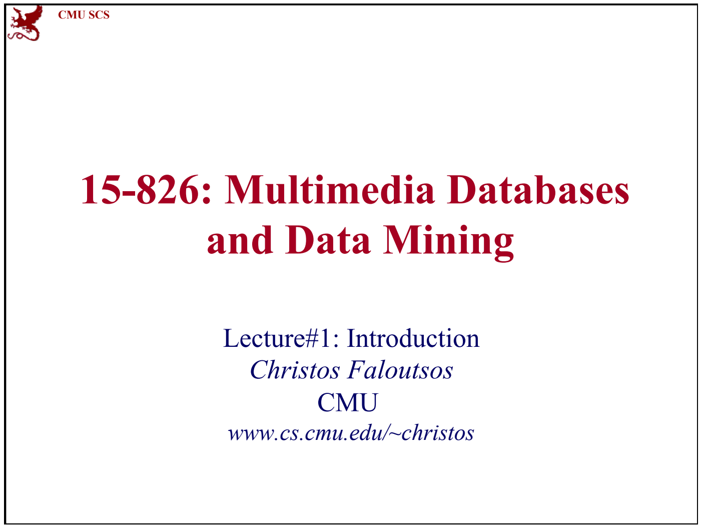

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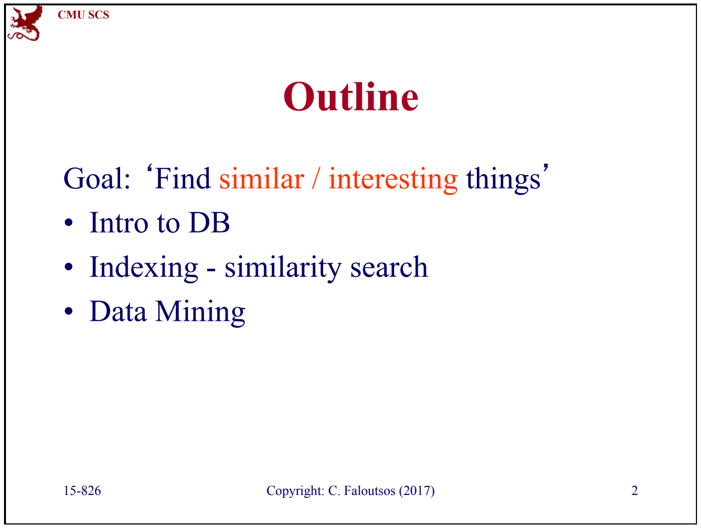
15-826: Multimedia Databases and Data Mining

Lecture#1: Introduction
Christos Faloutsos
CMU
www.cs.cmu.edu/~christos



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Outline

Goal: ‘Find similar / interesting things’

- Intro to DB
- Indexing - similarity search
- Data Mining

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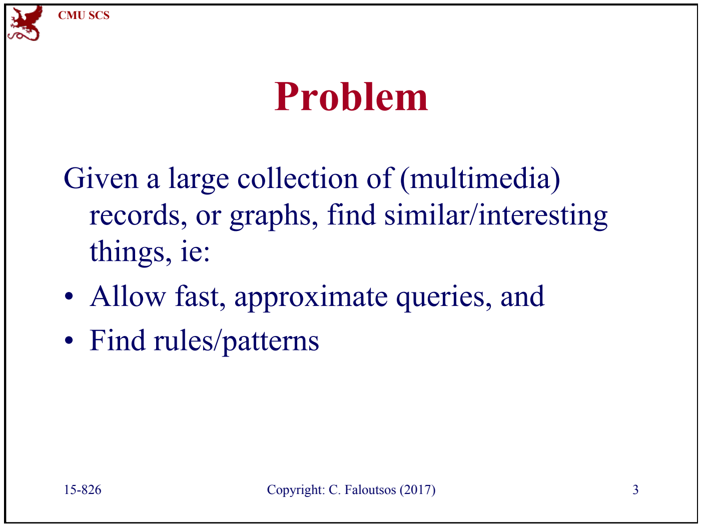

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Problem

Given a large collection of (multimedia) records, or graphs, find similar/interesting things, ie:

