Tuesday 8 October 2013

General Assembly

Practical SQL

Operations

We can do simple arithmetic math

```
SELECT
    score / 100 as pct_score,
    CAST(score AS decimal(8, 2)) / 100 as pct_score_2
FROM
    sampdb.score
LIMIT 5;
```

Clear Run

```
+-----------+-------------+
| pct_score | pct_score_2 |
+-----------+-------------+
|    0.2000 |    0.200000 |
|    0.2000 |    0.200000 |
|    0.1800 |    0.180000 |
|    0.1300 |    0.130000 |
|    0.1800 |    0.180000 |
+-----------+-------------+
```

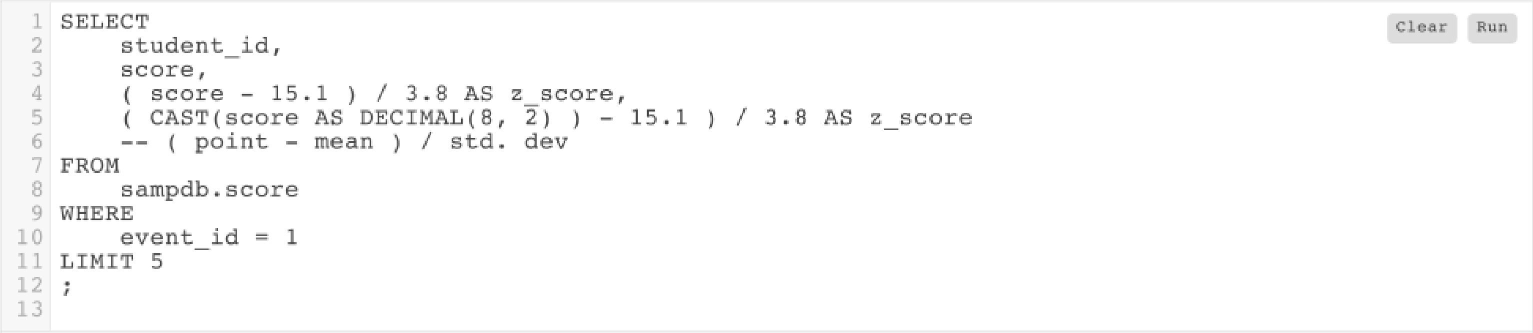
Clear Run

-- Note that MySQL will automatically convert the value returned as a decimal.

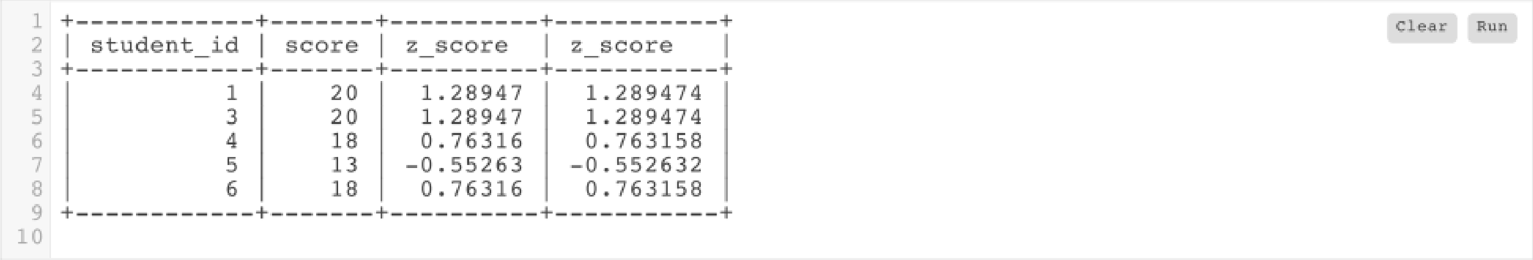
-- Other SQL versions will not. Postgres requires a type conversion of the INT to a DECIMAL type.

More complex math

We can do more complex math



```
SELECT
    student_id,
    score,
    ( score - 15.1 ) / 3.8 AS z_score,
    ( CAST(score AS DECIMAL(8, 2) ) - 15.1 ) / 3.8 AS z_score
    -- ( point - mean ) / std. dev
FROM
    sampdb.score
WHERE
    event_id = 1
LIMIT 5
;
```



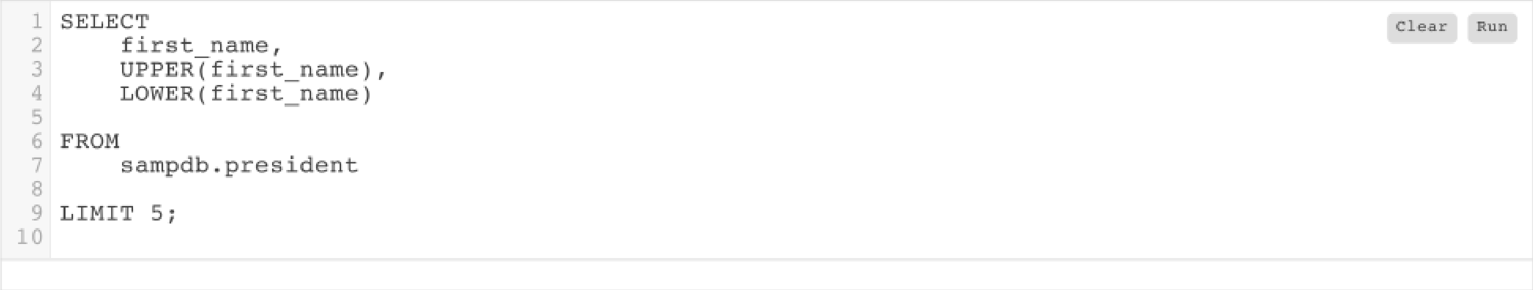
```
+------------+-------+----------+-----------+
| student_id | score | z_score  | z_score   |
+------------+-------+----------+-----------+
|          1 |    20 |  1.28947 |  1.289474 |
|          3 |    20 |  1.28947 |  1.289474 |
|          4 |    18 |  0.76316 |  0.763158 |
|          5 |    13 | -0.55263 | -0.552632 |
|          6 |    18 |  0.76316 |  0.763158 |
+------------+-------+----------+-----------+
```

We are 'hard coding' the mean and standard deviation values

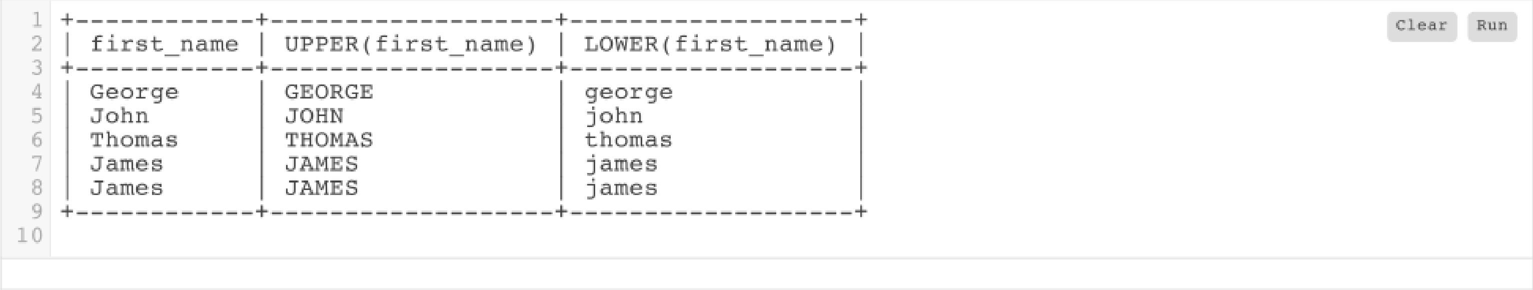
We'll discuss how to get these on the fly

