SQL

June 21, 2017
DSI, Galvanize, Seattle

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OBJECTIVES

- **Connect** to a Postgres database
- **Design** and **write** queries to answer questions using an RDBMS (i.e. Postgres)

By the end of today, you will be able to...

- Connect to a SQL database via command line (i.e. Postgres).
- Connect to a database from within a python program.
- State the function of basic SQL commands.
- Write simple queries on a single table including SELECT, FROM, WHERE, CASE... clauses and aggregates.
- Write complex queries including JOINS and subqueries.
- Explain how indexing works in Postgres.
- Create and dump tables.
- Format a query to follow a standard style.
- Move data from SQL database to text file.

Relational Database Management System (RDBMS)

It is a **persistent data storage system**

- survives after the process in which it was created has ended
- is written to non-volatile storage
- is infrequently accessed and unlikely to be changed

RDBMS was the de facto standard for storing data

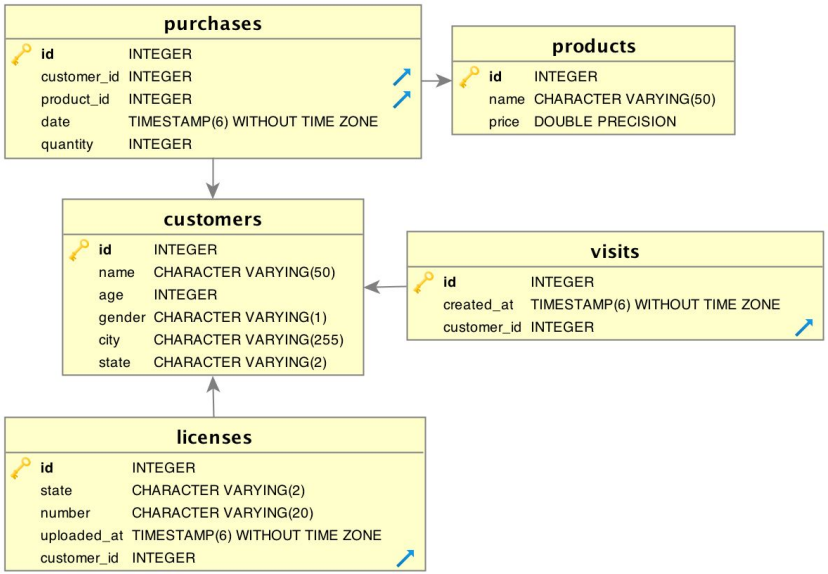
- Examples: Oracle, MySQL, SQLServer, Postgres
- With "Big Data", this is beginning to change

Why RDBMS ?

An RDBMS provides the ability to

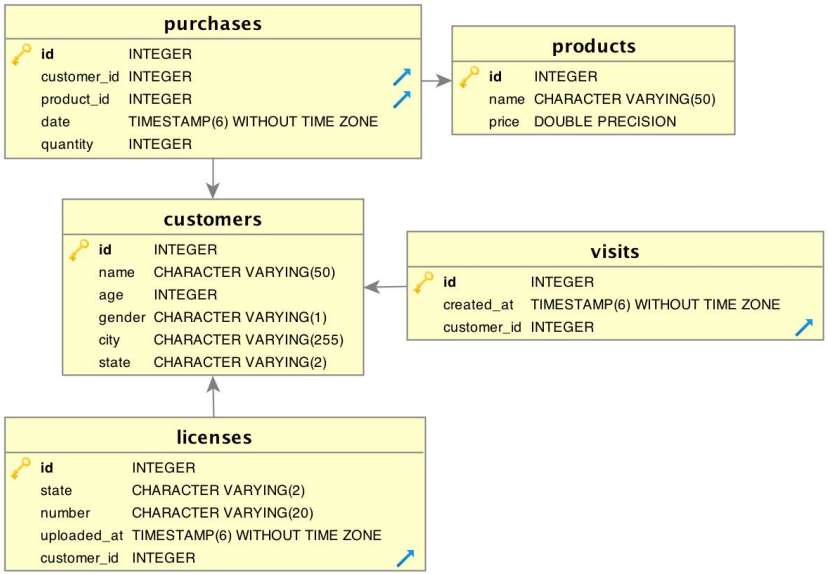
- **Model** relations in data
- **Query** data and their relations efficiently
- **Maintain** data consistency and integrity

It will require a Data Model



RDBMS Data Model

- **Schema** defines the structure of the data
- The **database** is composed of a number of user-defined **tables**
- Each **table** will have **columns** (aka fields) and **rows** (aka records)
- A column is of a given **data type**
- A row is an entry in a table with data for each column of that table



RDBMS and SQL (Structured Query Language)

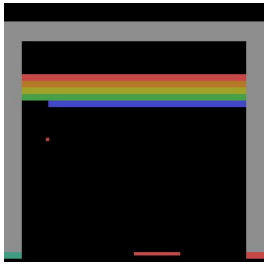
- SQL is the language used to query relational databases
- **All RDBMS use SQL** and the syntax and keywords are the same for the most part, across systems
- **SQL is used to interact** with RDBMS, allowing you to create tables, alter tables, insert records, update records, delete records, and query records within and across tables.
- Even non-relational databases like **Hadoop** usually have a SQL-like interface available.