- Allow fast, approximate queries, and
- Find rules/patterns

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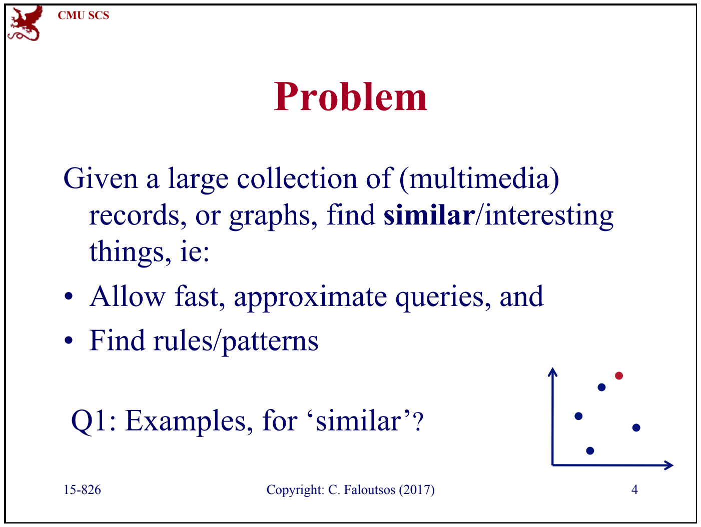

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Problem

Given a large collection of (multimedia) records, or graphs, find **similar**/interesting things, ie:

- Allow fast, approximate queries, and
- Find rules/patterns

Q1: Examples, for ‘similar’?

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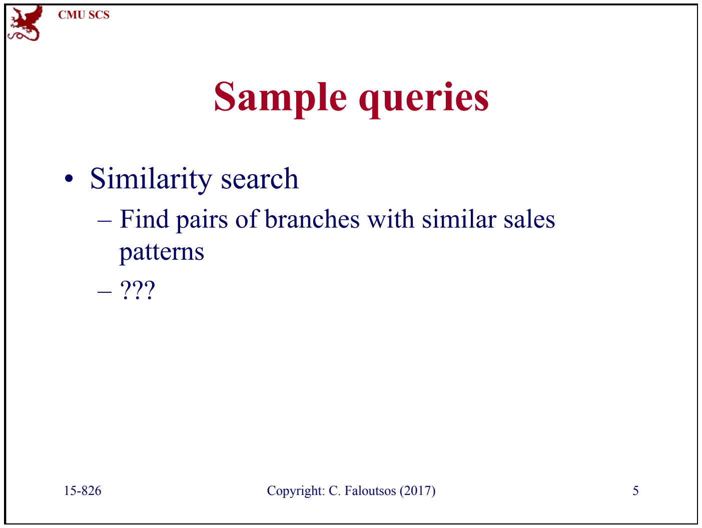
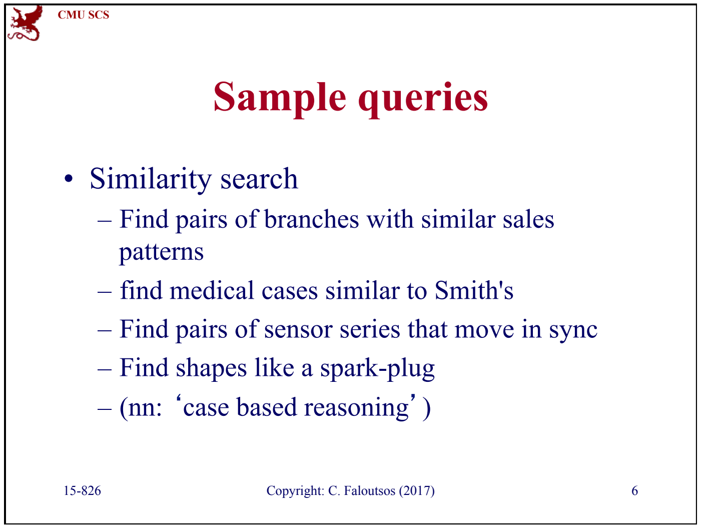


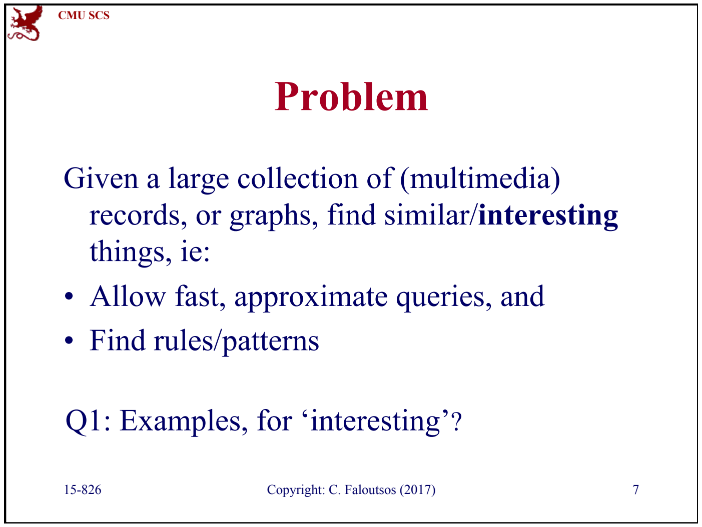
Sample queries

- Similarity search
  - Find pairs of branches with similar sales patterns
  - ???