Strings

String functions manipulate the appearance of text



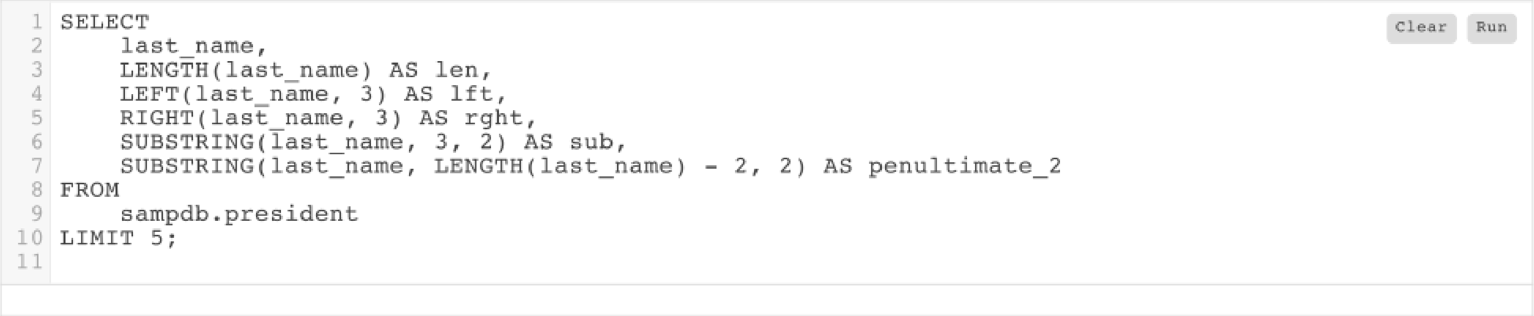
```
SELECT
    first_name,
    UPPER(first_name),
    LOWER(first_name)

FROM
    sampdb.president

LIMIT 5;
```



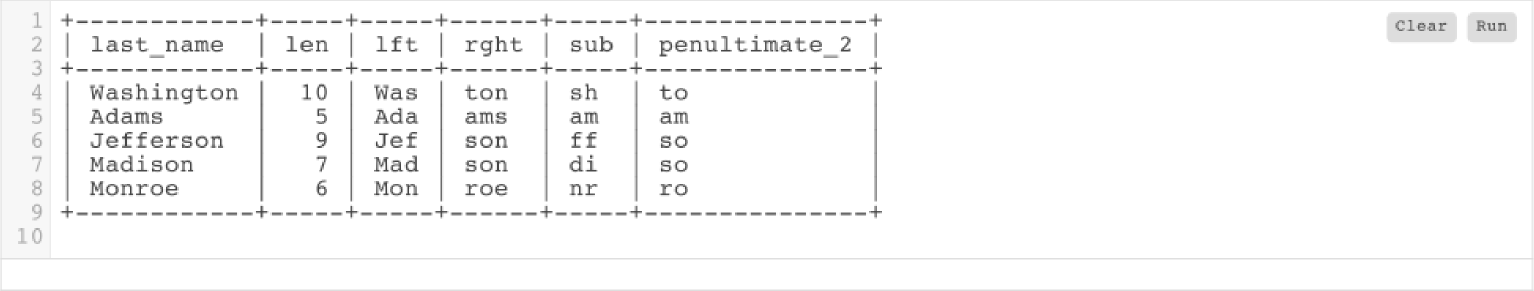
```
+------------+-------------------+-------------------+
| first_name | UPPER(first_name) | LOWER(first_name) |
+------------+-------------------+-------------------+
| George     | GEORGE            | george            |
| John       | JOHN              | john              |
| Thomas     | THOMAS            | thomas            |
| James      | JAMES             | james             |
| James      | JAMES             | james             |
+------------+-------------------+-------------------+
```

String extraction

String functions can "reach into" strings



```
SELECT
    last_name,
    LENGTH(last_name) AS len,
    LEFT(last_name, 3) AS lft,
    RIGHT(last_name, 3) AS rght,
    SUBSTRING(last_name, 3, 2) AS sub,
    SUBSTRING(last_name, LENGTH(last_name) - 2, 2) AS penultimate_2
FROM
    sampdb.president
LIMIT 5;
```



```
+------------+-----+-----+------+-----+---------------+
| last_name  | len | lft | rght | sub | penultimate_2 |
+------------+-----+-----+------+-----+---------------+
| Washington |  10 | Was | ton  | sh  | to            |
| Adams      |   5 | Ada | ams  | am  | am            |
| Jefferson  |   9 | Jef | son  | ff  | so            |
| Madison    |   7 | Mad | son  | di  | so            |
| Monroe     |   6 | Mon | roe  | nr  | ro            |
+------------+-----+-----+------+-----+---------------+
```

Finding strings allows more interesting usages

String manipulation becomes more interesting when we start looking for strings

Clear Run

```
SELECT
    email,
    -- LOCATE('@', email),
    position('@' in email)
FROM
    sampdb.member
LIMIT 5;
```

Clear Run

```
+----------------------------+------------------------+
| email                      | position('@' in email) |
+----------------------------+------------------------+
| jeanne_s@earth.com         |                      9 |
| august.lundsten@pluto.com  |                     16 |
| NULL                       |                   NULL |
| arbogast.ruth@mars.net     |                     14 |
| c.dorfman@uranus.net       |                     10 |
+----------------------------+------------------------+
```

Here we get the position of the @ sign

We can use that, with our other functions, to get a list of domains

Putting string functions together

With the location of the '@', we can extract the domain name

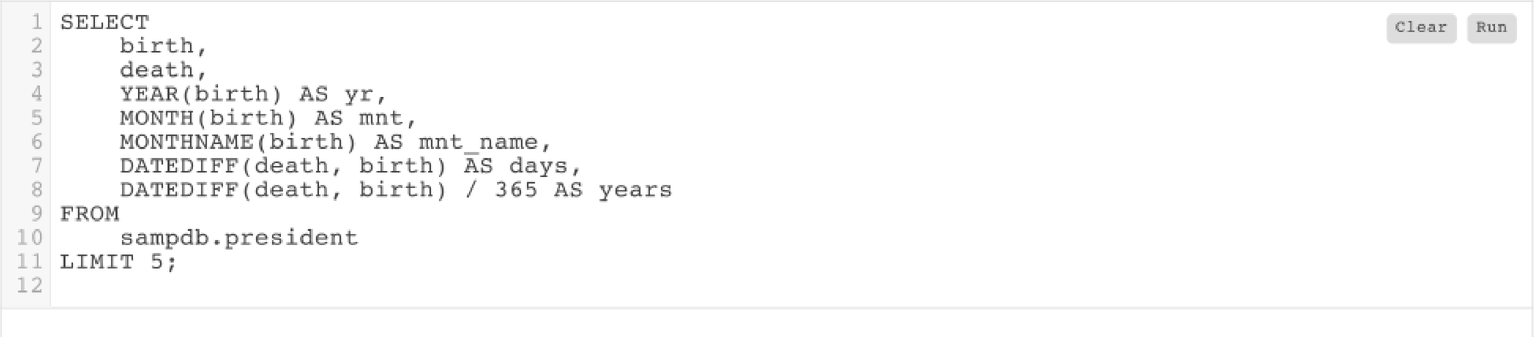
```
SELECT
    email,
    RIGHT(email, LENGTH(email) - LOCATE('@', email)) AS domain
FROM
    sampdb.member
LIMIT 5;
```

```
+--------------------------+------------+
| email                    | domain     |
+--------------------------+------------+
| jeanne_s@earth.com       | earth.com  |
| august.lundsten@pluto.com | pluto.com  |
| NULL                     | NULL       |
| arbogast.ruth@mars.net   | mars.net   |
| c.dorfman@uranus.net     | uranus.net |
+--------------------------+------------+
```

