



I have
connections

Common
problems

SQLite3

DB Browser

Automation/AI
traction

NoSQL

Mongo

Neo4J

Introduction to Database Systems: CS312

The Great Summary

Oliver Bonham-Carter

30 Nov 2020

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Notable dates

- **Status Update Due:** Wednesday, 2nd December 2020, 11:59pm. The file writing/statusUpdate.md will contain your writing about the following details. This work will cover about half a page.
- **Final Project Due:** Due on Monday, 11th December, by 9am. The file writing/report.md will contain the written portion of your deliverable. Your report is to contain the above-mentioned details and items. See the above discussion for details of the content. You will submit all work using GitHub where you have placed all relevant files and with the report.
- **GitHub Project Repository:**

<https://classroom.github.com/a/SMTIG73x>

What has this class covered?

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- Some of the fundamental theory and methods behind modern databases systems
 - SQL: *Sqlite3, DBBrowser*
 - NoSQL: *Mongo,*
 - Graphical: *Neo4J*
- Building schemas with integrity constraints for data management
- Manipulating data, populating bases and extracting out filtered information
- Programming queries across all DB systems
- Management and Automation: Programming for abstraction
- How to pull information (knowledge) from raw data

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What is the function of a database?

To Connect Data

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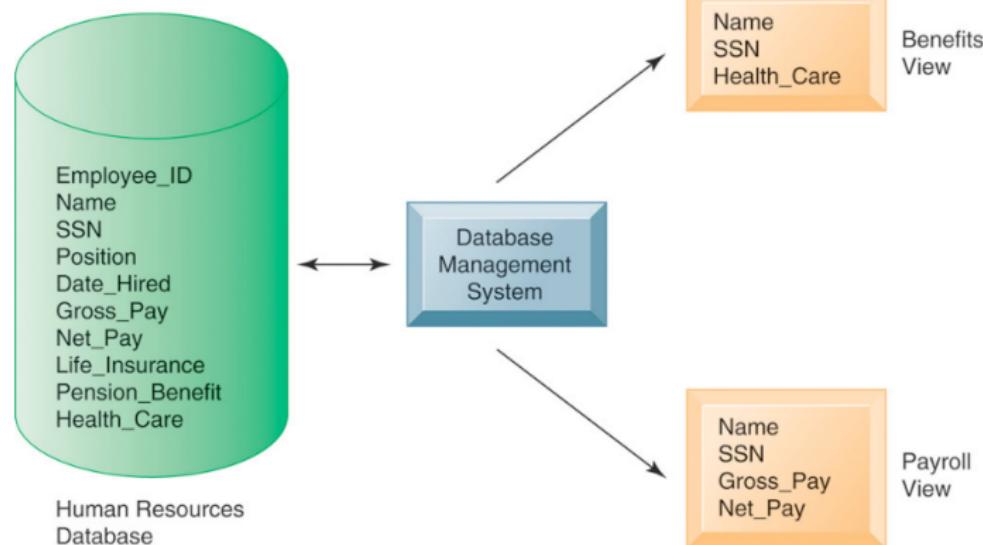
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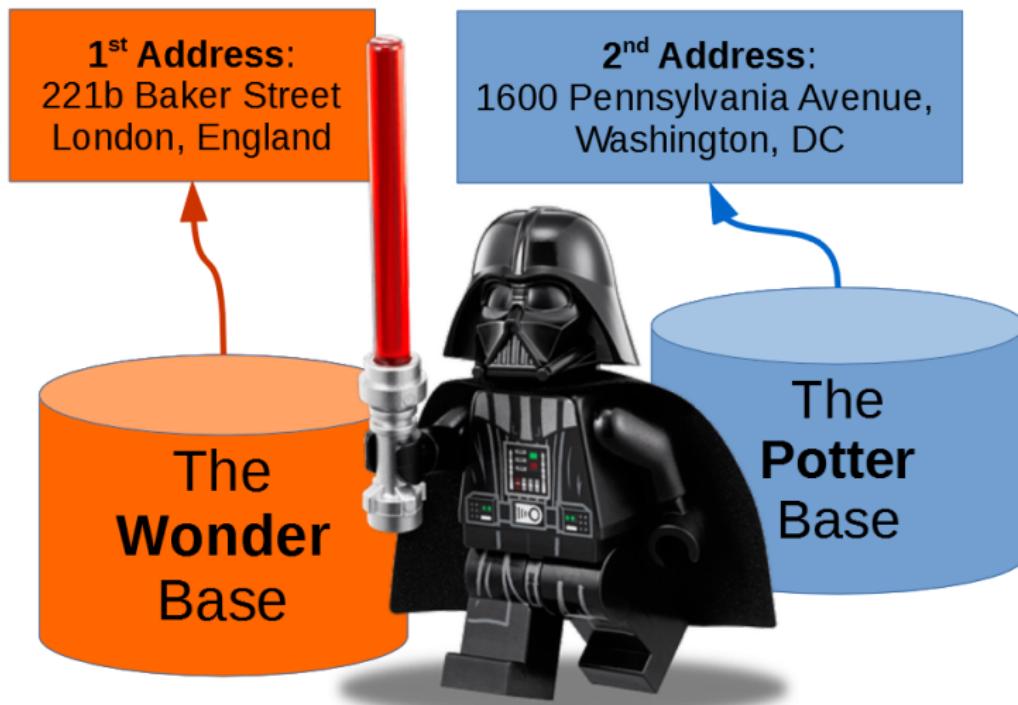
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Dr. Vader's actual address?



