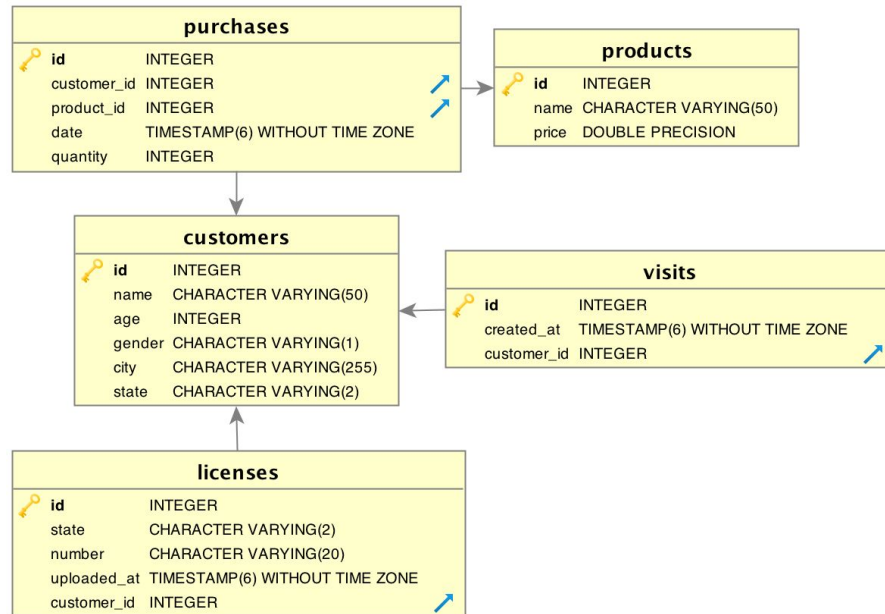




SQL

June 21, 2017
DSI, Galvanize, Seattle

Moses Marsh





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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.



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

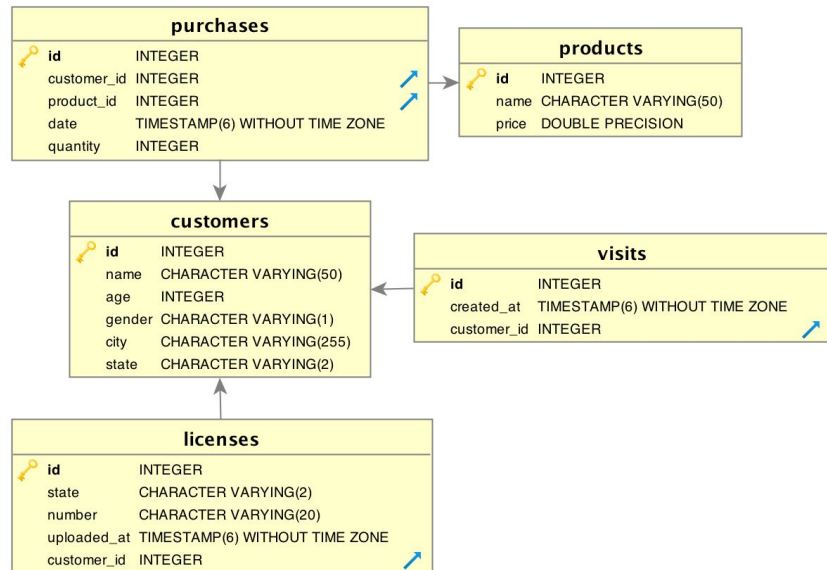
Why RDBMS ?



An RDBMS provides the ability to

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

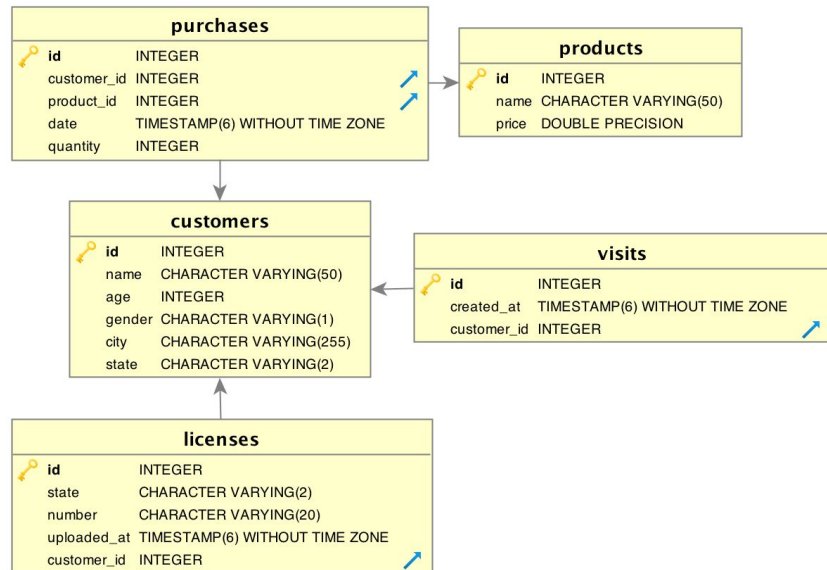
It will require a Data Model



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)

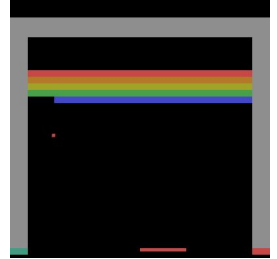


- SQL is the language used to query relational databases
- **All RDBMS use SQL** and the syntax and keywords are the same for the most part, across systems
- **SQL is used to interact** with RDBMS, allowing you to create tables, alter tables, insert records, update records, delete records, and query 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) ?