Sample queries

- Similarity search
  - Find pairs of branches with similar sales patterns
  - find medical cases similar to Smith's
  - Find pairs of sensor series that move in sync
  - Find shapes like a spark-plug
  - (nn: ‘case based reasoning’)

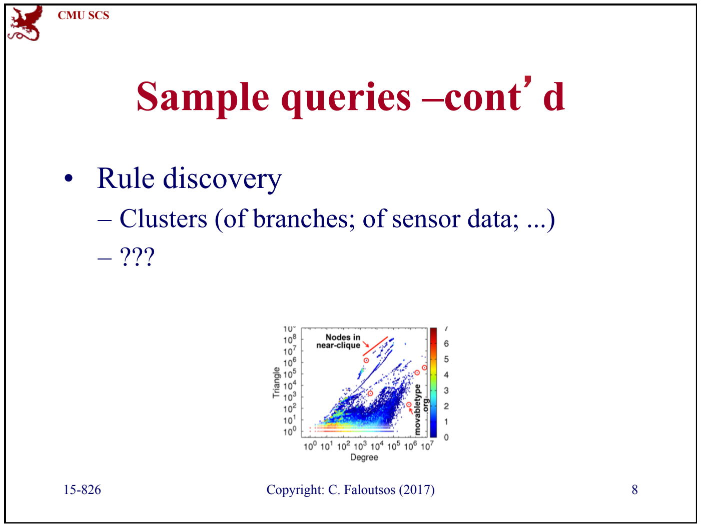


Problem

Given a large collection of (multimedia) records, or graphs, find similar/**interesting** things, ie:

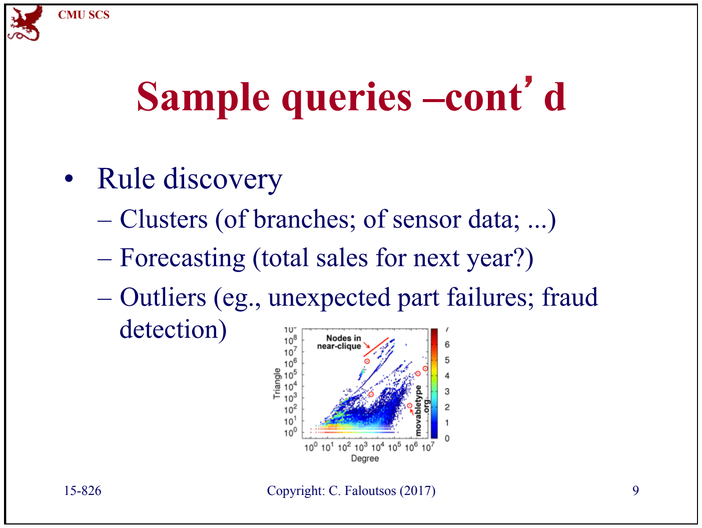
- Allow fast, approximate queries, and
- Find rules/patterns

Q1: Examples, for ‘interesting’?



Sample queries –cont’ d

- Rule discovery
  - Clusters (of branches; of sensor data; ...)
  - ???



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Sample queries –cont’ d

- Rule discovery
  - – Clusters (of branches; of sensor data; ...)
  - – Forecasting (total sales for next year?)
  - – Outliers (eg., unexpected part failures; fraud detection)

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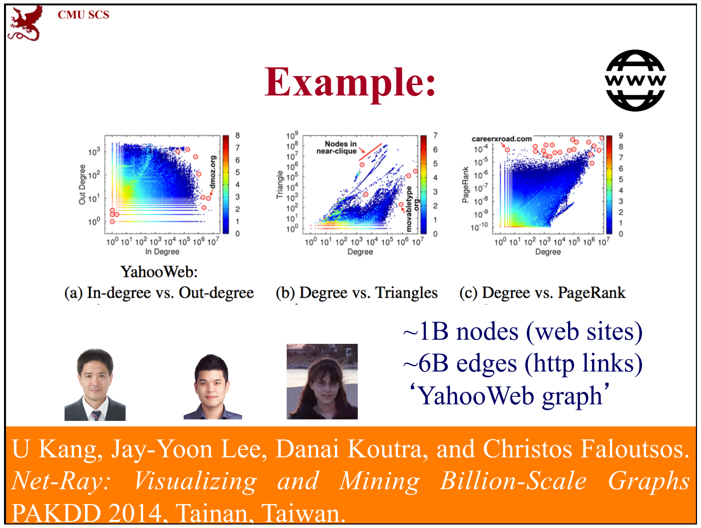