How Many Databases Do You Need??

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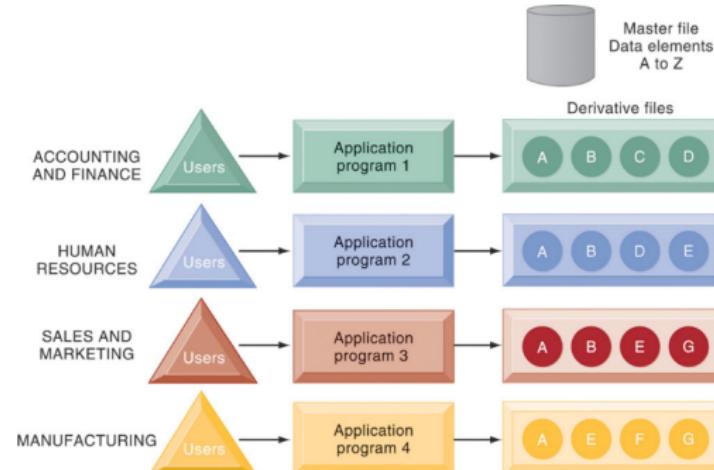
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- A firm may have managed several information sources at the same time
- Anything wrong with disconnecting databases?



Specific Information For Each Table

Combine and connect the data in one base

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ID	name	dept_name	salary
22222	Einstein	Physics	95000
12121	Wu	Finance	90000
32343	El Said	History	60000
45565	Katz	Comp. Sci.	75000
98345	Kim	Elec. Eng.	80000
76766	Crick	Biology	72000
10101	Srinivasan	Comp. Sci.	65000
58583	Califieri	History	62000
83821	Brandt	Comp. Sci.	92000
15151	Mozart	Music	40000
33456	Gold	Physics	87000
76543	Singh	Finance	80000

(a) The *instructor* table

dept_name	building	budget
Comp. Sci.	Taylor	100000
Biology	Watson	90000
Elec. Eng.	Taylor	85000
Music	Packard	80000
Finance	Painter	120000
History	Painter	50000
Physics	Watson	70000

(b) The *department* table

- Specific tables for types of data

SQL Is So Very ...



- Pronounced “ess-que-el” stands for *Structured Query Language*.
- Used to communicate with a database.
- According to ANSI (American National Standards Institute), it is the standard language for relational database management systems.
- The standard computer language for relational database management and data manipulation.
 - Used to query, insert, update and modify data



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Schema
Keys
Create and Link
Tables