Question !

As a data scientist, what are the advantages of

storing, querying, and maintaining data in a SQL database

over curating your own flat files (e.g. csv files) ?



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PostGres Basics

Ways to use psql in the shell/term:

`$ psql`	connects to postgres server
`$ psql -U [USERNAME]`	connects with given username
`$ psql [DBNAME]`	connects to a given database
`$ psql < script.sql`	reads file script.sql and send commands to psql

Try it live:

- *Open file sql/lecture_create.sql in atom*
- *Use it to create a "dsilecture" database on your psql server*

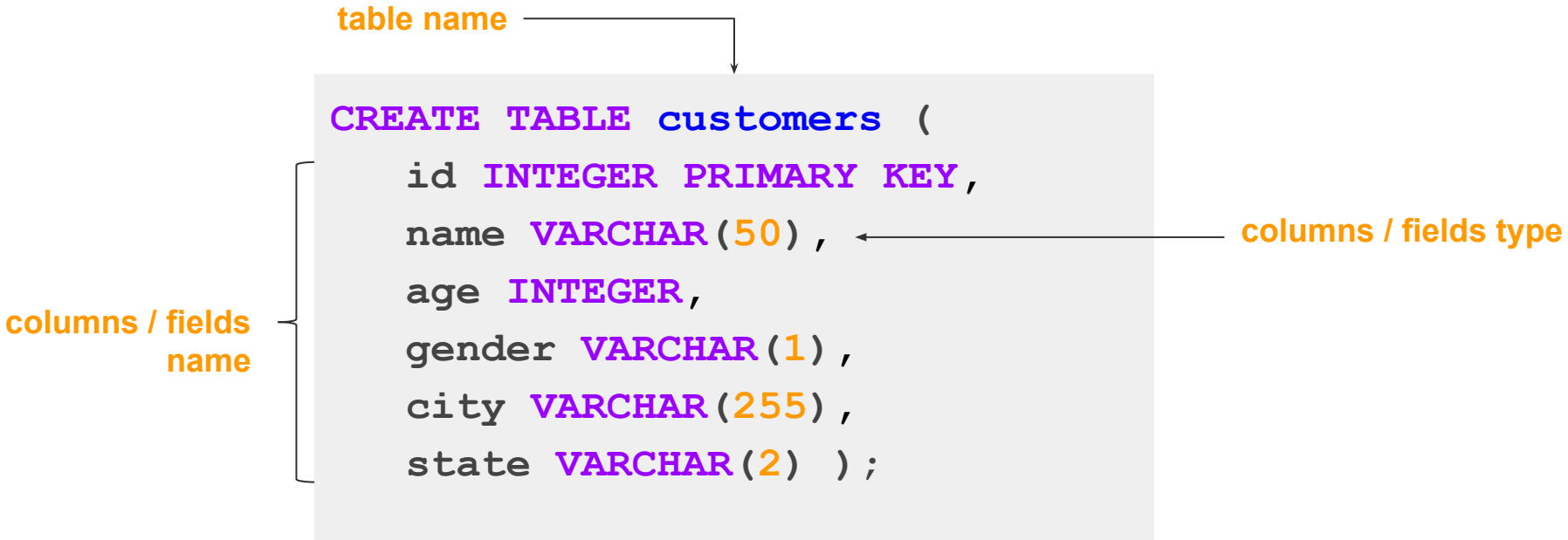
PostGres Basics

Useful psql commands at the prompt [link]:

`# \h`	SQL help
`# \?`	psql commands help
`# \l`	List all the tables in the database
`# \d`	Describe the table schema
`# \d db_name`	Describe tables for a specific db
`# \connect db_name`	Connects to a database

Try it live: Connect to “dsilecture” and describe schema of table “customer”

Creating a table with a schema



Inserting values in a table

table name

records and their values

```
INSERT INTO products (id, name, price) VALUES
  (1, 'soccer ball', 20.5),
  (2, 'iPod', 200),
  (3, 'headphones', 50);
```

SQL Queries for table creation / maintenance

Creating a table from query:

```
CREATE [TEMPORARY] TABLE table AS <SQL query>;
```

Inserting records in a table:

```
INSERT INTO table [(c1,c2,c3,…)] VALUES (v1,v2,v3,…);
```

Updating records:

```
UPDATE table SET c1=v1,c2=v2,… WHERE cX=vX;
```

Delete records:

```
DELETE FROM table WHERE cX=vX;
```

Change model (add, drop, modify columns):

```
ALTER TABLE table [DROP/ADD/ALTER] column [datatype];
```

Delete a table:

```
DROP TABLE table;
```

Designing a database with keys

Primary Key

A primary key is a special column of a table that uniquely identifies that entry.