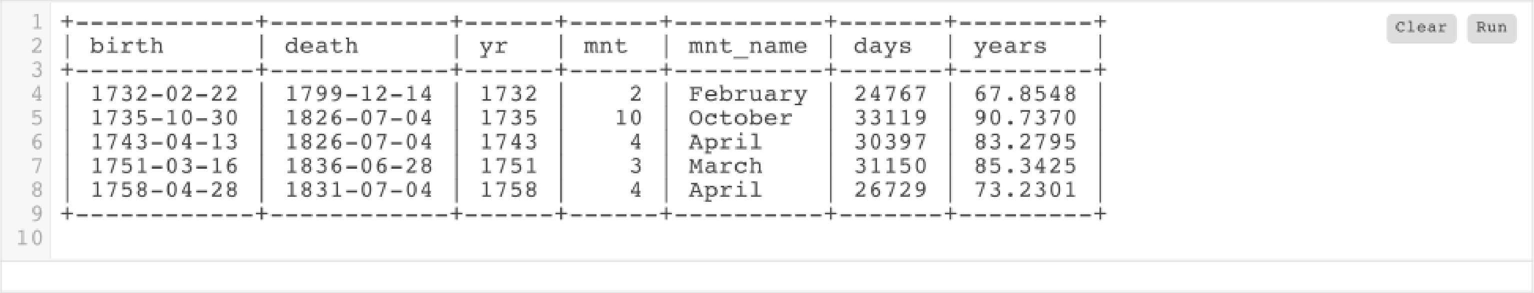
Now, for each record, we can extract the domain name

Might use this to count members by domain our list use, or check for correlation with other factors

Date Functions



```
SELECT
    birth,
    death,
    YEAR(birth) AS yr,
    MONTH(birth) AS mnt,
    MONTHNAME(birth) AS mnt_name,
    DATEDIFF(death, birth) AS days,
    DATEDIFF(death, birth) / 365 AS years
FROM
    sampdb.president
LIMIT 5;
```



```
+------------+------------+------+------+----------+-------+---------+
| birth      | death      | yr   | mnt  | mnt_name | days  | years   |
+------------+------------+------+------+----------+-------+---------+
| 1732-02-22 | 1799-12-14 | 1732 |    2 | February | 24767 | 67.8548 |
| 1735-10-30 | 1826-07-04 | 1735 |   10 | October  | 33119 | 90.7370 |
| 1743-04-13 | 1826-07-04 | 1743 |    4 | April    | 30397 | 83.2795 |
| 1751-03-16 | 1836-06-28 | 1751 |    3 | March    | 31150 | 85.3425 |
| 1758-04-28 | 1831-07-04 | 1758 |    4 | April    | 26729 | 73.2301 |
+------------+------------+------+------+----------+-------+---------+
```

Putting it together

We can combine records, operations and functions to calculate and format output

Clear Run

```
SELECT
    CONCAT(
        first_name,
        " ",
        last_name,
        " lived ",
        ROUND(DATEDIFF(death, birth) / 365, 1),
        " years"
    ) AS sentence
FROM
    sampdb.president
LIMIT 5;

```

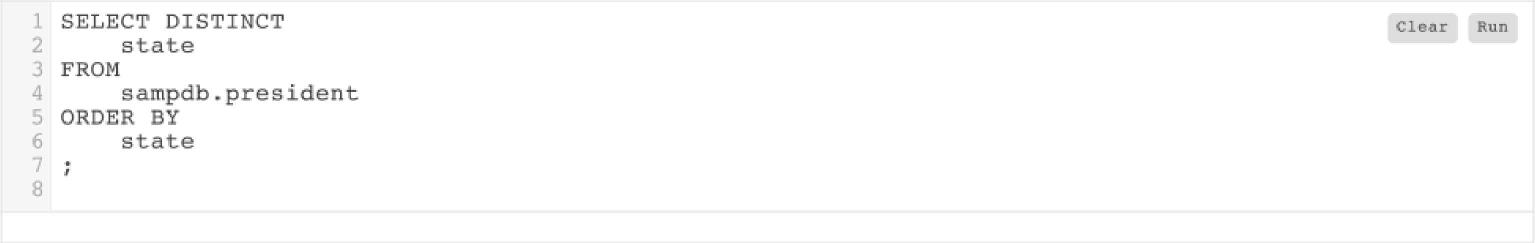
Clear Run

```
+-----------------------------------+
| sentence                          |
+-----------------------------------+
| George Washington lived 67.9 years |
| John Adams lived 90.7 years       |
| Thomas Jefferson lived 83.3 years |
| James Madison lived 85.3 years    |
| James Monroe lived 73.2 years     |
+-----------------------------------+

```

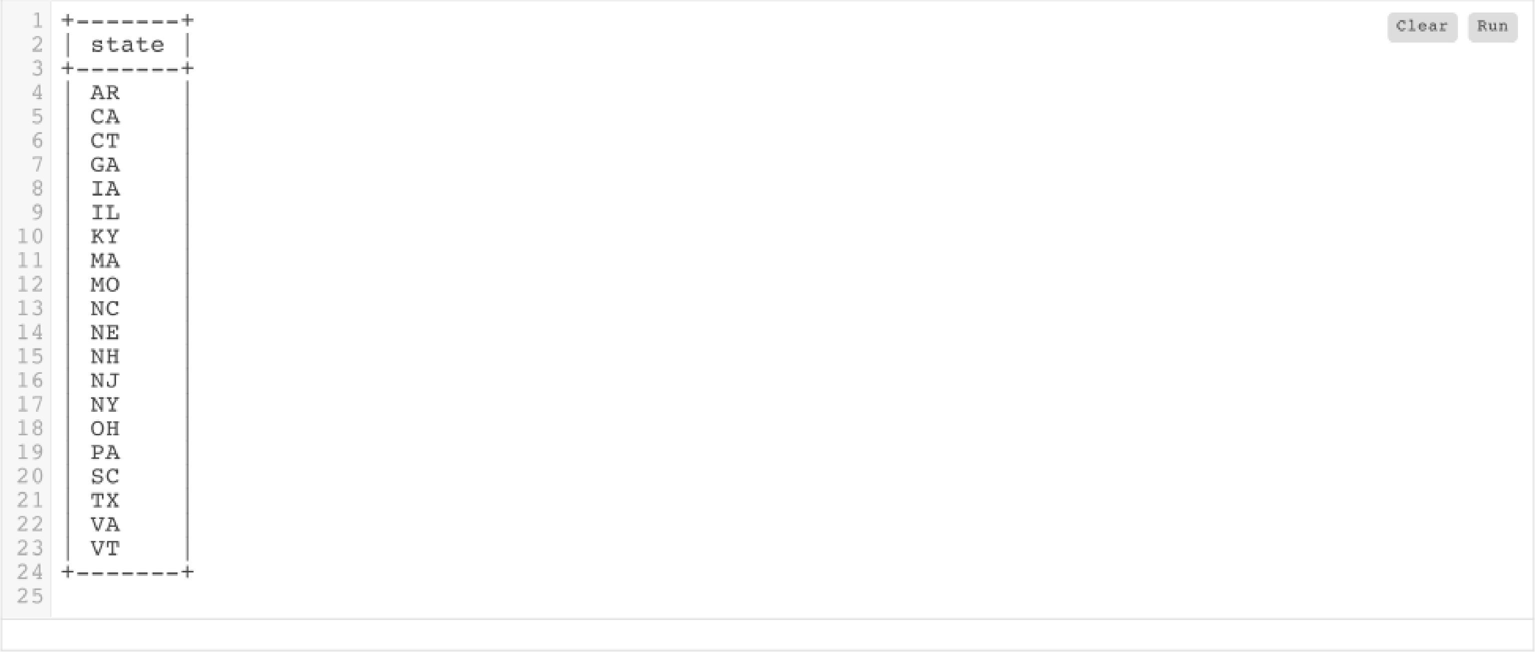
More on Aggregate Functions

We attack this through dataset exploration

SELECT DISTINCT gives us the set of values in an attribute -- no repetitions



```
SELECT DISTINCT
    state
FROM
    sampdb.president
ORDER BY
    state
;