CSV files

SELECT

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Command

\$sqlite3

You should see this

SQLite version 3.11.0 2016-02-15 17:29:24

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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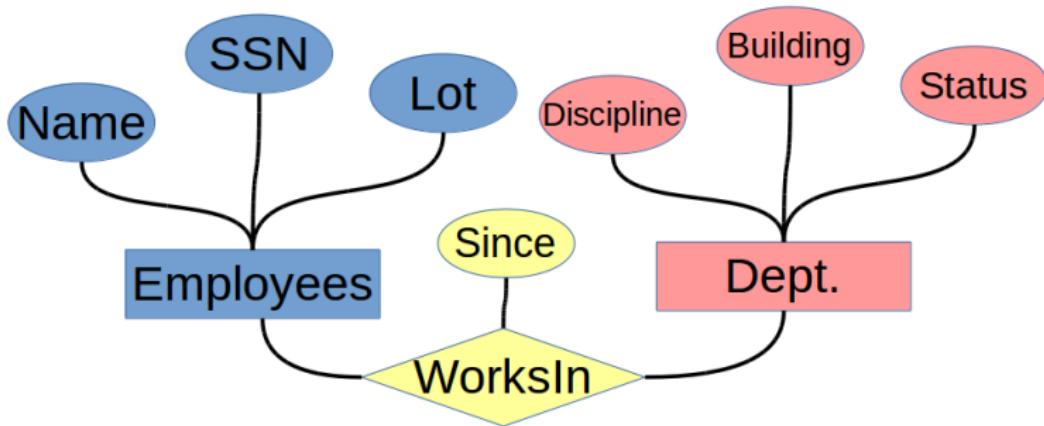
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- A schema resembles a subroutine and describes the table and the data that it contains.
- Relationship: An association among two or more entities
- Relationship Set: A collection of similar relationships for entities
- Relationship sets can also have *descriptive attributes* (i.e., the “since” attribute of *WorksIn*)

Chinook's Database Schema

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- Schema
- Keys
- Create and Link Tables
- CSV files
- SELECT
- Integrity Constraints

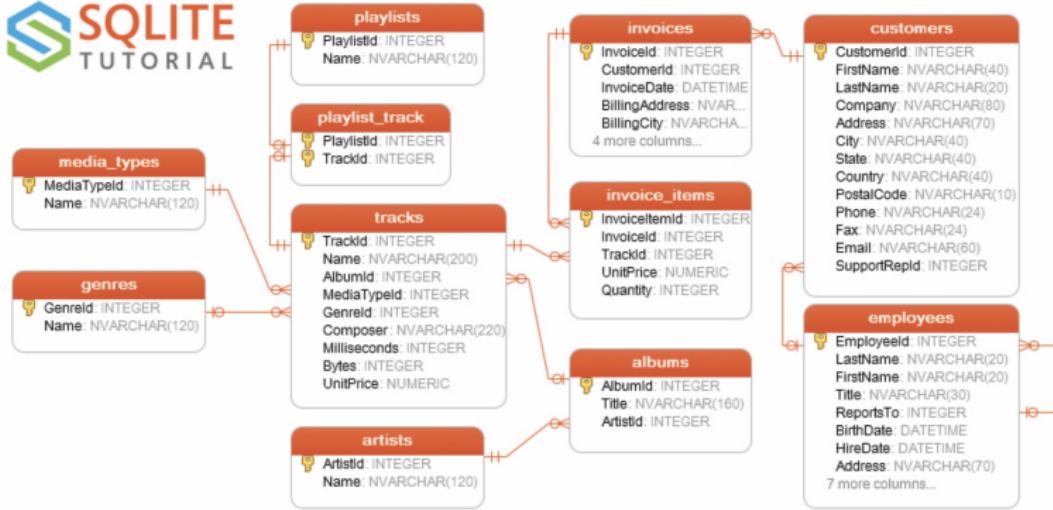
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- Ref: <http://www.sqlitetutorial.net/sqlite-sample-database/>

Entity sets

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Neo4J

ID	Tea	Sandwich
JJ	1	Ruban
OBC	1	PBJ
AM	1	Chicken
GK	1	Chicken
JJ	1	Ruban
DW	0	PBJ
MC	1	Ruban
JJ	1	Ruban
SR	1	Ruban
JJ	1	Ruban
KT	1	Ruban

- **Entity set:** a collection of entities of the same kind
 - (i.e., the preferred sandwiches.)
- Strong Entity sets: Each row is unique in the table.

Keys for SQL

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- **Primary keys:** Unique identifiers for the row of information sharing a relation (n -tuple).
- **Super keys:** A superkey is a set of attributes within a table whose values can be used to uniquely identify a n -tuple.
- **Candidate keys:** is a minimal set of attributes necessary to identify a n -tuple.
- **SuperKeys:** a set of attributes within a table whose values can be used to uniquely identify a tuple (each row is unique from the other rows)

Keys

You will note the importance of keys once you start storing your data in your own databases!