...

Ways to use psql in the shell/term:

- | | |
|--------------------------------------|---|
| <code>\$ psql</code> | connects to postgres server |
| <code>\$ psql -U [USERNAME]</code> | connects with given username |
| <code>\$ psql [DBNAME]</code> | connects to a given database |
| <code>\$ psql < script.sql</code> | 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*

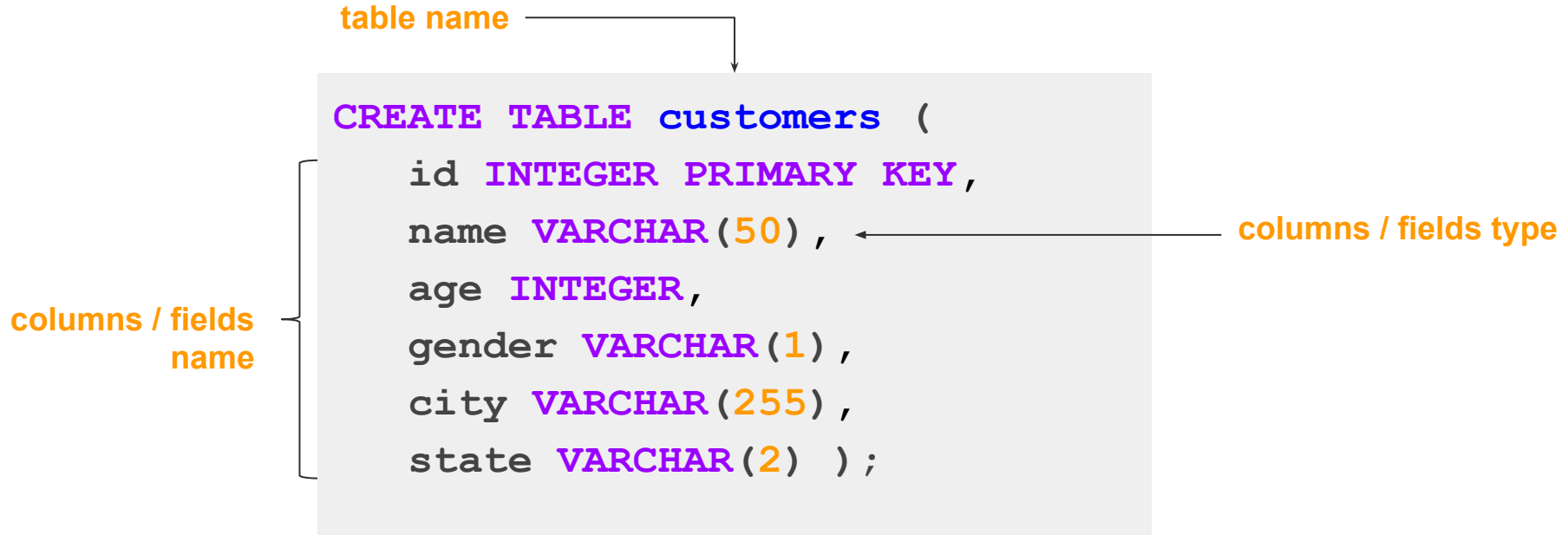


Useful psql commands at the prompt [[link](#)]:

| | |
|--------------------|-------------------------------------|
| # \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



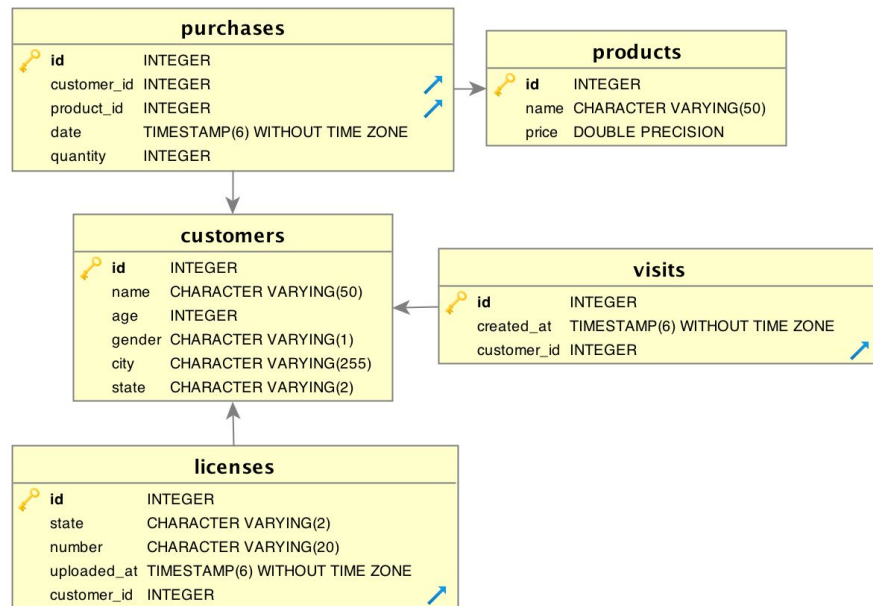
Primary Key

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.





