

An SQL Beginner Tutorial

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This document aims to give you beginner level knowledge of the following points in databases:

- Learn about relationships
- Learn about views
- Learn about polymorphic relationships
- work with SQLite, MySQL, and PostgreSQL (their differences, and use cases)
- slight talk about other data storage facilities such as Redis, and MongoDB

Approach

We will be going over 2 SQL implementations. One of the implementation is SQLite3. The next implementation we will focus on is PostgreSQL. SQLite3 will be used in the beginning due to its easy configuration with the system. We will be able to disregard other issues, such as database user management, and get at the coding as fast as possible. As stated this is to learn the language, and SQLite3 should not normally be considered as a good database for a system that requires higher concurrency and responsiveness (though please note that it still has valid use cases on other applications)

At the end of the document, we'll briefly talk about other database-like storage alternatives that might be used as well. We will make a distinction however, and emphasize that for the right job, we must choose the right tool.

Minor Forenote

A database contains tables. Tables contain records, often called rows. A database usually contains data of a specific application. Tables represent entities in the domain logic of that application, that require persistence.

For example, a **Person** class could require to have its state persisted. A **Person** class, may aggregate (have many of / have a list of) **Book** classes. On the programming level, these relationships are possible using memory allocation and references to objects. When persisting such relationships, we need to identify the type of relationship (has-one, has-many), and represent them using unique keys, and proper schemas (table structures).

SQLite3

First you'll need to install the database system. Please follow the installation instructions here:

<http://www.sqlite.org/download.html>

Specifically, download the precompiled binaries for windows (sqlite-shell-win32).

If you're on linux, use the package manager specific to your distribution to install sqlite3.

Both of these should provide you with a shell that will allow you to manipulate sqlite3 databases.

Using the shell

When you run the sqlite3 shell, you'll see the following:

```
[psyomn@aeolus ~ 0]$ sqlite3
SQLite version 3.8.1 2013-10-17 12:57:35
Enter ".help" for instructions
Enter SQL statements terminated with a ";"
sqlite>
```

Creating a table

Consider that we want to persist information in a database of people. The information we want to store for each person is their name, surname and their age. If we had a notebook, and we wanted to store this information, we would create a table by separating the page in three parts: name, surname and age. This is what we want to do as well with the table in this database.

```
sqlite3> create table person (
...>   name varchar(50),
...>   surname varchar(50),
...>   age int);
```

Inserting into a table

Run the following provided you have created the required table.

```
sqlite3> insert into person (name,surname,age) values ('jon', 'doe', 18);
```

If you want to enter a list of people in a single command, you can do the following:

```
sqlite3> insert into person (name,surname,age) values
...> ('jon', 'doe', 18),
...> ('jon', 'snow', 32),
...> ('marry', 'spanakopitakis', 21);
```

With the previous code sample, we now have a database that contains the current table:

Name	Surname	Age
jon	doe	18
jon	snow	32
marry	spanakopitakis	21

Selecting from the Table

Naturally, after inserting information to the table, we want to be able to retrieve it. The keyword to memorize for this aspect is *Select*. We need to provide it what fields we are interested from the table, and finally the table name as well. For an example let us select all the surnames and ages from the table *person*.

```
sqlite3> select surname, age from person;
```

But what if we wanted to impose a constraint? For example, let us require that we select the fields *name* and *age* for the person named 'marry'.

```
sqlite3> select name, age from person where name='marry';
```

That is good and all, but problem arises when we have more people being recorded in the system called 'marry'. Then we won't be able to distinguish who is who. This is where keys come into effect, and how specific find queries are usually implemented in *SQL*.

Destroying a Table

Since we want the ability to distinguish between data pairs where we can not rely on the uniqueness of each field, we can assign a key. We call this key an *id*. However we already defined the table *person*. Let's get rid of it, so we can create a new table with the *id* field.

```
sqlite3> drop table person;
```

Now let's recreate the table with the wanted *id*.

```
sqlite3> create table person (  
...>   id integer primary key autoincrement,  
...>   name varchar(50),  
...>   age int);
```

We set the key as an integer, and denote that it is a primary key. We also express the wish of making it automatically increment by adding *autoincrement* in the end. Each time a record is added to this table, an *id* will automatically be assigned to it, by increasing the previous maximum key by one. So for example, if we were to repeat the entries of *jon doe*, *jon snow*, and *marry spanakopitakis*, *jon doe* would have a key with value '1', *jon snow* '2', and *marry* '3'. We can now reference rows properly and form relations using them.

Deleting a row from a table

If we wish to remove an entry from the database table, we can do so by using *delete*. In order to delete something in particular we need to tell *sqlite3* specifically what row. So here we add a *WHERE* clause. Let's take the case that we want to remove the row with *id* '2'. We would need to do the following:

```
delete from person where id = 2;
```

Be cautious when writing this query. If you accidentally forget to add the where clause, and write:

```
delete from person;
```

All the rows will be deleted!

Updating a row in a table

Once we store the information in a row, there might be a situation where somewhere in the future, we wish to update the information. For example, let us consider the following table:

id	Name	Surname	Age
1	Jon	Johnson	23
2	Frank	Frankson	25

Jon came in a few weeks ago, and they entered his information. But the person entering his information did a mistake and instead of typing in '32', they typed in '23'. Jon comes in, and wants to have his proper age on the system.

