THE GEORGE WASHINGTON UNIVERSITY

WASHINGTON, DC

4. SQL SELECT Lab

CSCI 2541 Database Systems & Team Projects

Wood & Chaufournier

Slides adapted from Prof. Bhagi Narahari; Silberschatz, Korth, and Sudarshan; and Ramakrishnan, Gerhke, and Lawrence

Announcements

Say Hello on Slack!

Expect Relational Algebra HW soon

- SQL Lab today
- More SQL HW later

Extra resources:

- Recommended text: Database Systems Concepts
- RA equation building web link (check website)
- SELECT Star tutorial zine (check Slack)

Julia Evans

Last time…

this time…

SELECT Queries

Allow you to retrieve information from your database

Can be simple:

```
SELECT * FROM Instructor;
```

```
 id          name              department  office
----------  ---------------  ----------  ----------
   1           Modesty Tournay  MENG        173
   2           Roberto Finlais  CIVIL       185
```

Or complex:

```
SELECT name, class, grade,
    ROW_NUMBER()
      OVER (
        PARTITION BY class
        ORDER BY grade DESC
      )
      AS rank_in_class
FROM grades;
```

```
name       class      grade      rank_in_class
------     ---------  --------   -------------
lucia      1          98         1
juan       1          93         2
chen       2          90         1
raph       2          88         2
```

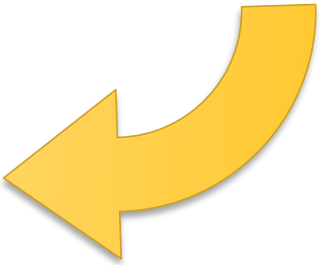
SELECT Syntax

```
SELECT ID, office, name
FROM instructor
```

$$\Pi_{ID,office,name}\ (\ instructor\ )$$

instructor Relation

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Sam	ECE	TOMP 231
E7	Sarah	LIT	Gelman 213
E8	Sarah	CS	SEH 125



ID	office	name
E1	SEH 111	Sam
E2	SEH 231	Sam
E3	SEH 321	Lily
E4	SEH 451	Lily
E5	SEH 341	Nick
E6	TOMP 231	Sam
E7	Gelman 213	Sarah
E8	SEH 125	Sarah

SELECT + WHERE

WHERE defines a predicate to match rows

```
SELECT name FROM instructor
WHERE department = 'CS' OR
department = 'EE';
```

$$\prod_{\text{name}} (\sigma_{\text{department} = \text{“CS”} \vee \text{department} = \text{“EE”}} (\text{instructor}))$$

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Susan	EE	TOMP 231
E7	Sarah	LIT	Gelman 213
E8	Sarah	CS	SEH 125

name
Sam
Sam
Sarah
Susan

By default, SQL DBMS will not enforce set uniqueness in the output

Logic operators:
∧ **AND**, ∨ **OR**,
¬ **NOT**

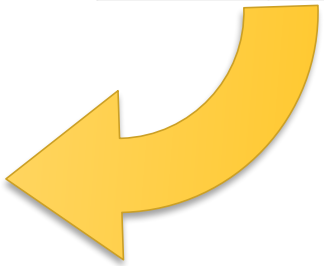
SELECT + WHERE + LIKE + IN

A WHERE predicate can use other keywords

- **LIKE** is used for string matching - **%** acts as a wildcard
- **IN** lets you list a set to test for equality

```
SELECT name FROM instructor
WHERE office LIKE 'TOMP%' OR
department IN ('BIO', 'ME');
```

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Susan	EE	TOMP 231
E7	Sarah	LIT	Gelman 213
E8	Sarah	CS	SEH 125



name
Lily
Nick
Susan

SELECT + ORDER + LIMIT

Tables don't have a defined sorting order, but you can control this with **ORDER BY** ← ASC DESC

LIMIT controls how many rows are returned

```
SELECT * FROM Instructor ORDER BY name LIMIT 5;

id          name              department  office
----------  ----------------  ----------  ----------
7           Birdie Greguoli   MATH        104
4           Brian Trewett     MATH        161
21          Candy Jeffries    CSCI        141
22          Carmon Londsdal   STAT        145
20          Claiborne Titch   CIVIL       150
```

Activity 1 - Individual

Course

ID	Title	InstructorID
1	Intro to EE	E1
2	Intro to CS	E2
3	Intro to ME	E3

Enrollment

CourseID	StudentID	Year
1	5	2020
2	6	2019
3	7	2020

Student

ID	name	Major	Email
5	Brooke Shimon	LIT	bshimon4@google.com
6	Dolf Fergusson	ME	dferg@gmail.com
7	Bebe Goggin	ECE	bgogg@gmail.com
8	George Harrison	BIO	harrison@gmail.com
9	Bilbo Baggins	ME	myprecious@gmail.com

Instructor

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321

In a google document write out the sql syntax for the following four queries:

1. Find all of the students.
2. Find only three instructors.
3. Find all students who are have a major of Mechanical or Biomedical Engineering
4. Find just the name of the courses offered sorted by instructorID.