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

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'
```




Open file sql/lecture_examples.sql

Run them in psql

JOIN clause used to query across multiple tables using foreign keys

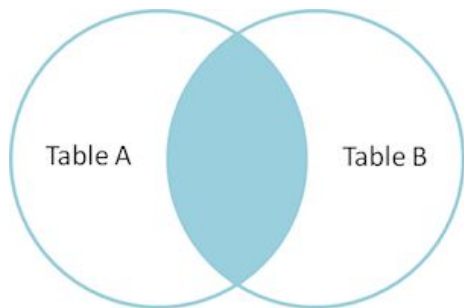
Every JOIN has two segments:

Specifying the tables to JOIN

Specifying the columns to match

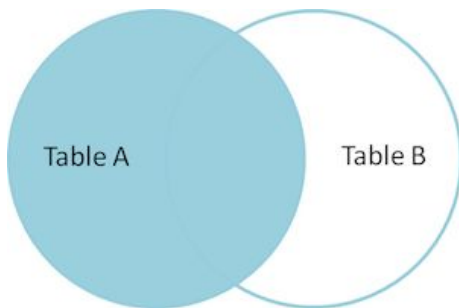
INNER JOIN

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



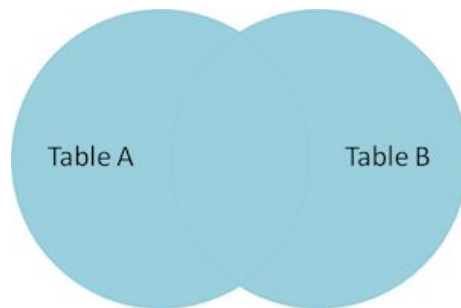
LEFT OUTER JOIN

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



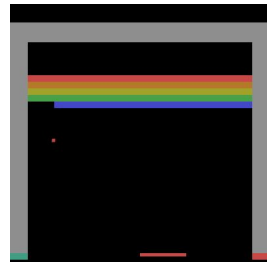
Question ! (JOIN the fun)



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

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

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

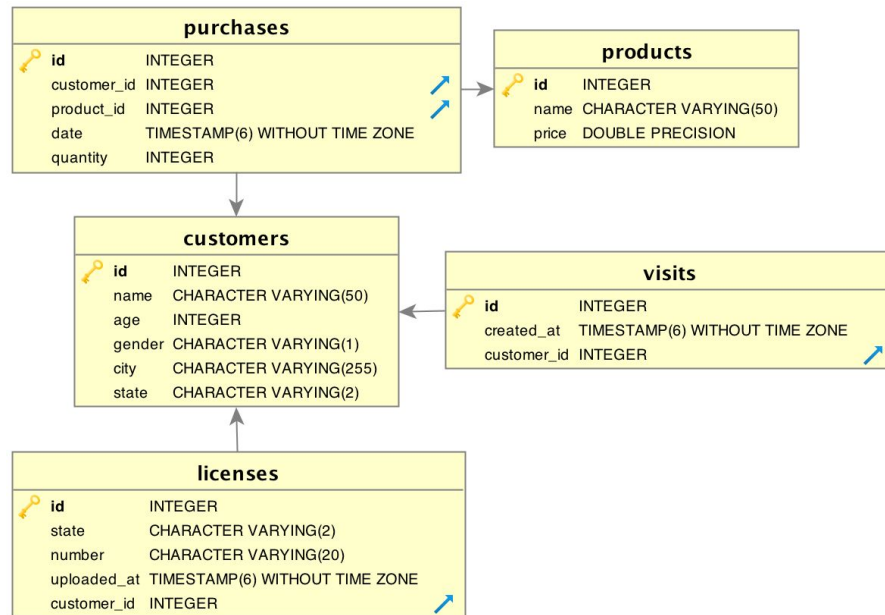
If a query returns a **single value**, you can treat it as such.

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

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

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

- 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)





- “self join”: JOIN a table with itself:
<http://www.w3resource.com/sql/joins/perform-a-self-join.php>
- CROSS JOIN: join each row in table A with every row in table B:
<http://www.w3resource.com/sql/joins/cross-join.php>
- window functions:
<https://www.postgresql.org/docs/9.1/static/tutorial-window.html>
- COALESCE: often used to turn NULL values into non-null values:
<https://www.postgresql.org/docs/9.5/static/functions-conditional.html>
- EXCEPT: return rows from one SELECT statement that are NOT returned by a second SELECT statement:
<https://www.tutorialspoint.com/sql/sql-except-clause.htm>