Linking the tables by queries

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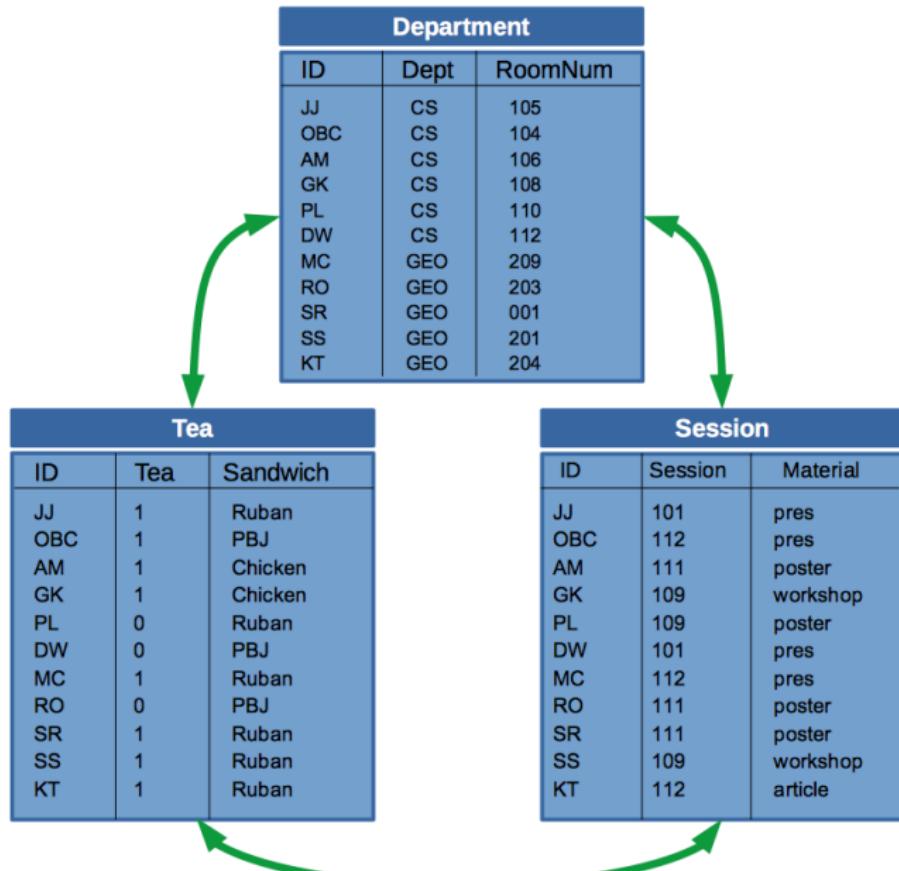
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Putting Data into CSV format

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- Data as Comma-Separated Values

Making files of CSV's (Comma-separated values)...?

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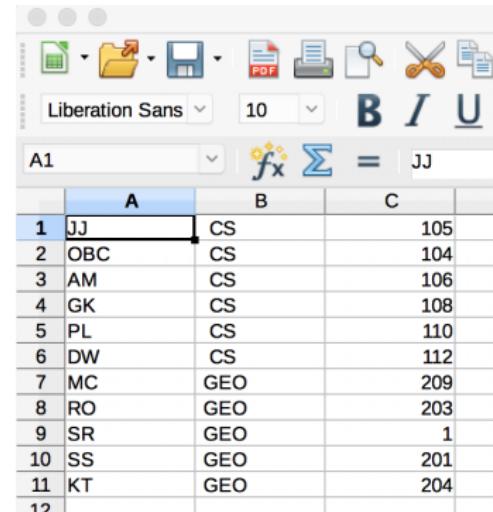
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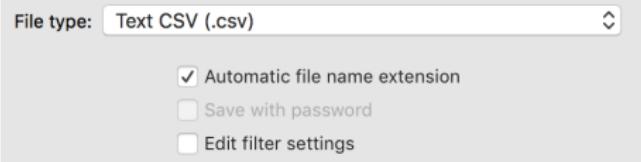
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	A	B	C
1	JJ	CS	105
2	OBC	CS	104
3	AM	CS	106
4	GK	CS	108
5	PL	CS	110
6	DW	CS	112
7	MC	GEO	209
8	RO	GEO	203
9	SR	GEO	1
10	SS	GEO	201
11	KT	GEO	204
12			



Making files of CSV's (Comma-separated values)...?

