Tokyo | 700 |
| New York | Paris | 435 |
| Moscow | Paris | 245 |

TEXT

TEXT

INTEGER

| origin | destination | duration |
|-----------------|--------------------|-----------------|
| New York | London | 415 |
| Shanghai | Paris | 760 |
| Istanbul | Tokyo | 700 |
| New York | Paris | 435 |
| Moscow | Paris | 245 |

```
CREATE TABLE flights (  
    id INTEGER PRIMARY KEY AUTOINCREMENT,  
    origin TEXT NOT NULL,  
    destination TEXT NOT NULL,  
    duration INTEGER NOT NULL  
);
```

```
CREATE TABLE flights (  
    id INTEGER PRIMARY KEY AUTOINCREMENT,  
    origin TEXT NOT NULL,  
    destination TEXT NOT NULL,  
    duration INTEGER NOT NULL  
);
```

```
CREATE TABLE flights (  
    id INTEGER PRIMARY KEY AUTOINCREMENT,  
    origin TEXT NOT NULL,  
    destination TEXT NOT NULL,  
    duration INTEGER NOT NULL  
);
```



```
CREATE TABLE flights (  
    id INTEGER PRIMARY KEY AUTOINCREMENT,  
    origin TEXT NOT NULL,  
    destination TEXT NOT NULL,  
    duration INTEGER NOT NULL  
);
```

```
CREATE TABLE flights (  
    id INTEGER PRIMARY KEY AUTOINCREMENT,  
    origin TEXT NOT NULL,  
    destination TEXT NOT NULL,  
    duration INTEGER NOT NULL  
);
```

```
CREATE TABLE flights (  
    id INTEGER PRIMARY KEY AUTOINCREMENT,  
    origin TEXT NOT NULL,  
    destination TEXT NOT NULL,  
    duration INTEGER NOT NULL  
);
```

Attributes (aka Constraints)

- NOT NULL
- UNIQUE
- PRIMARY KEY
- DEFAULT
- INDEX
- CHECK
- ...

Attributes (aka Constraints)

- NOT NULL
- UNIQUE
- PRIMARY KEY
- DEFAULT
- INDEX
- CHECK
- ...

Attributes (aka Constraints)

- NOT NULL
- UNIQUE
- PRIMARY KEY
- **DEFAULT**
- INDEX
- CHECK
- ...

Attributes (aka Constraints)

- NOT NULL
- UNIQUE
- PRIMARY KEY
- DEFAULT
- **INDEX**
- CHECK
- ...

Insert New Data


```
INSERT INTO <table>
(<col1>, <col2>, ... )
VALUES
(<val1>, <val2>, ... );
```

```
INSERT INTO flights
(origin, destination, duration)
VALUES
('Lima', 'New York', 455);
```

```
INSERT INTO flights
(origin, destination, duration)
VALUES
('Lima', 'New York', 455);
```

```
INSERT INTO flights
(origin, destination, duration)
VALUES
('Lima', 'New York', 455);
```

```
INSERT INTO flights
(origin, destination, duration)
VALUES
('Lima', 'New York', 455);
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```

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(origin, destination, duration)
VALUES
('Lima', 'New York', 455);
```

```
INSERT INTO flights
(origin, destination, duration)
VALUES
('Lima', 'New York', 455);
```


| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

Create
Retrieve
Update
Delete

Selecting Data

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights;
```

| id | origin | destination | duration |
|----|----------|-------------|----------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |


```
SELECT origin, destination FROM flights;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT origin, destination FROM flights;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights WHERE id = 3;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights WHERE id = 3;
```

| id | origin | destination | duration |
|----|----------|-------------|----------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights WHERE id = 3;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights WHERE origin = 'New York';
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights WHERE origin = 'New York';
```

| id | origin | destination | duration |
|----|----------|-------------|----------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights WHERE duration > 500;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |


```
SELECT * FROM flights WHERE duration > 500;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE destination = 'Paris' AND duration > 500;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE destination = 'Paris' AND duration > 500;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE destination = 'Paris' OR duration > 500;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE destination = 'Paris' OR duration > 500;
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE origin IN ('New York', 'Lima');
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE origin IN ('New York', 'Lima');
```

| id | origin | destination | duration |
|----|----------|-------------|----------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE origin IN ('New York', 'Lima');
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |


```
SELECT * FROM flights
WHERE origin LIKE '%a%';
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE origin LIKE '%a%';
```

| id | origin | destination | duration |
|----|----------|-------------|----------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE origin LIKE '%a%';
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

```
SELECT * FROM flights
WHERE origin LIKE '%a%';
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

Some Useful SQL Functions

- SUM
- COUNT
- MIN
- MAX
- AVG
- ...

Helpful Selector Clauses

- LIMIT
- ORDER BY
- GROUP BY
- HAVING
- ...

Create
Retrieve
Update
Delete

Updating Data