Let's run some actual SQL!

We will use repl.it's support for **sqlite**

- A simple "embedded" database -> you don't need to run a separate database server

You can enter queries into the console, or you can write them in a file and "Run" the code

- We provide you a file that automatically creates a set of tables and loads data into it
- You will need to Run our script at least once to setup the data (running it multiple times is fine, the DB is reset with each run)

Aggregation Functions

SQL can do some helpful calculations

- **AVG, MIN, MAX, SUM, COUNT**

```
SELECT COUNT(StudentID) FROM Enrollment WHERE CourseID=12;

COUNT(StudentID)
----------------
4
```

```
SELECT MAX(year) AS LatestYear FROM Enrollment;

LatestYear
----------
2021
```

- Also: Use **AS** to rename an output column!

Activity 2 - Pairs

Fork the following repl.it: https://repl.it/@thelimeburner/Lab4

1. Enter all your queries from activity 2 and make sure they work successfully.

2. Write out the sql syntax(and run them) to the following queries:
    1. Count the total number of students.
    2. Find the maximum course ID from the courses table.
    3. Find the total sum of student ID's.
    4. Find all student ID's enrolled in course 17.
    5. Find all course ID's offered in 2019.

3. You will submit your queries later in a google form

GROUP BY

What if we want to group together similar rows?

How many students are enrolled in each course?

Enrollment

CourseID	StudentID	Year
1	123	2019
2	123	2019
1	456	2019
1	678	2020
2	987	2019
…	…	…

We need to "group" rows based on the CourseID

Then we need to count the number of StudentIDs

GROUP BY

What if we want to group together similar rows?

How many students are enrolled in each course?

```
SELECT CourseID, COUNT(StudentID) as NumS
FROM Enrollment GROUP BY CourseID LIMIT 4;

CourseID    NumS
----------  -----
1           3
2           1
3           2
4           1
```

CourseID	StudentID	Year
1	123	2019
2	123	2019
1	456	2019
1	678	2020
2	987	2019
…	…	…

We need to “group” rows based on the CourseID

Then we need to count the number of StudentIDs

GROUP BY

What if we want to group together similar rows?

How many students are enrolled in each course?

```
SELECT CourseID, COUNT(StudentID) as NumS
FROM Enrollment GROUP BY CourseID;
```

VS

```
SELECT CourseID, COUNT(StudentID) as NumS
FROM Enrollment GROUP BY CourseID, Year;
```

CourseID	StudentID	Year
1	123	2019
2	123	2019
1	456	2019
1	678	2020
2	987	2019
…	…	…

What is the difference between these?

GROUP BY and HAVING

How do we combine filtering and grouping?

- WHERE statements happen BEFORE grouping

```
SELECT CourseID, COUNT(StudentID) as NumS
FROM Enrollment WHERE Year=2019 GROUP BY CourseID;
```

To filter AFTER grouping, we use HAVING instead

```
SELECT CourseID, COUNT(StudentID) as NumS
FROM Enrollment GROUP BY CourseID HAVING NumS > 5;
```

- Should operate on aggregated fields

```
SELECT month
FROM sales
GROUP BY month
HAVING SUM(price) > 100;
```

Month	Product	Price
Jan	tomato	2.00
Jan	grapes	3.99
Feb	water	1.99

Join Queries

Allow you to take two tables and combine them into one

class Relation

ID	Instructor	Class name	Building
1	E5	BIO101	SEH
2	E3	ME201	SEH
3	E1	EE301	SEH
4	E7	LIT101	Gelman
5	E6	ECE102	TOMP
6	E4	CE101	SEH
7	Null	CS401	SEH

instructor Relation

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Sam	ECE	TOMP 231
E7	Sarah	LIT	Gelman 213
E8	Sarah	CS	SEH 125
E9	David	CE	SEH 455

Join Queries: Inner Join

```
SELECT * FROM instructor INNER JOIN class ON
instructor.ID = class.Instructor
```

class Relation

ID	Instructor	Class name	Building
1	E5	BIO101	SEH
2	E3	ME201	SEH
3	E1	EE301	SEH
4	E7	LIT101	Gelman
5	E6	ECE102	TOMP
6	E4	CE101	SEH
7	Null	CS401	SEH

instructor Relation

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Sam	ECE	TOMP 231
E7	Sarah	LIT	Gelman 213
E9	David	CE	SEH 455

class.ID	Instructor	Class name	Building	instructor.ID	name	Department	Office
1	E5	BIO101	SEH	E5	Nick	BIO	SEH 341
2	E3	ME201	SEH	E3	Lily	ME	SEH 321
3	E1	EE301	SEH	E1	Sam	EE	SEH 111
4	E7	LIT101	Gelman	E7	Sarah	LIT	Gelman 213
5	E6	ECE102	TOMP	E6	Sam	ECE	Tomp 231
6	E4	CE101	SEH	E4	Lily	CE	SEH451