```

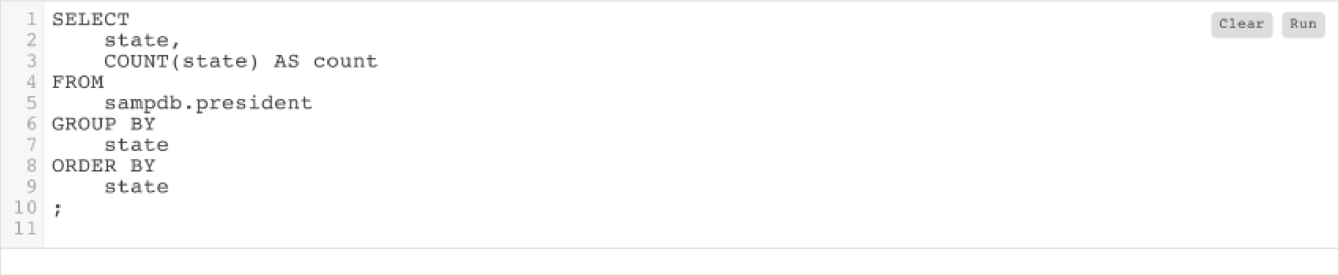


```
+-------+
| state |
+-------+
| AR    |
| CA    |
| CT    |
| GA    |
| IA    |
| IL    |
| KY    |
| MA    |
| MO    |
| NC    |
| NE    |
| NH    |
| NJ    |
| NY    |
| OH    |
| PA    |
| SC    |
| TX    |
| VA    |
| VT    |
+-------+

```

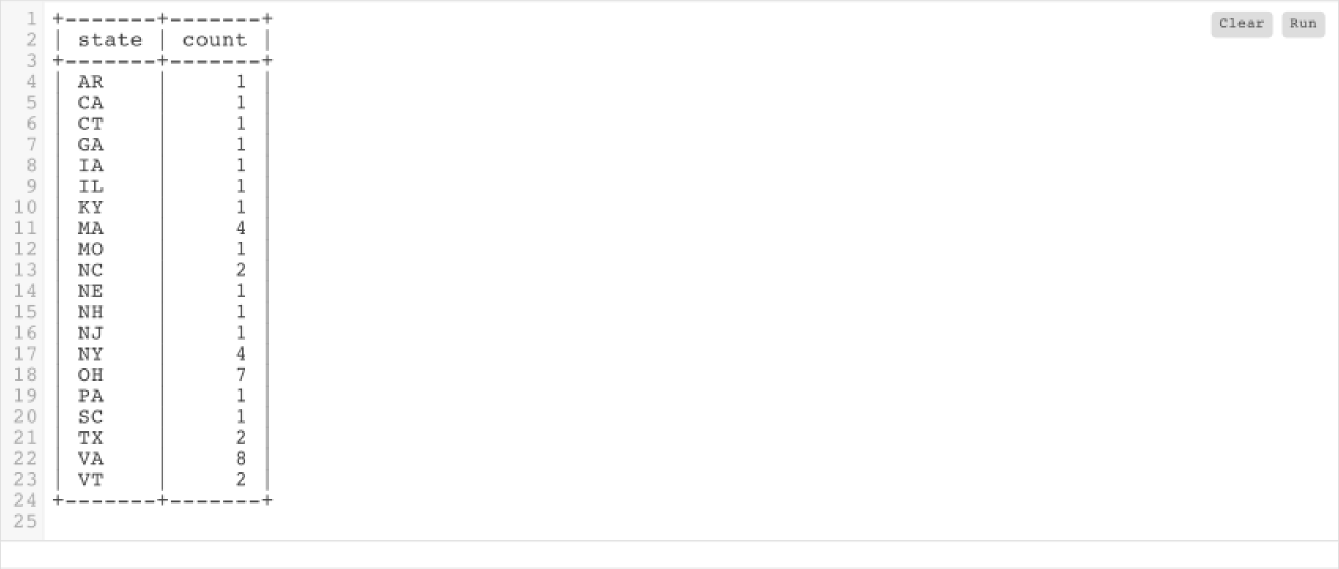
This is basically what we get from GROUP BY

GROUP BY subdivides the dataset into subsets

Each subset is characterized by having the same value for the GROUP BY attribute



```
SELECT
    state,
    COUNT(state) AS count
FROM
    sampdb.president
GROUP BY
    state
ORDER BY
    state
;
```



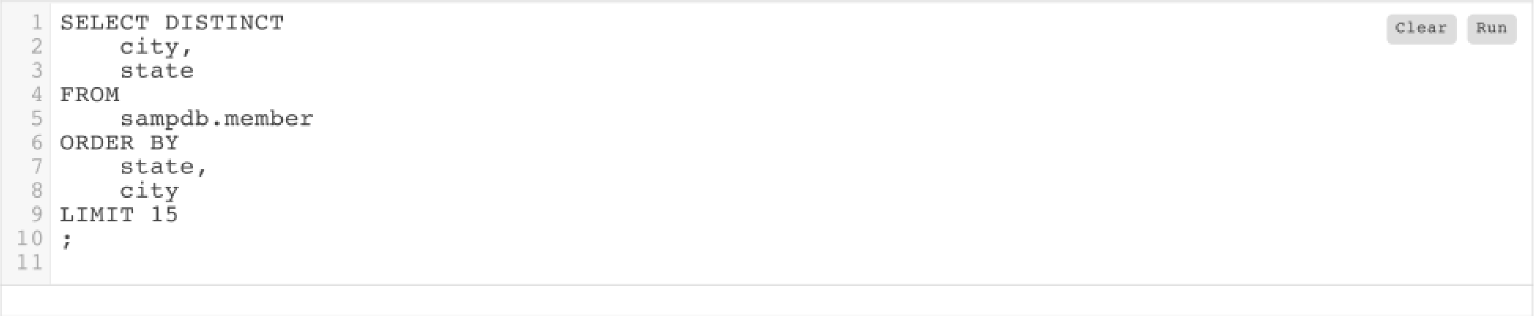
```
+-------+-------+
| state | count |
+-------+-------+
| AR    |     1 |
| CA    |     1 |
| CT    |     1 |
| GA    |     1 |
| IA    |     1 |
| IL    |     1 |
| KY    |     1 |
| MA    |     4 |
| MO    |     1 |
| NC    |     2 |
| NE    |     1 |
| NH    |     1 |
| NJ    |     1 |
| NY    |     4 |
| OH    |     7 |
| PA    |     1 |
| SC    |     1 |
| TX    |     2 |
| VA    |     8 |
| VT    |     2 |
+-------+-------+
```