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JJ,CS,105
OBC,CS,104
AM,CS,106
GK,CS,108
PL,CS,110
DW,CS,112
MC,GEO,209
RO,GEO,203
SR,GEO,001
SS,GEO,201
KT,GEO,204

JJ,1,Ruban
OBC,1,PBJ
AM,1,Chicken
GK,1,Chicken
PL,0,Ruban
DW,0,PBJ
MC,1,Ruban
RO,0,PBJ
SR,1,Ruban
SS,1,Ruban
KT,1,Ruban

JJ,101,pres
OBC,112,pres
AM,111,poster
GK,109,workshop
PL,109,poster
DW,101,pres
MC,112,pres
RO,111,poster
SR,111,poster
SS,109,workshop
KT,112,article

- Tables: *department, tea, session*
- Once your file is in this CSV format, it can be easily loaded into the database

The **select** Clause

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The SELECT clause filters out particular data from a table.

- SQL allows duplicates in relations as well as in query results.
- The SELECT statement has many optional clauses:
 - WHERE specifies which rows to retrieve.
 - GROUP BY groups rows sharing a property so that an aggregate function can be applied to each group.
 - HAVING selects among the groups defined by the GROUP BY clause.
 - ORDER BY specifies an order in which to return the rows.
 - AS provides an alias which can be used to temporarily rename tables or columns..



Given table 'T'

SELECT

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SELECT

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Table "T"	Query	Result												
<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>1</td><td>a</td></tr><tr><td>2</td><td>b</td></tr></tbody></table>	C1	C2	1	a	2	b	<code>SELECT * FROM T;</code>	<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>1</td><td>a</td></tr><tr><td>2</td><td>b</td></tr></tbody></table>	C1	C2	1	a	2	b
C1	C2													
1	a													
2	b													
C1	C2													
1	a													
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<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>1</td><td>a</td></tr><tr><td>2</td><td>b</td></tr></tbody></table>	C1	C2	1	a	2	b	<code>SELECT C1 FROM T;</code>	<table border="1"><thead><tr><th>C1</th></tr></thead><tbody><tr><td>1</td></tr><tr><td>2</td></tr></tbody></table>	C1	1	2			
C1	C2													
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C1														
1														
2														
<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>1</td><td>a</td></tr><tr><td>2</td><td>b</td></tr></tbody></table>	C1	C2	1	a	2	b	<code>SELECT * FROM T WHERE C1 = 1;</code>	<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>1</td><td>a</td></tr></tbody></table>	C1	C2	1	a		
C1	C2													
1	a													
2	b													
C1	C2													
1	a													
<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>1</td><td>a</td></tr><tr><td>2</td><td>b</td></tr></tbody></table>	C1	C2	1	a	2	b	<code>SELECT * FROM T ORDER BY C1 DESC;</code>	<table border="1"><thead><tr><th>C1</th><th>C2</th></tr></thead><tbody><tr><td>2</td><td>b</td></tr><tr><td>1</td><td>a</td></tr></tbody></table>	C1	C2	2	b	1	a
C1	C2													
1	a													
2	b													
C1	C2													
2	b													
1	a													

Integrity Constraints

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- The CONSTRAINTS are an integrity which defines some conditions that restrict the column to contain the true data while inserting or updating or deleting.
- Integrity constraints provide a mechanism for ensuring that data conforms to guidelines specified by the database administrator. The most common types of constraints include:
 - UNIQUE constraints: To ensure that a given column is unique
 - NOT NULL constraints: To ensure that no null values are allowed
 - FOREIGN KEY constraints: To ensure that two keys share a primary key to foreign key relationship
 - Ensure that a link exists between two tables.

One to many relationships

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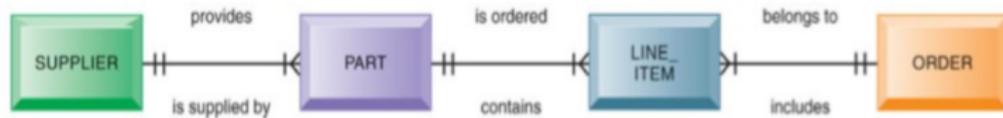
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Each person has
many fingers,
But each finger belongs
to only one person.

