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Relational Database Management Systems

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❖ What is an RDBMS?

A relational database management system (RDBMS) is

- software designed to support large-scale data-intensive applications
- allowing high-level description of data (tables, constraints)
- with high-level access to the data (relational model, SQL)
- providing efficient storage and retrieval (disk/memory management)
- supporting multiple simultaneous users (privilege, protection)
- doing multiple simultaneous operations (transactions, concurrency)
- maintaining reliable access to the stored data (backup, recovery)

Note: databases provide persistent storage of information

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❖ RDBMSs in COMP3311

PostgreSQL

- full-featured, client-server DBMS, resource intensive
- applications communicate via server to DB
- can run distributed and replicated
- follows SQL standard closely, but not totally
- extra data types (e.g. JSON), multiple procedural languages

SQLite

- full-featured, serverless DBMS, light user of resources
- intended to be embedded in applications
- follows SQL standard closely, but not totally
- no stored procedures, add functions by embedding in apps

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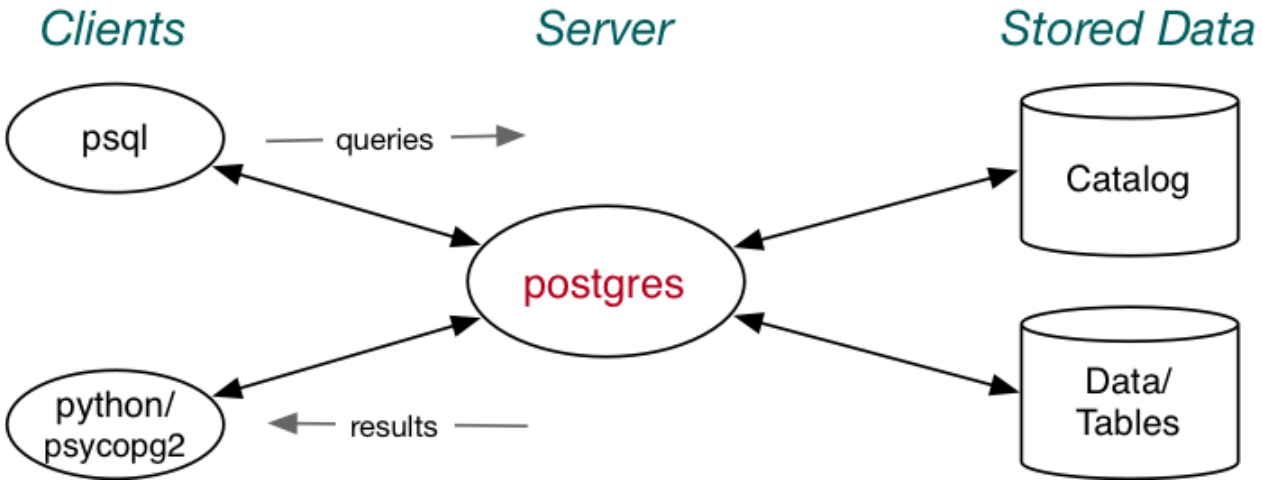
❖ PostgreSQL Architecture

PostgreSQL's client-server architecture:



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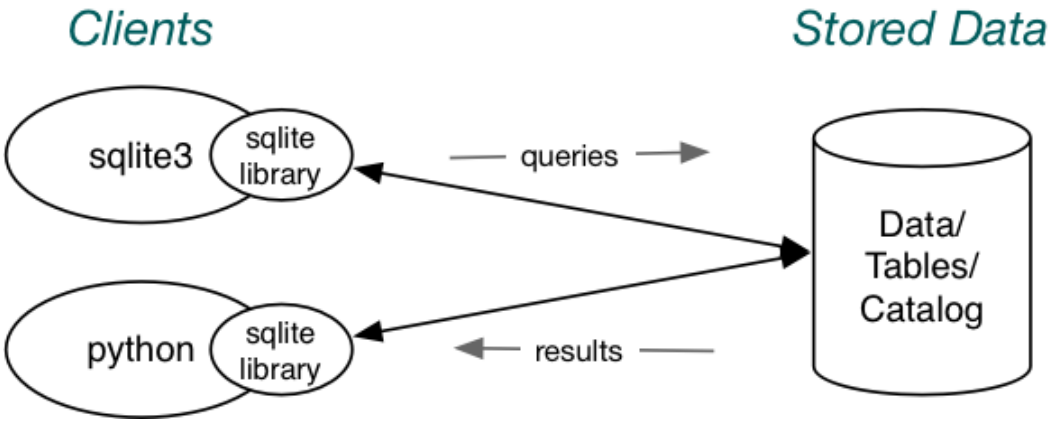
❖ SQLite Architecture