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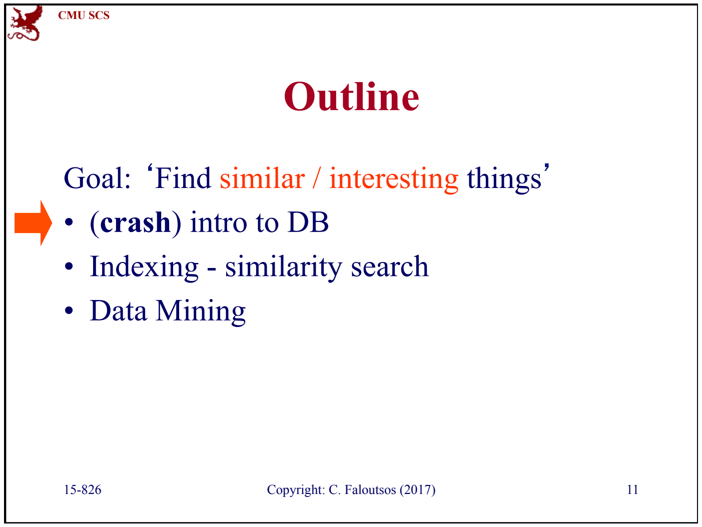
Example:

YahooWeb:
(a) In-degree vs. Out-degree (b) Degree vs. Triangles (c) Degree vs. PageRank

~1B nodes (web sites)
~6B edges (http links)
‘YahooWeb graph’

U Kang, Jay-Yoon Lee, Danai Koutra, and Christos Faloutsos. *Net-Ray: Visualizing and Mining Billion-Scale Graphs* PAKDD 2014, Tainan, Taiwan.



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Outline

Goal: ‘Find similar / interesting things’

- (**crash**) intro to DB
- Indexing - similarity search
- Data Mining

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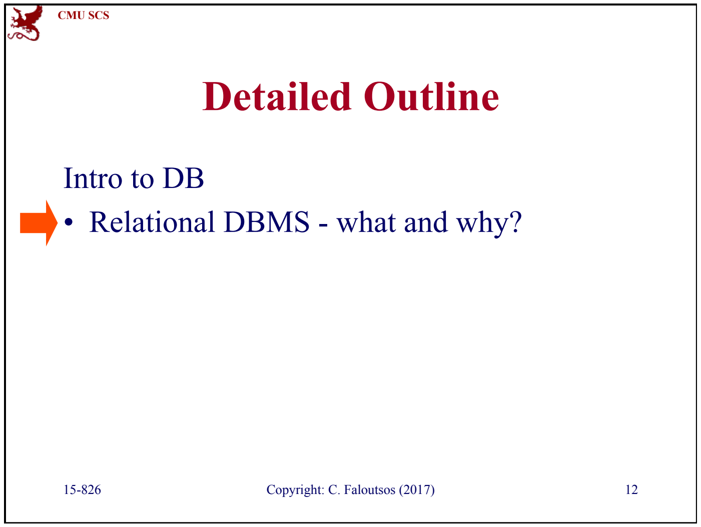

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Detailed Outline

Intro to DB

- Relational DBMS - what and why?