FIGURE 6-11 AN ENTITY-RELATIONSHIP DIAGRAM



DB Browser

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DB Browser

Joins

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SQLite Database Browser – /Users/jc/tmp/example.db

New Database Open Database Write Changes Revert Changes

Database Structure Browse Data Edit Pragmas Execute SQL

Table: total_members New Record Delete Record

	list	month	members
1	gluster-board	2013-09-05	99999
2	gluster-users	2013-09-05	99999

< 1 – 2 of 12 > Go to: 1

SQL Log

Show SQL submitted by Application Clear

```
PRAGMA foreign_keys = "1";
PRAGMA encoding
SELECT type, name, sql, tbl_name FROM sqlite_master;
SELECT COUNT(*) FROM (SELECT rowid,* FROM `total_members` ORDER BY `rowid` ASC);
SELECT rowid,* FROM `total_members` ORDER BY `rowid` ASC LIMIT 0, 50000;
```

UTF-8

Joins

CROSS JOIN: Cartesian Products

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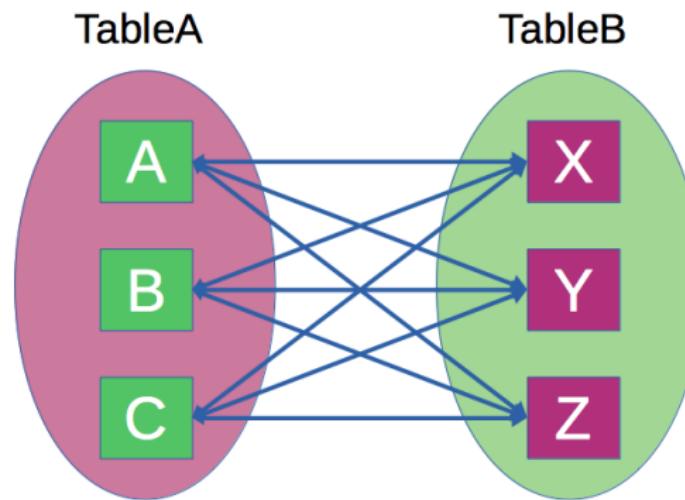
Joins

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SELECT * FROM tableA CROSS JOIN tableB

```
SELECT * from TableA CROSS JOIN TableB;  
SELECT * from tableA, TableB;
```

Joins with SQL code

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Joins

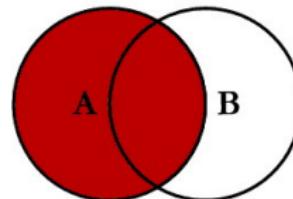
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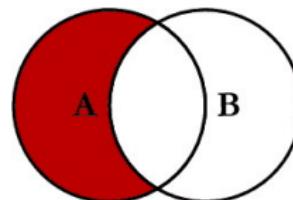
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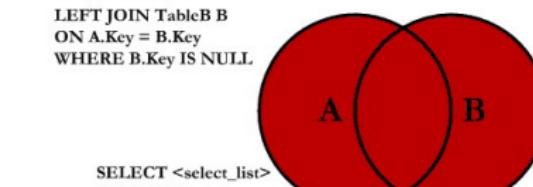
SQL JOINS



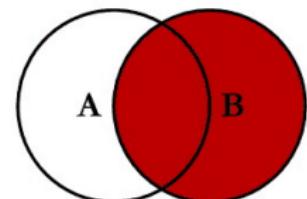
```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
ON A.Key = B.Key
```



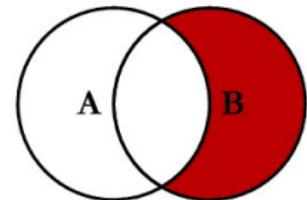
```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
ON A.Key = B.Key
WHERE B.Key IS NULL
```



```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
ON A.Key = B.Key
```



```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
ON A.Key = B.Key
```



```
SELECT <select_list>
FROM TableA A
INNER JOIN TableB B
ON A.Key = B.Key
```

```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
ON A.Key = B.Key
WHERE A.Key IS NULL.
```



```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
ON A.Key = B.Key
WHERE A.Key IS NULL
OR B.Key IS NULL
```





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Five basic steps to using a database according to the Python Database API Specification v2.0

- Step 1: Defining the query
- Step 2: Connecting to the database
- Step 3: Execute the query
- Step 4i, (SELECT): Analyze the result
- Step 4ii, or (UPDATE): Commit the change
- Step 5: Cleaning up; close the database connection



Where is the Database?