SQLite's serverless architecture:



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❖ Using PostgreSQL in CSE

Using your PostgreSQL server in CSE (once installed):

- login to `grieg`, set up environment, start server
- use `psql`, etc. to manipulate databases
- stop server, log off `grieg`

```
wagner$ ssh YOU@grieg
grieg$ source /srvr/YOU/env
grieg$ pg start
grieg$ psql myDatabase
... do stuff with your database ...
grieg$ pg stop
grieg$ exit
```

Need to run the command **`priv srvr`** once before the above will work

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❖ Using PostgreSQL in CSE (cont)

PostgreSQL files (helps to understand state of server)

- PostgreSQL environment settings ... **`/srvr/YOU/env`**
- PostgreSQL home directory ... **`/srvr/YOU/pgsql/`**
- under the home directory ...
  - **`postgresql.conf`** ... main configuration file
  - **`base/`** ... subdirectories containing database files
  - **`postmaster.pid`** ... process ID of server process
  - **`.s.PGSQL.5432`** ... socket for clients to connect to server
  - **`.s.PGSQL.5432.lock`** ... lock file for socket
  - **`Log`** ... log file to monitor server errors, etc.

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❖ Managing Databases

Shell commands to create/remove databases:

- **`createdb`** *dbname* ... create a new totally empty database
- **`dropdb`** *dbname* ... remove *all* data associated with a DB

(If no *dbname* supplied, assumes a database called *YOU*)

Shell commands to dump/restore database contents:

- **`pg_dump`** *dbname* **`>`** *dumpfile*
- **`psql`** *dbname* **`-f`** *dumpfile*

(Database *dbname* is typically created just before restore)

Main SQL statements in *dumpfile*: **`CREATE TABLE`**, **`ALTER TABLE`**, **`COPY`**

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❖ Managing Tables

SQL statements:

- **CREATE TABLE** *table* **(** *Attributes+Constraints* **)**
- **ALTER TABLE** *table TableSchemaChanges*
- **DROP TABLE** *table(s)* [**CASCADE**]
- **TRUNCATE TABLE** *table(s)* [**CASCADE**]

(All conform to SQL standard, but all also have extensions)

DROP..CASCADE also drops objects which depend on the table

- objects could be tuples or views, but *not* whole tables

TRUNCATE..CASCADE truncates tables which refer to the table

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❖ Managing Tuples

SQL statements:

- **INSERT INTO** *table* **(** *Attrs* **) VALUES** *Tuple(s)*
- **DELETE FROM** *table* **WHERE** *condition*
- **UPDATE** *table* **SET** *AttrValueChanges* **WHERE** *condition*

Attrs = **(** $attr_1$**,** , ... $attr_n$ **)** *Tuple* = **(** val_1**,** , ... val_n **)**

AttrValueChanges is a comma-separated list of:

- *attrname* **=** *expression*

Each list element assigns a new value to a given attribute.

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❖ Table Definition Example

Make a table to hold student data:

```
CREATE TABLE Student (
    zid     serial,
    family  varchar(40),
    given   varchar(40) NOT null,
    d_o_b   date NOT NULL,
    gender  char(1) check (gender in ('M','F')),
    degree  integer,
    PRIMARY KEY (zid),
    FOREIGN KEY (degree) REFERENCES Degrees(did)
);
```

`serial` is a special type which automaticall generates unique integer values

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❖ Exercise: Creating/Populating Databases

Do the following:

- create a database called **`ex1`**
- create a table **`T`** with two integer fields **`x`** and **`y`**
- examine the catalog definition of table **`T`**
- use **`insert`** statements to load some tuples
- use **`pg_dump`** to make a copy of the database contents
- remove the **`ex1`** database, then restore it from the dump

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❖ Managing Other DB Objects

Databases contain objects other than tables and tuples:

- views, functions, sequences, types, indexes, roles, ...

Most have SQL statements for:

- **CREATE** *ObjectType name* ...
- **DROP** *ObjectType name* ...

Views and functions also have available:

- **CREATE OR REPLACE** *ObjectType name* ...

See PostgreSQL documentation Section VI, Chapter I for SQL statement details.

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