The query we need to come up with consists of at least the keyword 'update'. However we need to pinpoint where the update will happen exactly. Since we want to update Jon, we need to add a **where** clause on **id = 1**. We need to specify also the columns that we want to modify. We use the keyword **set** for this.

Here is the required query:

```
sqlite3> update person set age=32 where id = 1;
```

Frank Frankson changed his name to Charlie Thawson. He came in in order to update this information. We have to update two columns simultaneously now. We just need to use **set** once, and then separate the columns by comma. And then we're done.

```
sqlite3> update person set name='charlie', surname='thawson' where id = 2;
```

Altering a table

Table alterations are required when we want to change the table schema, while there is still data inside. For example if we did not care about contents in the table, we could *drop* it, and create the new table with the new schema.

Usually the most common alterations that you will have to consider are when you want to add columns to the table. Consider the following schema:

```
sqlite3> create table pet (name varchar(50));
```

Now, we want to add a cuteness rank to the pet, so that we can persist how cute a cat is in comparison with a dog.

```
sqlite> alter table pet add column cuteness_score int;
```

We are now able to assign cute scores to pets!

Constraints

It is possible to impose constraints on information that is to be added to the table. The three commonly used accross most SQL implementations are *unique*, *not null* and *foreign key* constraints. We will talk about *foreign keys* later, as they are a little more involved.

The constraint *not null* as it suggests, requires that added information to a table column is *not null* (eg: you explicitly pass *null*, or you don't provide a value for the column at all).

Not Null Here is an example of using the constraint. We want a person record to require a name in order to be inserted:

```
sqlite> create table person (name varchar(30) not null, age int);
sqlite> insert into table person (name) values ('jon'), ('david');
Error: near "table": syntax error
sqlite> insert into person (name) values ('jon'), ('david');
sqlite> insert into person (name,age) values ('jon',13), ('david', 12);
sqlite> insert into person (age) values (12);
Error: person.name may not be NULL
```

Unique Unique just makes sure that all the values in the given column are *unique*. An example use case for this constraint would be a online forum (like phpbb, and other boards) where the user that is registering, is required to have a unique nickname.

```
sqlite> create table user (email varchar(30),
...> password varchar(30), nickname varchar(30) unique);
sqlite> insert into user (email, password,
...> nickname) values ("someone@somewhere",
...> "mypass", "nick123");
sqlite> insert into user (email, password,
...> nickname) values ("someone@somewhere",
...> "mypass", "nick123");
Error: column nickname is not unique
```

Table Relations

We previously referenced the foreign key constraints. Before talking about those, we want to cover slightly the topic of table relations.

Storing records of data is useful, but often it is not enough. For example we can have a class Person, that aggregates (has a list of) Books. We can store people as records, and Books as well. However we need a way to identify which user's in a table, books belong to. To demonstrate a simple example, think of the following issue: Bob and Joe are two users of the system. They both store books in the system. They forget about the books because it's the weekend, and reading can wait up until monday. When they come back they don't remember which books they own. Luckily they have both written their names inside them, and can find them again, without accidentally taking a book that belongs to someone else.

Writing 'names' in the books is a high level example of what actually happens here: they have given their identity to the book, in order to claim it back later on. By labeling many books this way, they can own many books. In more technical terms, they are *assigning their id* to the *book record*.

This way we can visualize the problem with the two following tables: one for the user base, and the second one for any book that they own.

User Table

id	Name	Age
1	Joe	32
2	Bob	42

Book Table

id	Book Title	user_id
1	Neuromancer	1
2	Wizard of Oz	2
3	Logicomix	1
4	Full Metal Alchemist	1
7	Alice in Wonderland	2

Now for example, if we wanted to find out what books user 'Joe' had left during the weekend, we would first look at Joe's id. Once we have his id, we would use it to search on the 'book' table.

Let us look at the actual code behind this. First we need to create and populate the tables.

```
sqlite> create table users (id integer primary key autoincrement,  
...> name varchar(30),  
...> age int);  
  
sqlite> create table books (id integer primary key autoincrement,  
...> title varchar(60),  
...> user_id integer);  
  
sqlite> insert into users (name, age) values  
...> ('joe', 32),  
...> ('bob', 42);  
  
sqlite> insert into books (title, user_id) values  
...> ('Neuromancer', 1), ('Wizard of Oz', 2), ('Logicomix', 1),  
...> ('Full Metal Alchemist', 1), ('Alice in Wonderland', 2);
```

Now to find the id of the user Joe we would need to look into our users table.

```
sqlite> select id from users where name='joe';  
1
```

So this id represents 'joe'. Now if we want to retrieve all the books that the user 'joe' has left behind we run the following:

```
sqlite> select * from books where user_id=1;  
1|Neuromancer|1  
3|Logicomix|1  
4|Full Metal Alchemist|1
```

It is also possible to nest the sql queries in this manner (the query in the brackets finds the id of the user, and the result is used to find the books with the given `__user_id`):

```
sqlite> select * from books where user_id=(select id from users where name='joe');  
1|Neuromancer|1  
3|Logicomix|1  
4|Full Metal Alchemist|1
```

This is how we are able to represent relationships in databases.