Computers use DBs

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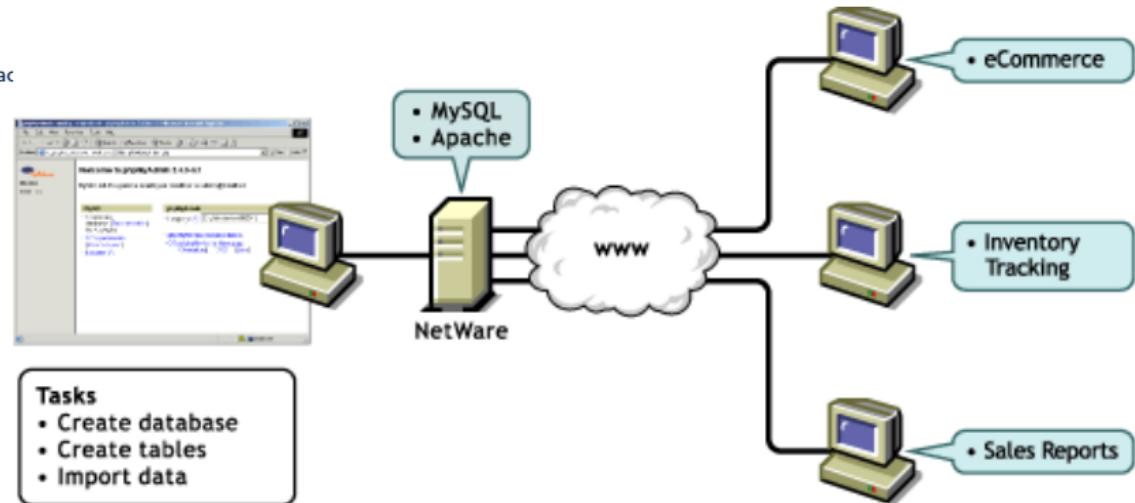
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Django

An easy-to-create web site and online database server

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- Putting a database on a website!
- <https://www.djangoproject.com/>

Yes! Your Django Project Worked!

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The install worked successfully! Congratulations!

You are seeing this page because `DEBUG=True` is in
your settings file and you have not configured any
URLs.

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Notable Files

- **apps.py**: The main file for the *hello* App
- **models.py**: A blueprint for how data will be used in the site
- **tests.py**: For adding tests for bug checking the *hello* part of the project
- **views.py**: A request-handler for connecting the URL to the displayed website
- **mysite/mysite/urls.py**: Requests for apps are all directed using this file.
- **mysite/hello/urls.py**: Requests for the *hello* apps are all directed using this file.

NoSQL: Another Type of Database

"Not only SQL" (so much more to offer!)

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Key-value



Graph database



Document-oriented



Column family



- Different types of NoSQL databases



A NoSQL Database Management System (SQLite3 cannot operate here.)

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Schema

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mongoDB®

- <https://www.mongodb.com/>

Schema Free

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Schema

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Collection

- No pre-defined data schema
 - Data may be entered at in absence of a defined schema
 - Every document in a collection could have different data

Databases, Visually

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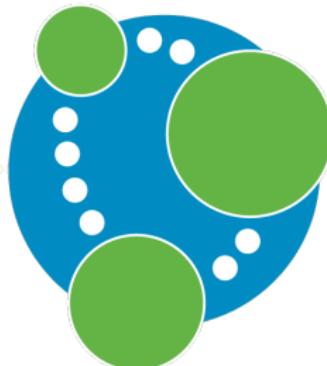
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neo4j

- A visual database system using methods from graph theory to use networks to determine relationships (edges) and discover meaning from connected data-points (nodes). Users are able to interact with the data in a network.

- <https://neo4j.com/>
- Graphgists Projects: <https://neo4j.com/graphgists/>



Networks Of Data

Relationships exist by connectivity

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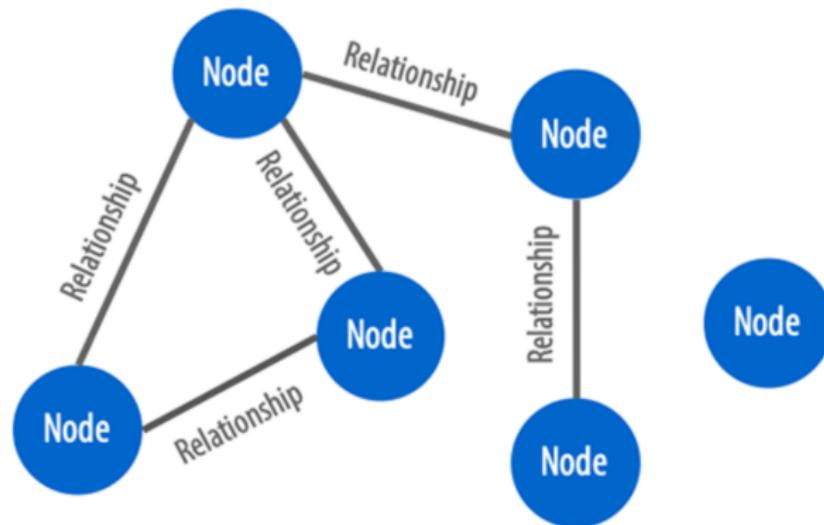
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- Nodes and edges represent inter-relationships
- Relationships are described by connections between nodes
- Single nodes have no immediate relationships with the others