Same analysis, against member

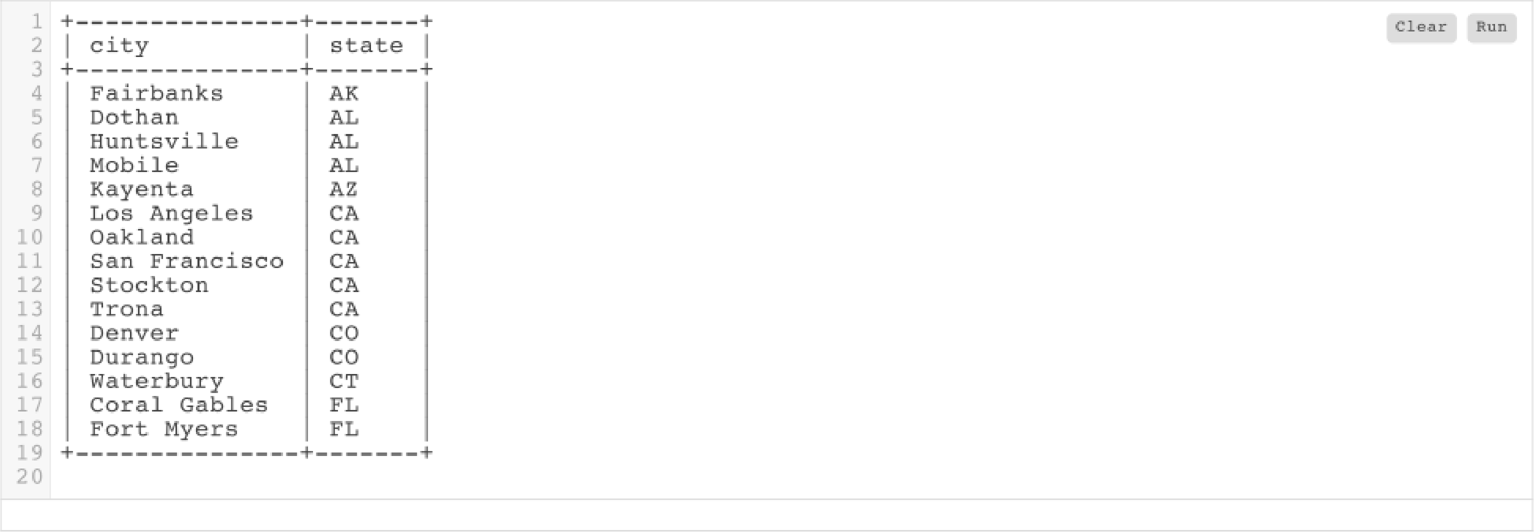
```
SELECT
    state,
    COUNT(state) AS count
FROM
    sampdb.member
GROUP BY
    state
ORDER BY
    state
LIMIT 15;
```

```
+-------+-------+
| state | count |
+-------+-------+
| AK    |     1 |
| AL    |     3 |
| AZ    |     1 |
| CA    |     6 |
| CO    |     3 |
| CT    |     1 |
| FL    |     5 |
| GA    |     3 |
| HI    |     1 |
| IA    |     2 |
| ID    |     1 |
| IL    |     6 |
| IN    |     3 |
| KS    |     2 |
| KY    |     2 |
+-------+-------+
```

DISTINCT also works by _tuples_



```
SELECT DISTINCT
    city,
    state
FROM
    sampdb.member
ORDER BY
    state,
    city
LIMIT 15
;
```



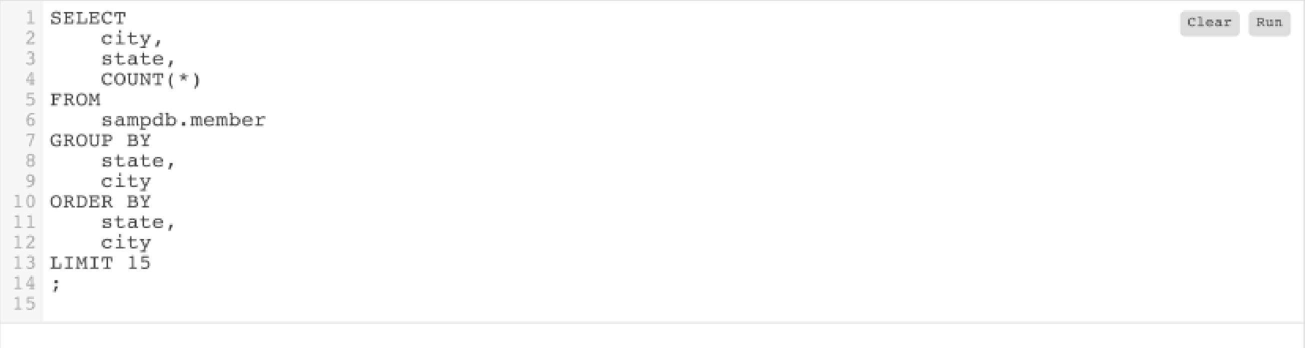
```
+---------------+-------+
| city          | state |
+---------------+-------+
| Fairbanks     | AK    |
| Dothan        | AL    |
| Huntsville    | AL    |
| Mobile        | AL    |
| Kayenta       | AZ    |
| Los Angeles   | CA    |
| Oakland       | CA    |
| San Francisco | CA    |
| Stockton      | CA    |
| Trona         | CA    |
| Denver        | CO    |
| Durango       | CO    |
| Waterbury     | CT    |
| Coral Gables  | FL    |
| Fort Myers    | FL    |
+---------------+-------+
```

Here we are getting a list of city / state value pairs that occur at least once in the data

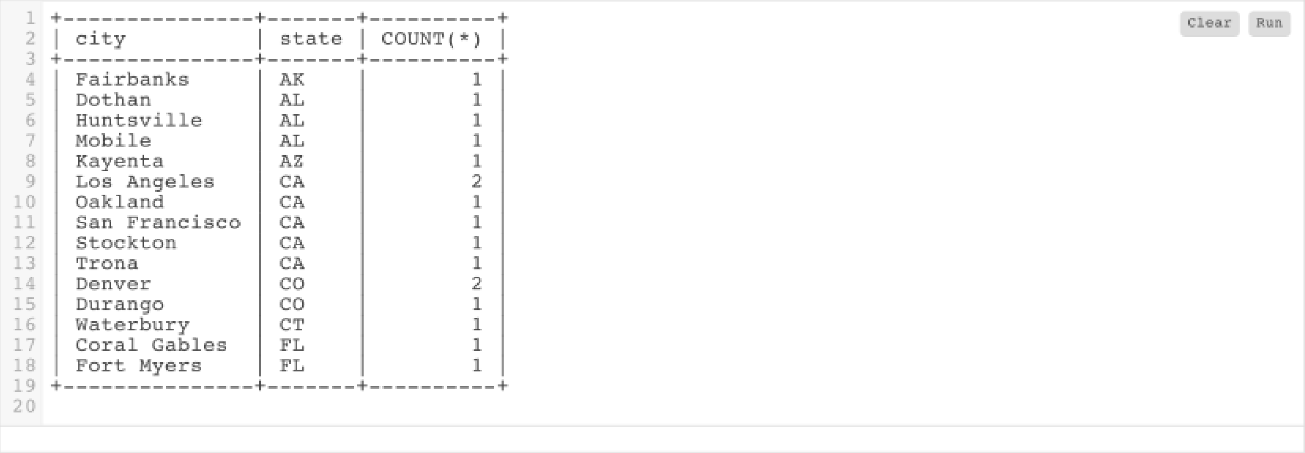
This is not _permutations_, e.g. the possible combinations of these values -- each of these _does_ appear at least once

As does GROUP BY

Grouping by _several_ attributes subdivides counts



```
SELECT
    city,
    state,
    COUNT(*)
FROM
    sampdb.member
GROUP BY
    state,
    city
ORDER BY
    state,
    city
LIMIT 15
;
```

