

Introduction to Database Systems: CS305 A Small Database System

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All types of data!

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Relational
Models

Data to add

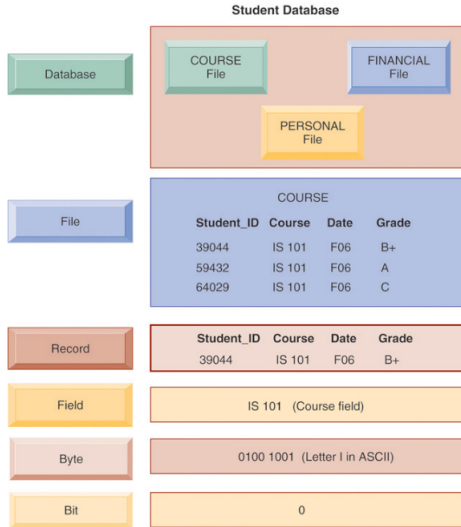
Create table

Persistent
Databases

Consider
this...

Populate

Conditional
Queries



A database, simply stated

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this...

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ID	Dept	RoomNum
JJ	CS	105
OBC	CS	104
AM	CS	106
GK	CS	108
PL	CS	110
DW	CS	112

- The entire database fits into one table.
- Is the column “Dept” necessary in this table?

A database, not-so-simply stated

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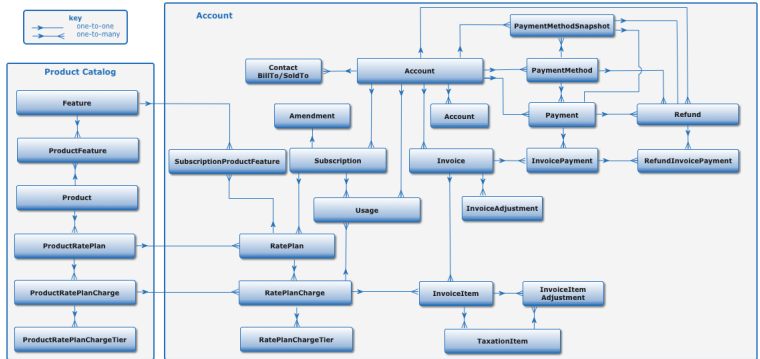
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- The entire database is made up of many tables.
- A table must be **connected** to the others *in some way*.

Relational Models: A single table

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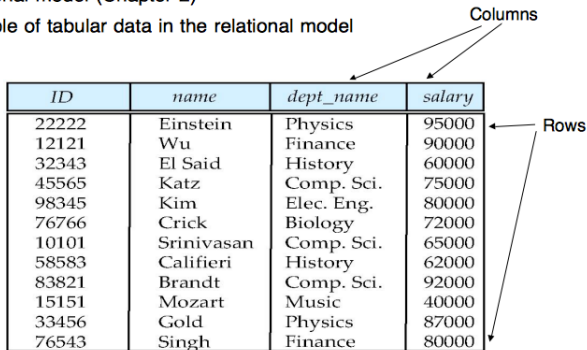
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Relational model (Chapter 2)

Example of tabular data in the relational model



<i>ID</i>	<i>name</i>	<i>dept_name</i>	<i>salary</i>
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

- Each field of a row is an “observation”
- Rows are a series (i.e., tuples) of “observations”
- Columns contain same “observation” class (are called *attributes*)

Specific information for each table

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ID	Dept	RoomNum
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

ID	Tea	Sandwich
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

- Two tables containing *specific* types of data, using the same ID on a row
- Each table organizes non-redundant information, but needs a way to connect a row to the rest of the base (i.e., the common *ID* column serves as a primary key).

E-R Models ... Entities? Relationships?

Section 1.6.3, The Entity-Relationship Model

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Entities

- The entity-relationship (E-R) data model uses a collection of basic objects, called **entities**, and relationships exist to connect these objects.
- Entities are defined by attributes (i.e, *column headers* in tables)
- *ID*, *name*, and *salary* are points of information to describe an *instructor* entity

Relationships

- A *relationship* is an association among several *entities*
- For example, a member relationship associates an instructor with her department.
- The set of all *entities* of the same type and the set of all *relationships* of the same type are termed an *entity set* and *relationship set*, respectively.

Running an SQLite client

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Data to add

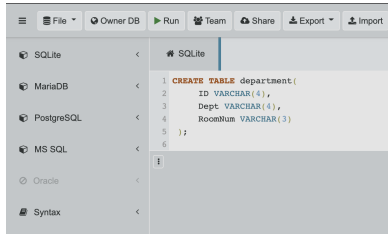
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Ways to run SQLite for this demo

- Download and install a local version (*Recommended*);
 - <https://www.sqlite.org/index.html>
- Use Docker solution:
 - See *classDocs/* for Dockerfile and execution bash scripts
- Use an online tool (Class examples only, not for homework)
 - See *sqliteonline* at <https://sqliteonline.com/>

Running SQLite3 from Docker

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Shortcut to running and building a working container

The following bash scripts simplify building the container.

OS	Building	Running
MacOS	<code>./build_macOS.sh</code>	<code>./run_macOS.sh</code>
Linux	<code>./build_linux.sh</code>	<code>./run_linux.sh</code>
Windows	<code>build_win.bat</code>	<code>run_win.bat</code>

- Create a working directory to contain your working notes and working database file and keep your docker scripts there.
- The directory where you run the Docker virtual machine is the root/ directory. Make sure you can still find your local files wherever when you use Docker

SQL is...