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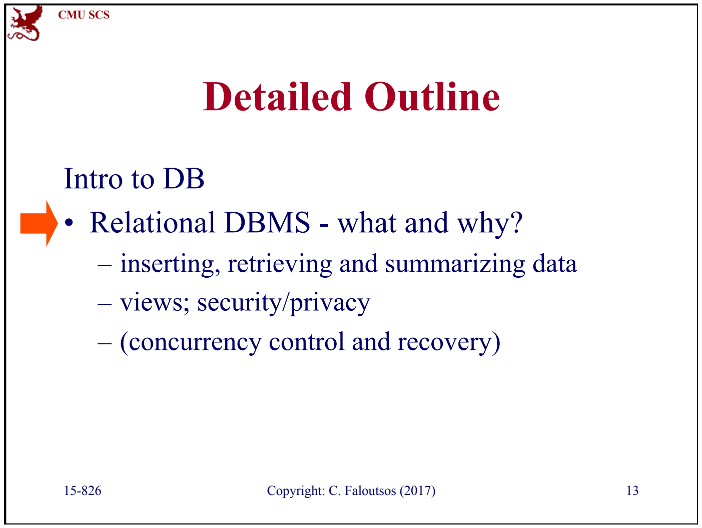
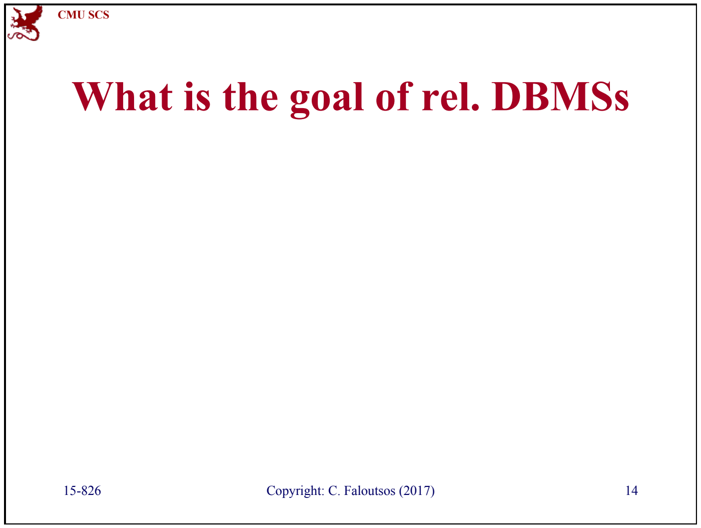


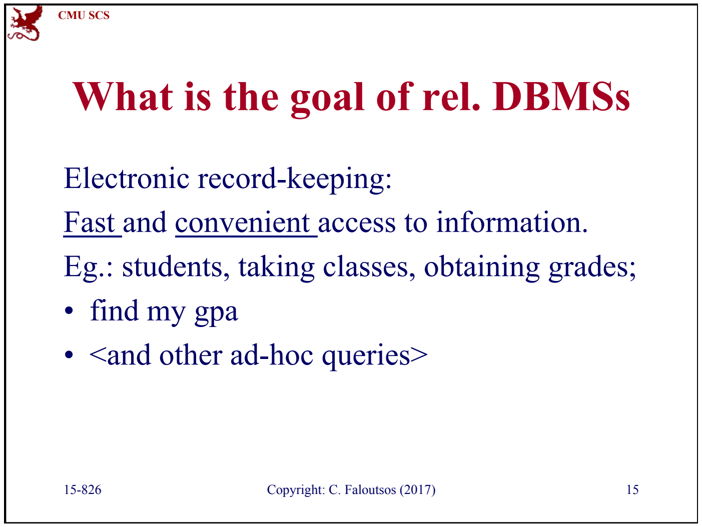
Detailed Outline

Intro to DB

- Relational DBMS - what and why?
  - inserting, retrieving and summarizing data
  - views; security/privacy
  - (concurrency control and recovery)



What is the goal of rel. DBMSs



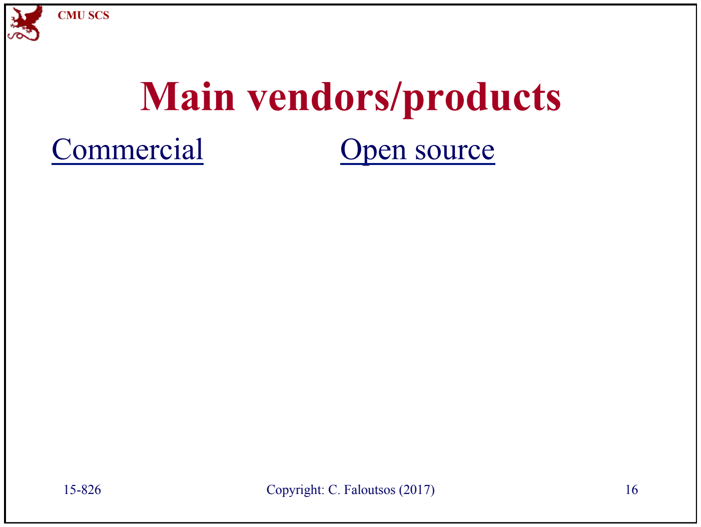
What is the goal of rel. DBMSs

Electronic record-keeping:

Fast and convenient access to information.