Join Queries: Left Join

```
SELECT * FROM class LEFT JOIN instructor ON
class.Instructor = instructor.ID
```

class Relation

ID	Instructor	Class name	Building
1	E5	BIO101	SEH
2	E3	ME201	SEH
3	E1	EE301	SEH
4	E7	LIT101	Gelman
5	E6	ECE102	TOMP
6	E4	CE101	SEH
7	Null	CS401	SEH

instructor Relation

ID	name	department	office
E1	Sam	EE	SEH 111
E2	Sam	CS	SEH 231
E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Sam	ECE	TOMP 231
E8	Sarah	CS	SEH 125
E9	David	CE	SEH 455

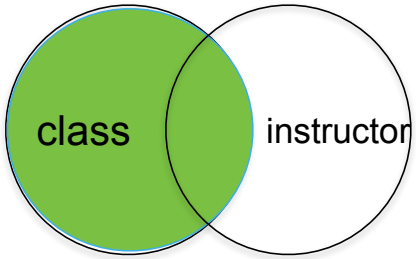
class.ID	Instructor	Class name	Building	instructor.ID	name	Department	Office
1	E8	CS101	SEH	E8	Sarah	CS	SEH125
2	E5	BIO101	SEH	E5	Nick	BIO	SEH 341
3	E3	ME201	SEH	E3	Lily	ME	SEH 321
4	E1	EE301	SEH	E1	Sam	EE	SEH 111
5	E7	LIT101	Gelman	Null	Null	Null	Null
6	E6	ECE102	TOMP	E6	Sam	ECE	Tomp 231
7	Null	CS401	SEH	Null	Null	Null	Null

Remembering Join Queries

Allow you to take two tables and combine them into one

Left Join

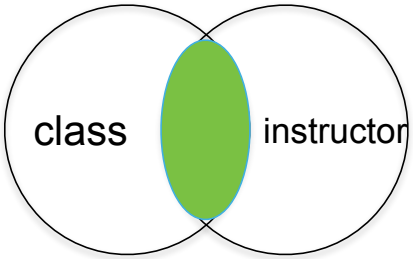
```
SELECT * FROM class
LEFT JOIN instructor ON
class.Instructor = instructor.ID
```



Includes every row in the left table, rows not in the right table are set to null

Inner Join

```
SELECT * FROM instructor
INNER JOIN class ON
instructor.ID = class.Instructor
```



Only includes rows that match the ON condition

Join Queries: Join + Where

```
SELECT * FROM instructor INNER JOIN class ON
instructor.ID = class.Instructor WHERE NOT class.Building = "SEH"
```

class Relation

ID	Instructor	Class name	Building
1	E5	BIO101	SEH
2	E3	ME201	SEH
3	E1	EE301	SEH
4	E7	LIT101	Gelman
5	E6	ECE102	TOMP
6	E4	CE101	SEH
7	Null	CS401	SEH

instructor Relation

ID	name	department	office
E1	Sam	EE	SEH 111
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E3	Lily	ME	SEH 321
E4	Lily	CE	SEH 451
E5	Nick	BIO	SEH 341
E6	Sam	ECE	TOMP 231
E7	Sarah	LIT	Gelman 213
E8	Sarah	CS	SEH 125
E9	David	CE	SEH 455

class.ID	Instructor	Class name	Building	instructor.ID	name	Department	Office
5	E7	LIT101	Gelman	E7	Sarah	LIT	Gelman 213
6	E6	ECE102	TOMP	E6	Sam	ECE	Tomp 231

Activity 3

Using this repl.it: https://repl.it/@thelimeburner/Lab43

1. Write out the sql syntax (and run them) to the following queries:
    1. Retrieve the name and address of all employees who work for the Research department.

    2. Retrieve the names of all employees who do not have a supervisor.

    3. For each project on which more than two employees work, retrieve the project number, project name, and the number of employees who work on the project.

    4. Find the payroll (i.e., sum of all the salaries of all employees), maximum salary, minimum salary and average salary in the Research department.

    5. Retrieve the list of employees and the projects they are working on, ordered by department and, within each department, ordered alphabetically by last name, first name.

2. Submit your queries using this form: **http://bit.ly/DB21-4**