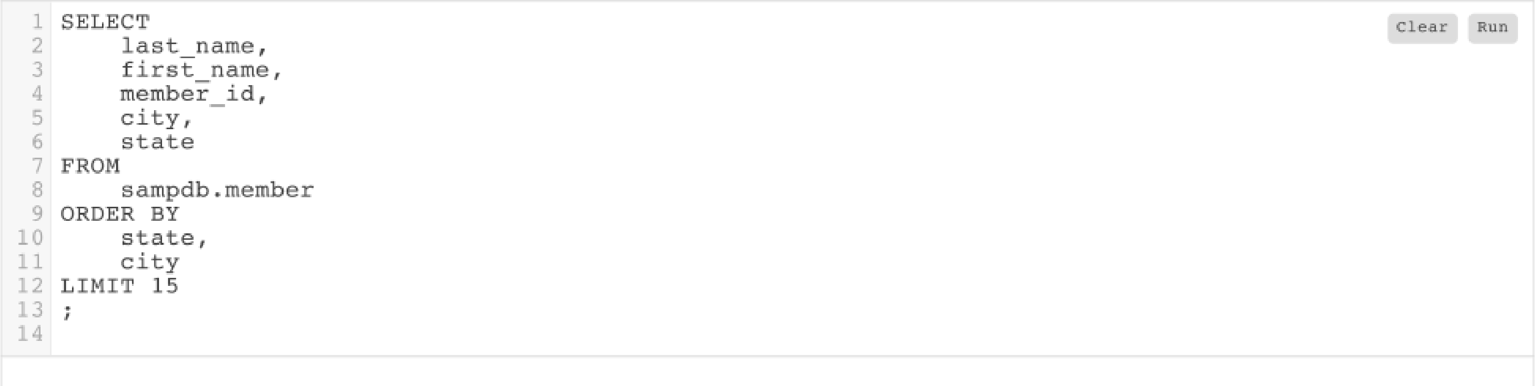


```
+----------------+-------+----------+
| city           | state | COUNT(*) |
+----------------+-------+----------+
| Fairbanks      | AK    |        1 |
| Dothan         | AL    |        1 |
| Huntsville     | AL    |        1 |
| Mobile         | AL    |        1 |
| Kayenta        | AZ    |        1 |
| Los Angeles    | CA    |        2 |
| Oakland        | CA    |        1 |
| San Francisco  | CA    |        1 |
| Stockton       | CA    |        1 |
| Trona          | CA    |        1 |
| Denver         | CO    |        2 |
| Durango        | CO    |        1 |
| Waterbury      | CT    |        1 |
| Coral Gables   | FL    |        1 |
| Fort Myers     | FL    |        1 |
+----------------+-------+----------+
```

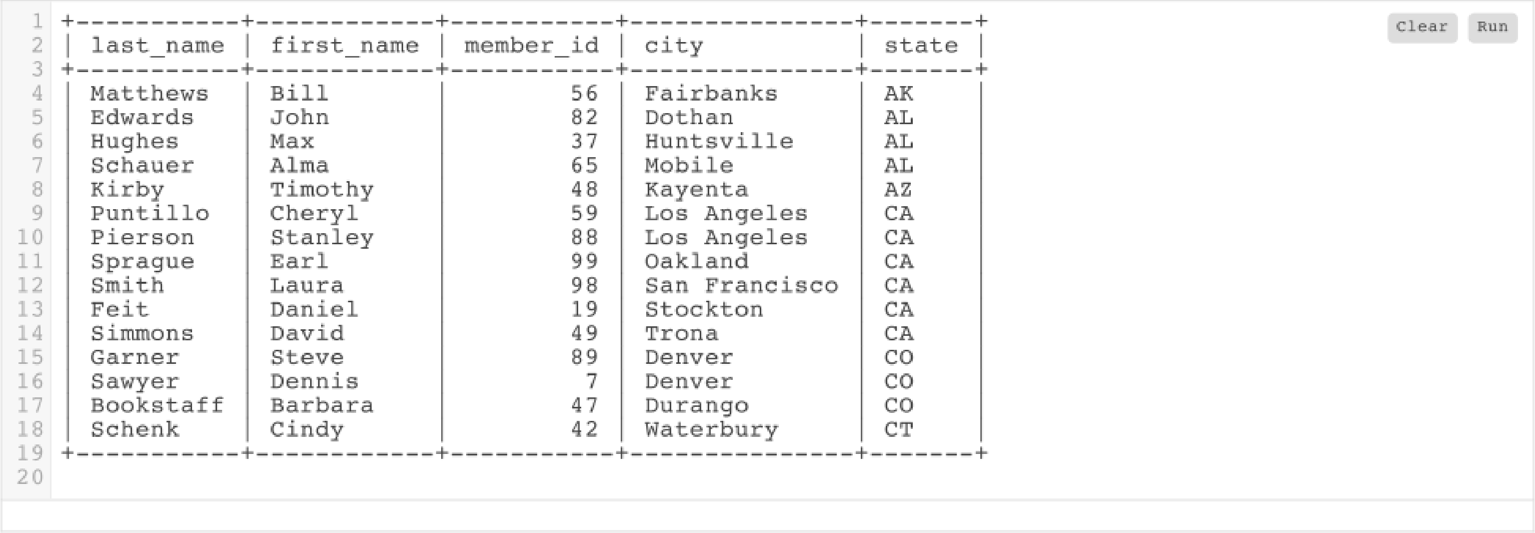
All the Alabama records are still in the output.

But the sum of Alabama records, which was 3, is now subdivided over three different cities

ORDER BY shows the grouping of the records



```
SELECT
    last_name,
    first_name,
    member_id,
    city,
    state
FROM
    sampdb.member
ORDER BY
    state,
    city
LIMIT 15
;
```



```
+-----------+------------+-----------+---------------+-------+
| last_name | first_name | member_id | city          | state |
+-----------+------------+-----------+---------------+-------+
| Matthews  | Bill       |        56 | Fairbanks     | AK    |
| Edwards   | John       |        82 | Dothan        | AL    |
| Hughes    | Max        |        37 | Huntsville    | AL    |
| Schauer   | Alma       |        65 | Mobile        | AL    |
| Kirby     | Timothy    |        48 | Kayenta       | AZ    |
| Puntillo  | Cheryl     |        59 | Los Angeles   | CA    |
| Pierson   | Stanley    |        88 | Los Angeles   | CA    |
| Sprague   | Earl       |        99 | Oakland       | CA    |
| Smith     | Laura      |        98 | San Francisco | CA    |
| Feit      | Daniel     |        19 | Stockton      | CA    |
| Simmons   | David      |        49 | Trona         | CA    |
| Garner    | Steve      |        89 | Denver        | CO    |
| Sawyer    | Dennis     |         7 | Denver        | CO    |
| Bookstaff | Barbara    |        47 | Durango       | CO    |
| Schenk    | Cindy      |        42 | Waterbury     | CT    |
+-----------+------------+-----------+---------------+-------+
```

Referring to SQL results in SQL queries -- Subqueries

Subqueries allow us to embed one query within another

These embedded queries are 'subqueries'

We have to watch the table returned by the subquery carefully

The returned table has to have the fields and row expected of it by the calling query