Eg.: students, taking classes, obtaining grades;

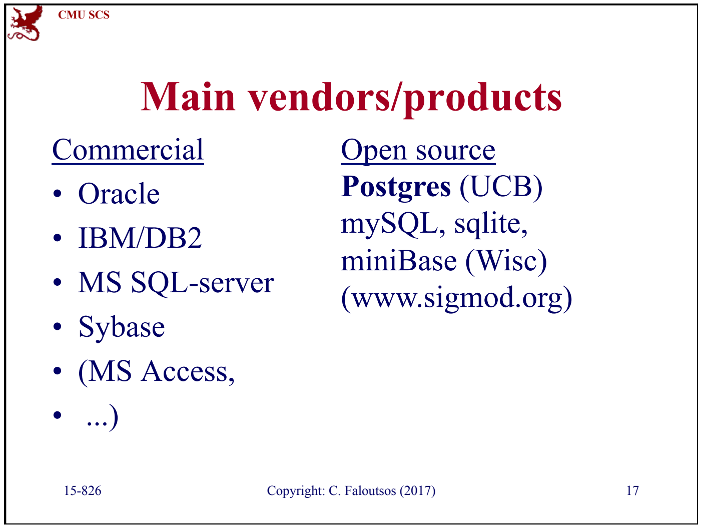
- find my gpa
- <and other ad-hoc queries>



Main vendors/products

Commercial

Open source



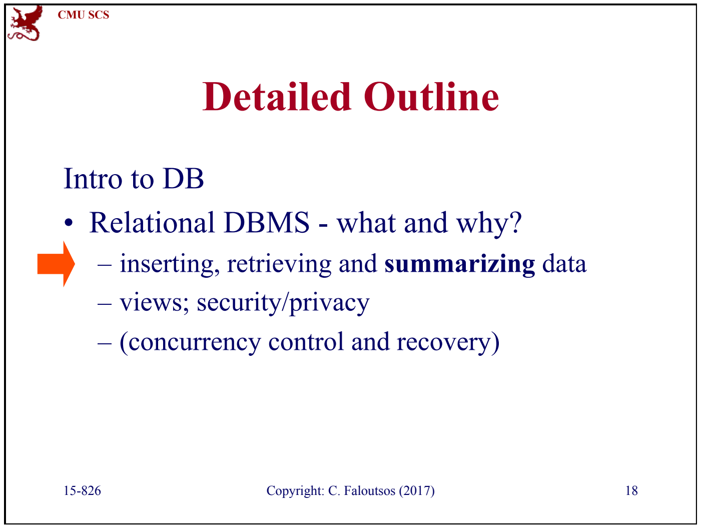
Main vendors/products

Commercial

- Oracle
- IBM/DB2
- MS SQL-server
- Sybase
- (MS Access,
- ...)

Open source

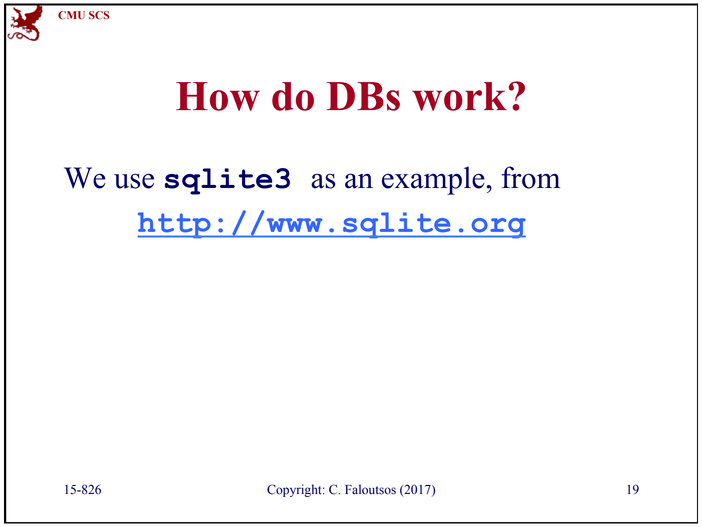
Postgres (UCB)
mySQL, sqlite,
miniBase (Wisc)
(www.sigmod.org)



Detailed Outline

Intro to DB

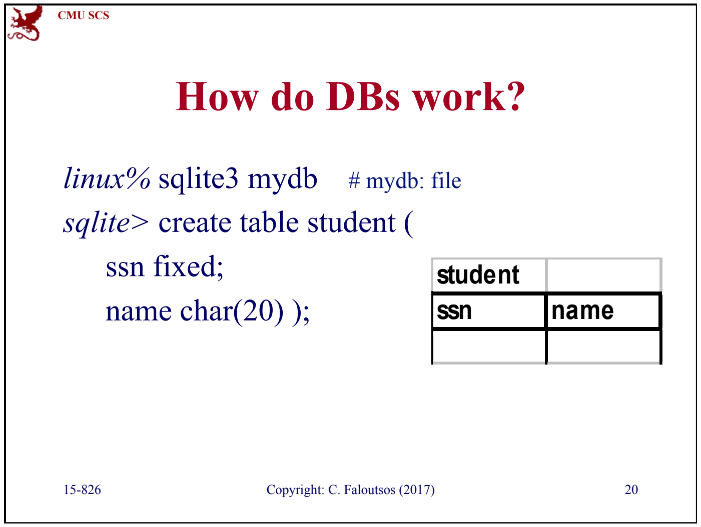
- Relational DBMS - what and why?
  - inserting, retrieving and **summarizing** data
  - views; security/privacy
  - (concurrency control and recovery)



How do DBs work?