```
UPDATE <table>  
SET <col> = <val>  
WHERE <condition>;
```

```
UPDATE flights
SET duration = 440
WHERE origin = 'New York'
AND destination = 'London';
```

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 440 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

Create
Retrieve
Update
Delete

Deleting Data

```
DELETE FROM <table>  
WHERE <condition>;
```

```
DELETE FROM flights  
WHERE destination = 'Tokyo';
```


| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 440 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 440 |
| 2 | Shanghai | Paris | 760 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

Foreign Keys

flights

| id | origin | destination | duration |
|----|----------|-------------|----------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

flights

| id | origin | orig_code | destination | dest_code | duration |
|-----------|-----------------|------------------|--------------------|------------------|-----------------|
| 1 | New York | JFK | London | LHR | 415 |
| 2 | Shanghai | PVG | Paris | CDG | 760 |
| 3 | Istanbul | IST | Tokyo | NRT | 700 |
| 4 | New York | JFK | Paris | CDG | 435 |
| 5 | Moscow | SVO | Paris | CDG | 245 |
| 6 | Lima | LIM | New York | JFK | 455 |

locations

| id | name | code |
|-----------|-----------------|-------------|
| 1 | New York | JFK |
| 2 | Shanghai | PVG |
| 3 | Istanbul | IST |
| 4 | London | LHR |
| 5 | Moscow | SVO |
| 6 | Lima | LIM |
| 7 | Paris | CDG |
| 8 | Tokyo | NRT |

flights

| id | origin | destination | duration |
|-----------|-----------------|--------------------|-----------------|
| 1 | New York | London | 415 |
| 2 | Shanghai | Paris | 760 |
| 3 | Istanbul | Tokyo | 700 |
| 4 | New York | Paris | 435 |
| 5 | Moscow | Paris | 245 |
| 6 | Lima | New York | 455 |

flights

| id | orig_id | dest_id | duration |
|-----------|----------------|----------------|-----------------|
| 1 | 1 | 4 | 415 |
| 2 | 2 | 7 | 760 |
| 3 | 3 | 8 | 700 |
| 4 | 1 | 7 | 435 |
| 5 | 5 | 7 | 245 |
| 6 | 6 | 1 | 455 |

locations

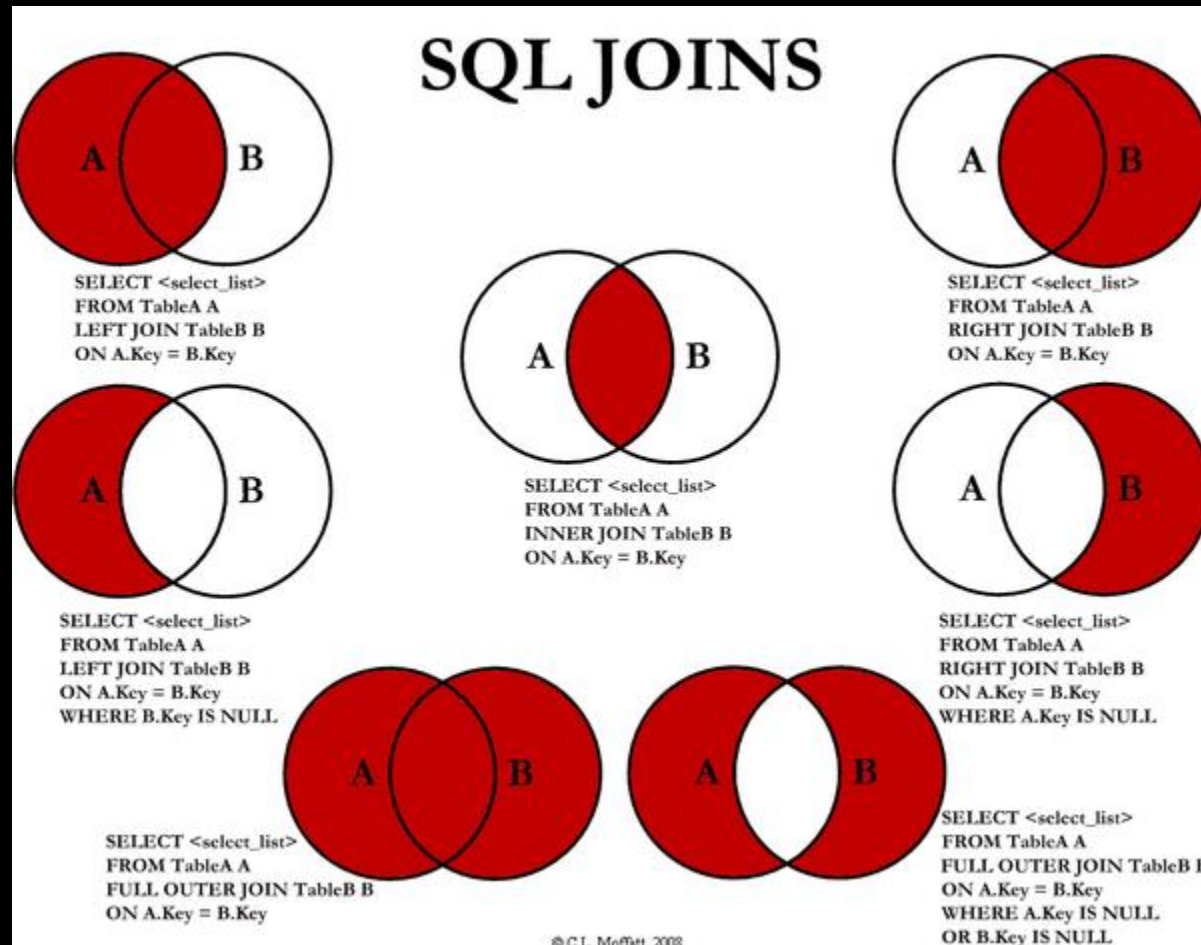
| id | name | code |
|-----------|-----------------|-------------|
| 1 | New York | JFK |
| 2 | Shanghai | PVG |
| 3 | Istanbul | IST |
| 4 | London | LHR |
| 5 | Moscow | SVO |
| 6 | Lima | LIM |
| 7 | Paris | CDG |
| 8 | Tokyo | NRT |

Joining Tables

Types of Joins

- JOIN (aka INNER JOIN)
- LEFT JOIN (aka LEFT OUTER JOIN)
- RIGHT JOIN (aka RIGHT OUTER JOIN)
- FULL OUTER JOIN

Types of Joins



Injection Attacks

HI, THIS IS YOUR SON'S SCHOOL. WE'RE HAVING SOME COMPUTER TROUBLE.



OH, DEAR - DID HE BREAK SOMETHING?
IN A WAY -)



DID YOU REALLY NAME YOUR SON Robert'); DROP TABLE Students;-- ?



OH, YES. LITTLE BOBBY TABLES, WE CALL HIM.

WELL, WE'VE LOST THIS YEAR'S STUDENT RECORDS. I HOPE YOU'RE HAPPY.



AND I HOPE YOU'VE LEARNED TO SANITIZE YOUR DATABASE INPUTS.

Username

Enter Username

Password

Enter Password

Login