Networks In Neo4J

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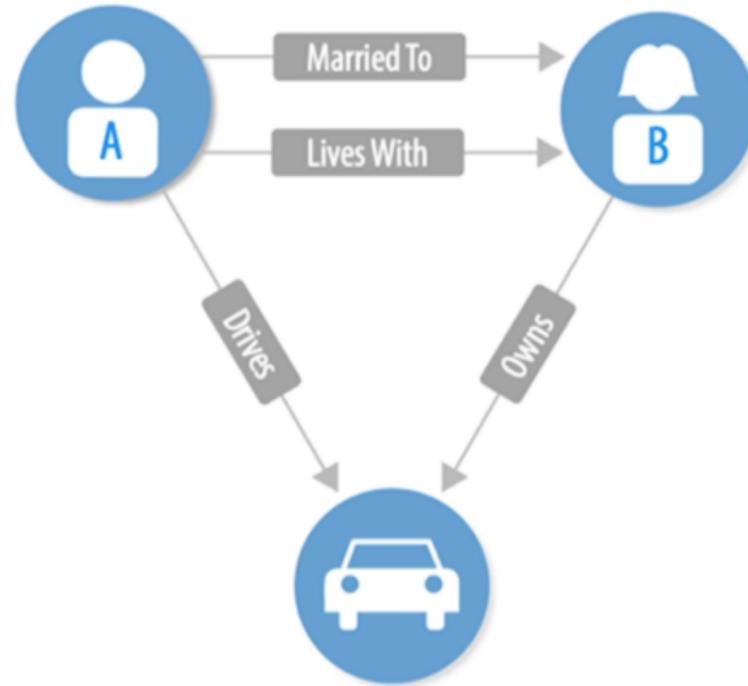
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- An acting schema: The relationships between nodes are built into the network

What Has This Class Covered?

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Common problems

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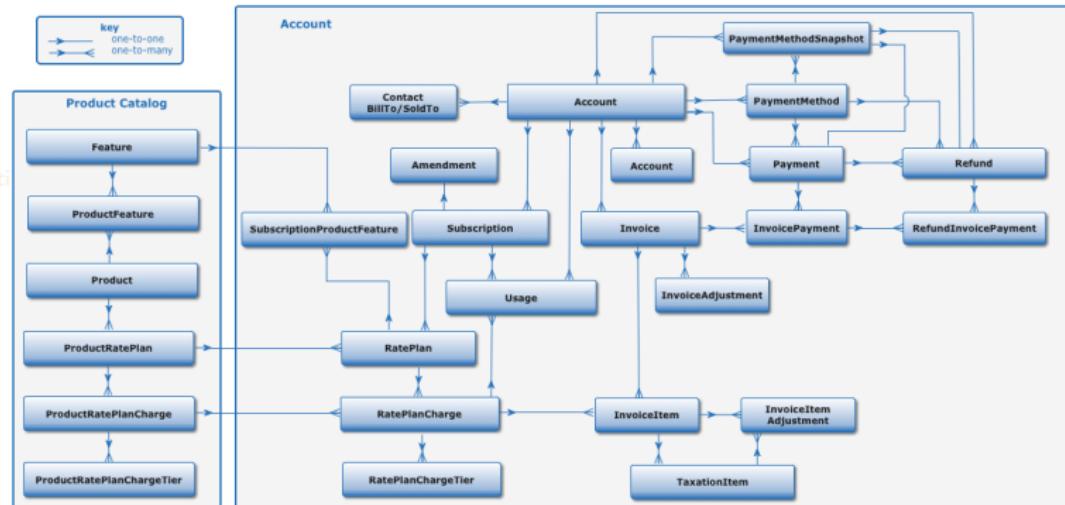
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Automation/AI | Page

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What has this class *not* covered?!

(Now go update the *Skills* section of your resumé!)