We use **`sqlite3`** as an example, from

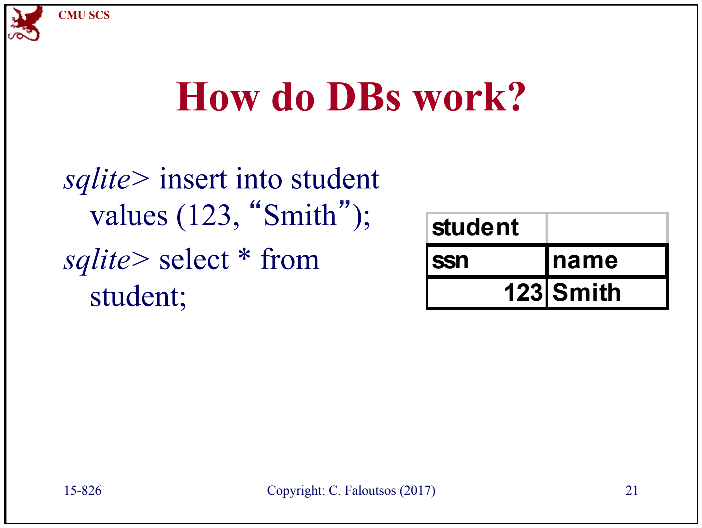
`http://www.sqlite.org`



How do DBs work?

```
linux% sqlite3 mydb    # mydb: file
sqlite> create table student (
    ssn fixed;
    name char(20) );
```

student	
ssn	name



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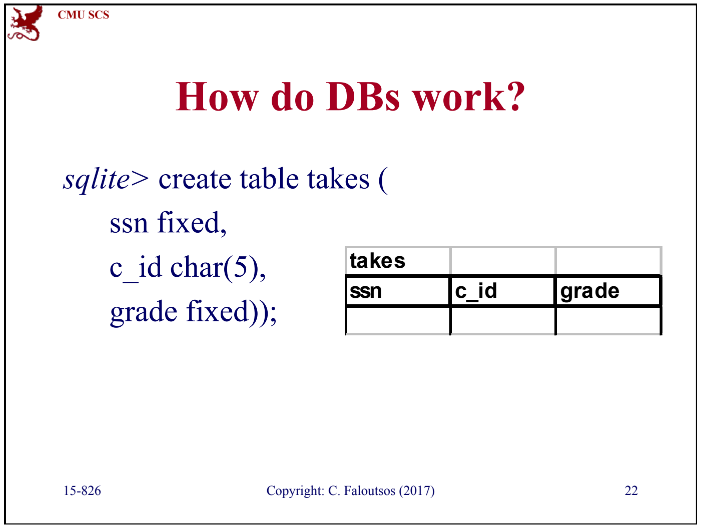
How do DBs work?

```
sqlite> insert into student
   values (123, “Smith”);
sqlite> select * from
   student;
```

student	
ssn	name
123	Smith



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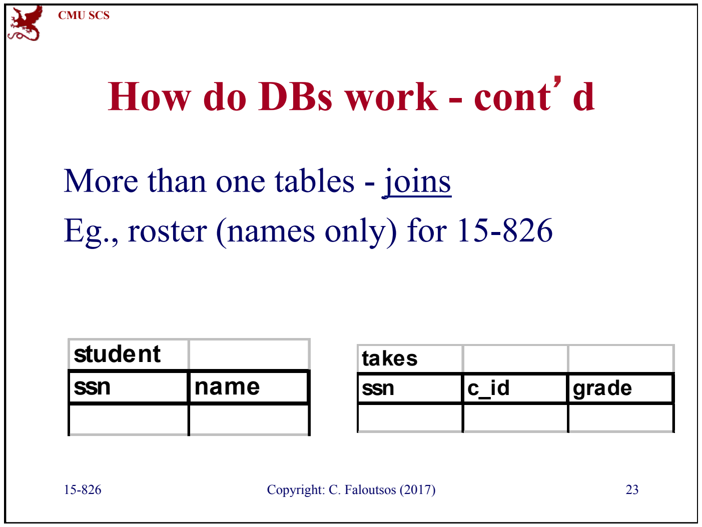
How do DBs work?

```
sqlite> create table takes (
     ssn fixed,
     c_id char(5),
     grade fixed));
```