```
SELECT * FROM users  
WHERE (username = uname)  
AND (password = pword)
```


Username

milo

Password

puppy

Login

```
SELECT * FROM users  
WHERE (username = uname)  
AND (password = pword)
```

```
SELECT * FROM users  
WHERE (username = 'milo')  
AND (password = 'puppy')
```

Username

hacker

Password

1' OR '1' = '1

Login

```
SELECT * FROM users
WHERE (username = uname)
AND (password = pword)
```

```
SELECT * FROM users
WHERE (username = 'hacker')
AND (password = '1' OR '1' = '1')
```

```
SELECT * FROM users
WHERE (username = 'hacker')
AND (password = '1' OR '1' = '1')
```

```
SELECT * FROM users
WHERE (username = 'hacker')
AND (password = '1' OR '1' = '1')
```



```
SELECT * FROM users
WHERE (username = 'hacker')
AND (password = '1' OR '1' = '1')
```

```
db.run(sql,  
      params,  
      (err, row) => {  
        // do something  
      });
```

```
db.run(sql,  
      params,  
      (err, row) => {  
        // do something  
      });
```

Race Conditions

Race Conditions

BANK ACCOUNT


**Doug Lloyd
Acct #27**

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```



BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```

BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```



BANK ACCOUNT

**Doug Lloyd
Acct #27**

Balance

\$0.00

Race Conditions

BANK ACCOUNT


**Doug Lloyd
Acct #27**

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```



BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

```
SELECT balance FROM bank WHERE  
acct = 27;
```

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```

BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$100.00

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```



BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$0.00

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```



BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

\$0.00

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```

Race Conditions

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```



BANK ACCOUNT

Doug Lloyd
Acct #27

Balance

-\$100.00

```
SELECT balance FROM bank WHERE  
acct = 27;
```

100.00

```
UPDATE bank  
SET balance = balance - 100  
WHERE acct = 27
```



Transactions

- BEGIN TRANSACTION
- COMMIT

- Note though that SQLite generally operates in an auto-commit mode.

Exercises

- Download youtunes.db from the course website.
- Download and install DB Browser for SQLite from the course website, if you haven't already.
- With a partner, if you'd like, and working within DB Browser (or indirectly sending your queries via Node, if you really want!), work through the five practice exercises linked on the course site.