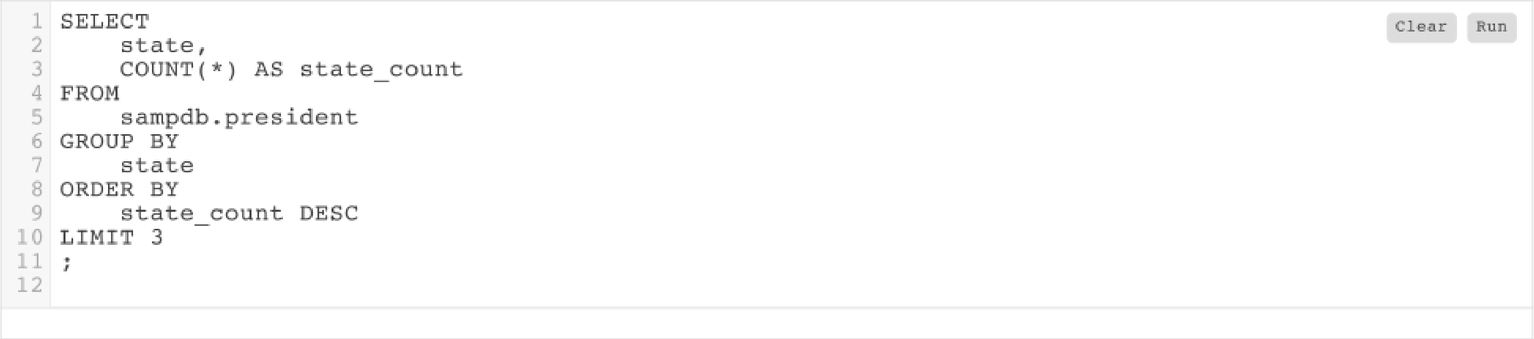
Two varieties, 'correlated' and 'uncorrelated'

'correlated' is cooler but harder, we'll do 'uncorrelated' first

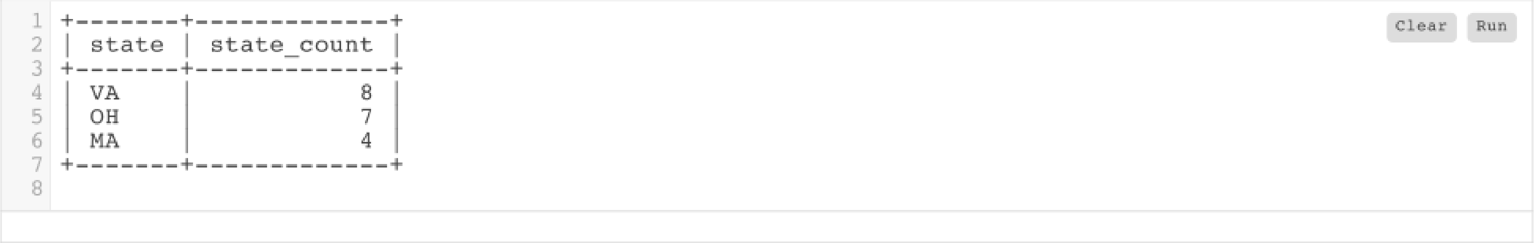
Presidents from the most presidential states

Say we want a list of those presidents from the three states that have sent the most presidents

We can get the list by a query:



```
SELECT
    state,
    COUNT(*) AS state_count
FROM
    sampdb.president
GROUP BY
    state
ORDER BY
    state_count DESC
LIMIT 3
;
```



```
+-------+-------------+
| state | state_count |
+-------+-------------+
| VA    |           8 |
| OH    |           7 |
| MA    |           4 |
+-------+-------------+
```

Hard-code the values

We can put those values into a query

Clear Run

```
SELECT
    last_name,
    first_name,
    state
FROM
    sampdb.president
WHERE
    state IN
    (
        'VA',
        'OH',
        'MA'
    )
ORDER BY
    state
;


```

Clear Run

```
+------------+---------------+-------+
| last_name  | first_name    | state |
+------------+---------------+-------+
| Bush       | George H.W.   | MA    |
| Adams      | John Quincy   | MA    |
| Kennedy    | John F.       | MA    |
| Adams      | John          | MA    |
| Harding    | Warren G.     | OH    |
| Taft       | William H.    | OH    |
| McKinley   | William       | OH    |
| Harrison   | Benjamin      | OH    |
| Garfield   | James A.      | OH    |
| Hayes      | Rutherford B. | OH    |
| Grant      | Ulysses S.    | OH    |
| Taylor     | Zachary       | VA    |
| Tyler      | John          | VA    |
| Harrison   | William H.    | VA    |
| Monroe     | James         | VA    |
| Wilson     | Woodrow       | VA    |
| Madison    | James         | VA    |
| Jefferson  | Thomas        | VA    |
| Washington | George        | VA    |
+------------+---------------+-------+

```

But, Kludgy!

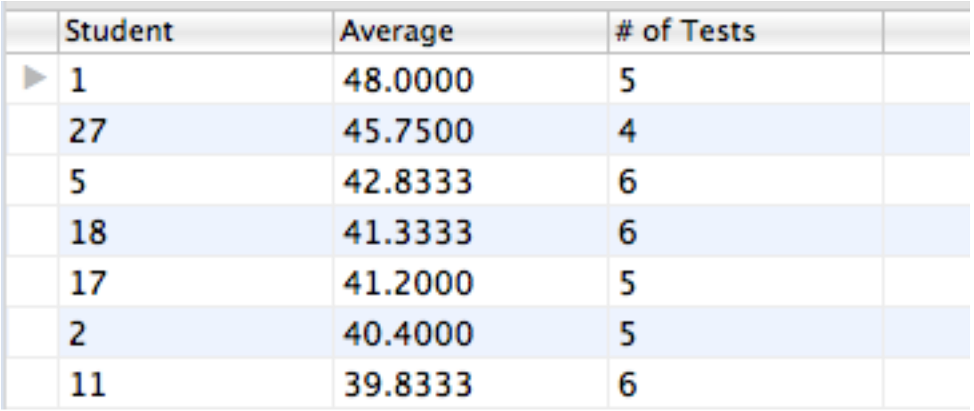
What if the data changes?

Joins

A basic query:

```
SELECT
   student_id AS Student,
   AVG(score) AS Average,
   COUNT(score) AS "# of Tests"
FROM
   sampdb.score
GROUP BY
   student_id
ORDER BY
   Average DESC
```

- Returns each student’s average

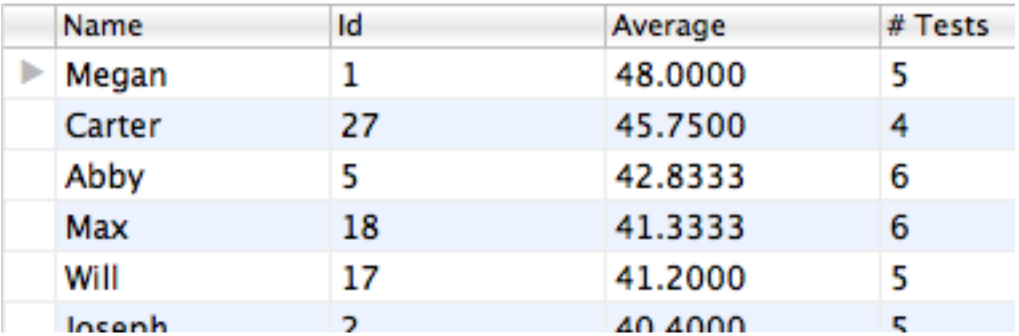


	Student	Average	# of Tests
▶	1	48.0000	5
	27	45.7500	4
	5	42.8333	6
	18	41.3333	6
	17	41.2000	5
	2	40.4000	5
	11	39.8333	6

- But can we get the student’s name rather than their id?