A primary key is not always an integer; it could be a combination of columns, hash, timestamp..etc.,

Foreign Keys

Foreign Keys are columns that reference some other entry in the database.

SQL Syntax

All SQL queries have three main ingredient :

`SELECT`	*What* data do you want?
`FROM`	*Where* do you want to get the data from?
`WHERE`	*Under what* conditions?

SQL is Declarative rather than Imperative. That is, you tell the machine what you want and it (database optimizer) decides how to do it

Advanced: You can use `EXPLAIN` to look at the how

SQL Queries

Select the columns name, age from the table users.

```
SELECT name, age
FROM customers
```

SQL always returns a table, so the output of the query above is a sub-table of users with 2 columns.
Select name and age for every user in users who live in CA.

```
SELECT name, age
FROM customers
WHERE state = 'CA'
```

SQL Examples

Open file sql/lecture_examples.sql

Run them in psql

JOIN

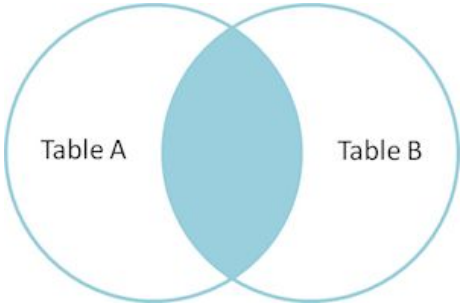
JOIN clause used to query across multiple tables using foreign keys

Every JOIN has two segments:

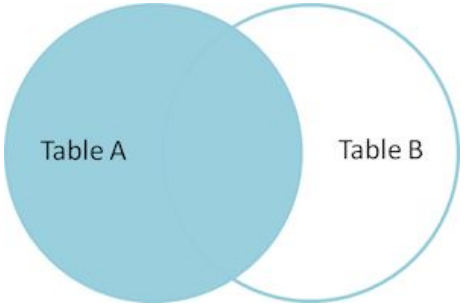
Specifying the tables to JOIN
Specifying the columns to match

JOIN types

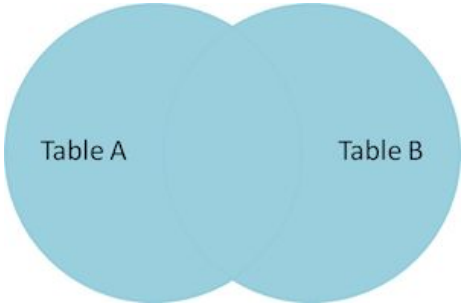
INNER JOIN
discards any entries
that do not have a match
between the tables
based on the given keys.



LEFT OUTER JOIN
keeps all entries
in the left table
regardless of
whether a match is found
in the right table



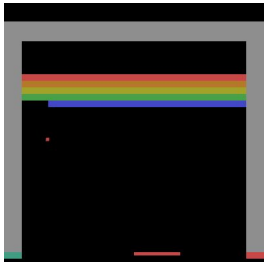
FULL OUTER JOIN
will keep the rows
of both tables
no matter what



copied from *http://blog.codinghorror.com/a-visual-explanation-of-sql-joins/*

Question ! (JOIN the fun)

How many rows would result after an
(inner join, left join, right join, full outer join) on `department_id` ?



employee_id	department_id	name	salary
2	1	Jon	40000
7	1	Linda	50000
12	2	Ashley	15000
1	0	Mike	80000

department_id	location
1	NY
2	SF
3	Austin

Given the following query, number what order the commands are executed:

```
SELECT a.userid, count(0) as recent_visits
FROM users a
LEFT JOIN visits b
ON a.userid = b.userid
WHERE b.dt > '2012-01-01'
GROUP BY a.userid
HAVING count(0) < 10
ORDER BY recent_visits;
```

Order of Evaluation of a SQL SELECT Statement

1. FROM + JOIN: first the product of all tables is formed

2. WHERE: the where clause filters rows that do not meet the search condition

3. GROUP BY + (COUNT, SUM, etc): the rows are grouped using the columns in the group by clause and the aggregation functions are applied on the grouping

4. HAVING: like the WHERE clause, but can be applied after aggregation

5. SELECT: the targeted list of columns are evaluated and returned

6. DISTINCT: duplicate rows are eliminated

7. ORDER BY: the resulting rows are sorted

Subqueries

In general, you can replace any table name with a SELECT statement.

```
SELECT ..... FROM (SELECT ....)
```

If a query returns a **single value**, you can treat it as such.

```
WHERE var1 = (SELECT ...)
```

If a query returns a **single column**, you can treat it sort of like a list/vector

```
WHERE var1 IN (SELECT ...)
```

Database Normalization

- Minimizes Redundancy, for example:
  - Details about a user(address, age) are only stored once (in a users table)
  - Any other table (eg. purchases) where this data might be relevant, only references the user_id
  - Choose Normalized or Denormalized Schemas based on the use case:
    - Heavy reporting (Data Warehouse)
    - Transactional Systems (Ordering System)