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- 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

SQLite3

A practical open source database

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this...

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Command

```
$sqlite3
```

You should see this, or similar:

```
SQLite version 3.19.3 2017-06-27 16:48:08
```

```
Enter ".help" for usage hints.
```

```
Connected to a transient in-memory database.
```

```
Use ".open FILENAME" to reopen on a persistent database.
```

```
sqlite>
```

Create database called *dept.sqlite3*

```
$sqlite3 dept.sqlite3
```

Save code and data, and exit using `.exit`) from the *sqlite3*.

Data and its Schema

We need to tell SQLite3 where to contain the data

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Consider
this...

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Data

- Only three columns in our base:
 - ① ID: up to four chars in size
 - ② Dept: up to four chars
 - ③ RoomNum: up to 3 chars
- Plenty of space for as many rows as we want:
 - ① Limited by memory

Make a General Table

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Consider
this...

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Remove the table to create it with new attributes

```
DROP TABLE IF EXISTS tablename;
```

Pseudo code

```
CREATE TABLE table_name (  
    column1 datatype,  
    column2 datatype,  
    column3 datatype  
    ...  
);
```

This data structure allocates the *memory space* for the database to keep data that is assigned to this table.

Schema

Create a table for the DB

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Consider
this...

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Create database called *dept.sqlite3*

```
$sqlite3 dept.sqlite3
```

```
DROP TABLE IF EXISTS department;
```

```
CREATE TABLE department(  
    ID VARCHAR,  
    Dept VARCHAR,  
    RoomNum VARCHAR);
```

- We create a table (a memory space) called *department* to contain our data
- Note: the VARCHAR attribute is a universal attribute type

After table is created

Add the data

SQLite: What tables are in the DB?

```
sqlite> .tables  
department
```

SQLite: What are the attributes and tables of the DB schema?

```
sqlite> .schema  
department
```

Insert some data as a *tuple*

```
INSERT INTO department VALUES (  
    "OBC",  
    "CS",  
    "203" );
```

After table is created

Add the data

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this...

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Query everything in the table, department

```
sqlite> select * from department;  
OBC|CS|203
```

Query ID and Dept in the table, department

```
sqlite> select ID, Dept from department;  
OBC
```

Exit and save your database

```
.exit
```

Load your database and run same queries again!

```
sqlite3 dept.sqlite3
```


Consider this...

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Consider
this...

Populate

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THINK

Can you add and populate a new database?

Can you populate your base by adding *more* data?

Can you also check that the data was correctly added?

Let's Make another Persistent Database!

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Data to add

Create table

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Consider
this...

Populate

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The data

```
1|Ezra|Weston Loomis|Pound|30/10/1885|1/11/1972|USA
2|Arthur|Conan|Doyle|05/22/1859|07/7/1930|UK
3|Ernest|Miller|Hemingway|07/21/1899|07/02/1961|USA
4|John|Edward|Williams|08/22/1922|03/3/1994|USA
```

Attributes

- ID
- first name
- middle name
- last name
- birth date
- death date
- country of origin

Create the file!

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Data to add

Create table

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Consider
this...

Populate

Conditional
Queries

The terminal command to open a new database

```
sqlite3 writers.sqlite3
```

```
obonhamcarter$ sqlite3 writers.sqlite3
SQLite version 3.19.3 2017-06-27 16:48:08
Enter ".help" for usage hints.
sqlite>
```

Create the Space

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Data to add

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Consider
this...

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Create Table command

```
CREATE TABLE Writers (  
    id INTEGER NOT NULL PRIMARY KEY,  
    first_name VARCHAR NOT NULL,  
    middle_name VARCHAR,  
    last_name VARCHAR NOT NULL,  
    birth_date VARCHAR NOT NULL,  
    death_date VARCHAR,  
    country_of_origin VARCHAR NOT NULL );
```

- Note: NOT NULL ensures that this field is not left blank when populating

Add Data for writers Table

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Consider
this...

Populate

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Insert Commands

```
INSERT INTO Writers VALUES(1, 'Ezra', 'Weston Loomis', 'Pound', '30/10/1885',  
'1/11/1972', 'USA');  
INSERT INTO Writers VALUES(2, 'Arthur', 'Conan', 'Doyle', '05/22/1859',  
'07/7/1930', 'UK');  
INSERT INTO Writers VALUES(3, 'Ernest', 'Miller', 'Hemingway', '07/21/1899',  
'07/02/1961', 'USA');  
INSERT INTO Writers VALUES(4, 'John', 'Edward', 'Williams', '08/22/1922',  
'03/3/1994', 'USA');
```

Tables and Schema

- What is the schema (i.e., the arrangement of data) of your database?
 - Type in **“.schema”** and see!
- What are the tables of your database?
 - Type in **“.tables”** and see!

Conditional Queries

Adding conditional clauses to queries

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Queries to play with using conditional clauses

```
select * from Writers where country_of_origin == "UK";
```

```
select * from Writers where country_of_origin == "USA";
```

```
select * from Writers where birth_date == "08/22/1922";
```

```
select * from Writers where first_name == "Arthur";
```

What else can you query using this code?

Save your DB and exit with following command:

.exit

Consider this...

Please see the *sandbox* file for code.

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Consider
this...

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THINK

- Can you populate your base by adding more data?
- Can you also check that the data was correctly stored in the table?
- Can you run queries to access particular attributes?