Yes

```
SELECT
   st.name AS          Name,
   scr.student_id AS   Id,
   AVG(scr.score) AS   Average,
   COUNT(scr.score) AS "# Tests"
FROM
   sampdb.score scr
INNER JOIN
   sampdb.student st
ON
   scr.student_id = st.student_id
GROUP BY
   scr.student_id
ORDER BY
   Average DESC
```



Name	Id	Average	# Tests
Megan	1	48.0000	5
Carter	27	45.7500	4
Abby	5	42.8333	6
Max	18	41.3333	6
Will	17	41.2000	5
Joseph	2	40.4000	5

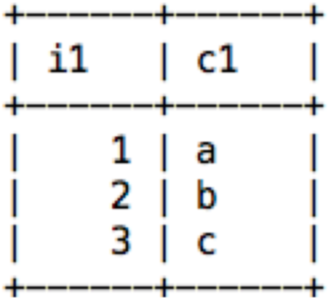
Breaking down the query

```
SELECT
   st.name AS        Name,
   scr.student_id AS   Id,
   AVG(scr.score) AS   Average,
   COUNT(scr.score) AS "# Tests"
FROM
   sampdb.score scr
INNER JOIN
    sampdb.student st
ON
    scr.student_id = st.student_id
GROUP BY
   scr.student_id
ORDER BY
   Average DESC
```

- A join combines rows from different tables
- The "ON" clause specifies conditions for combining records
  - Here, records with the same student_id value are combined into a single record
  - The SELECT clause still specifies which fields are displayed from that combined record
- INNER JOIN specifies which table to join data from
  - The addition of "scr" and "st" in the specification of tables provides alias values for reference by the other clauses
  - Without these the query wouldn't know which table it should find a field in

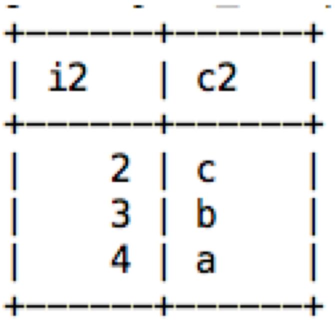
Two Really Simple Tables

- T1



```
+------+------+
| i1   | c1   |
+------+------+
|    1 | a    |
|    2 | b    |
|    3 | c    |
+------+------+
```

- t2

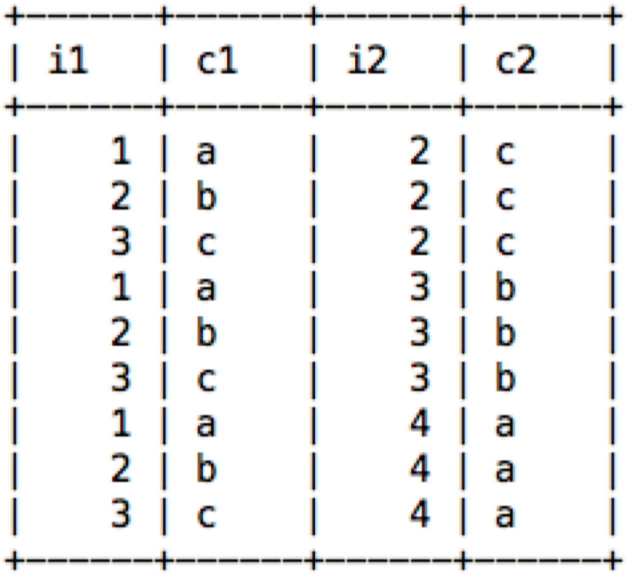


```
+------+------+
| i2   | c2   |
+------+------+
|    2 | c    |
|    3 | b    |
|    4 | a    |
+------+------+
```

Inner Join: All Rows Matched

- A simple inner join matches each row in one table with each row in the other
- So joining a 3 row table with a 3 row table produces a 9 row table
- Obviously we don't want all those rows

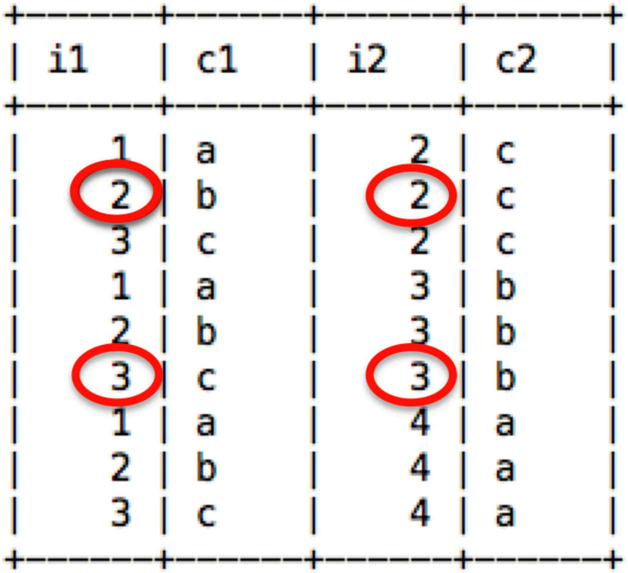
SELECT * FROM join_sample.t1 INNER JOIN join_sample.t2;



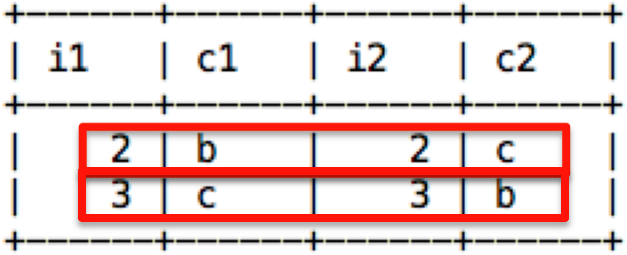
```
+------+------+------+------+
| i1   | c1   | i2   | c2   |
+------+------+------+------+
|    1 | a    |    2 | c    |
|    2 | b    |    2 | c    |
|    3 | c    |    2 | c    |
|    1 | a    |    3 | b    |
|    2 | b    |    3 | b    |
|    3 | c    |    3 | b    |
|    1 | a    |    4 | a    |
|    2 | b    |    4 | a    |
|    3 | c    |    4 | a    |
+------+------+------+------+
```

Limiting Inner Join Results

```
SELECT
   *
FROM
   join_sample.t1

INNER JOIN
   join_sample.t2

WHERE
   join_sample.t1.i1 = join_sample.t2.i2

;
```



```
+------+------+------+------+
| i1   | c1   | i2   | c2   |
+------+------+------+------+
|    1 | a    |    2 | c    |
|    2 | b    |    2 | c    |
|    3 | c    |    2 | c    |
|    1 | a    |    3 | b    |
|    2 | b    |    3 | b    |
|    3 | c    |    3 | b    |
|    1 | a    |    4 | a    |
|    2 | b    |    4 | a    |
|    3 | c    |    4 | a    |
+------+------+------+------+
```

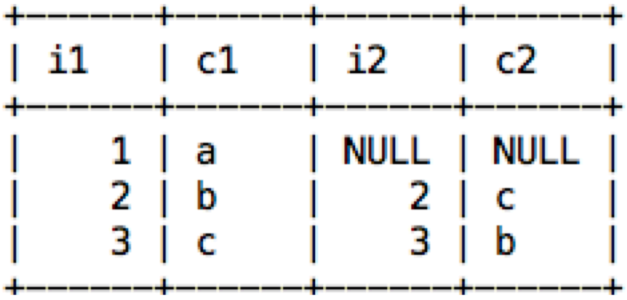


```
+------+------+------+------+
| i1   | c1   | i2   | c2   |
+------+------+------+------+
|    2 | b    |    2 | c    |
|    3 | c    |    3 | b    |
+------+------+------+------+
```

Left Join

- Get all rows from the “left” table, each with that row from the “right” table that matches on the specified fields

```
SELECT
   *
FROM
   join_sample.t1
LEFT JOIN
   join_sample.t2
   ON
      join_sample.t1.i1 = join_sample.t2.i2
;
```



```
+------+------+------+------+
| i1   | c1   | i2   | c2   |
+------+------+------+------+
|    1 | a    | NULL | NULL |
|    2 | b    |    2 | c    |
|    3 | c    |    3 | b    |
+------+------+------+------+
```

Contact

gordon@practicalhorseshoeing.com