takes		
ssn	c_id	grade



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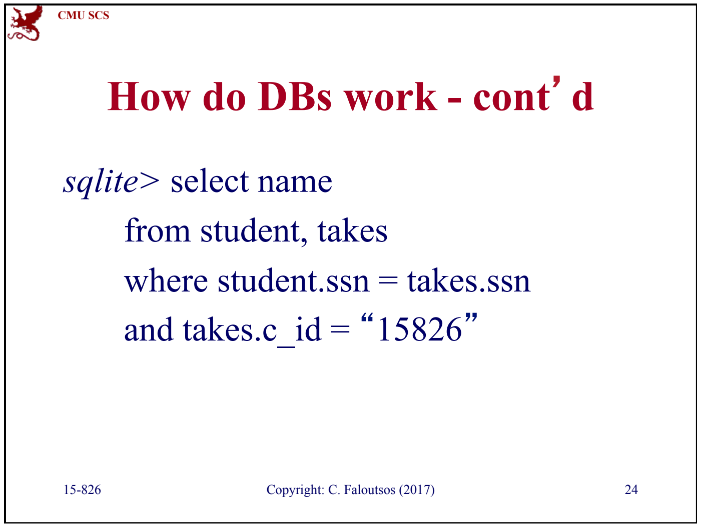
How do DBs work - cont’ d

More than one tables - joins

Eg., roster (names only) for 15-826

student	
ssn	name

takes		
ssn	c_id	grade



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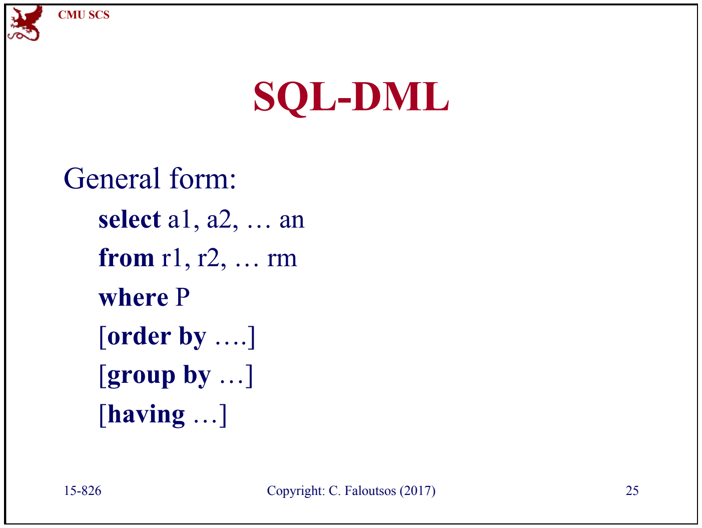
How do DBs work - cont’ d

```
sqlite> select name
      from student, takes
      where student.ssn = takes.ssn
      and takes.c_id = “15826”
```



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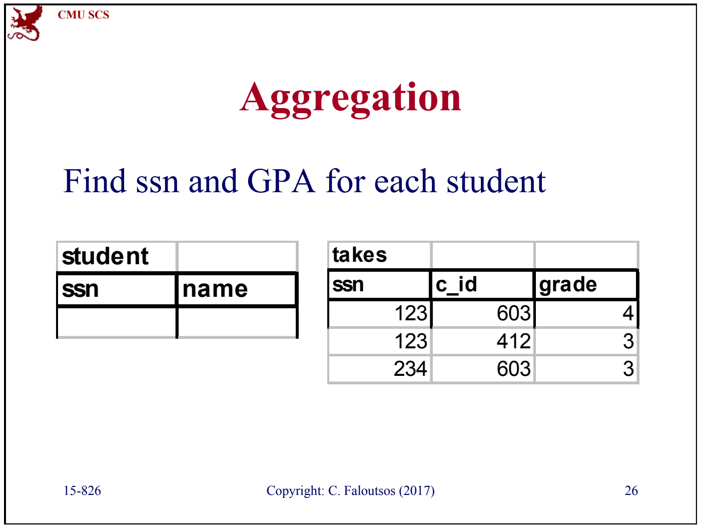
SQL-DML

General form:

select a1, a2, … an
from r1, r2, … rm
where P
[**order by** ….]
[**group by** …]
[**having** …]



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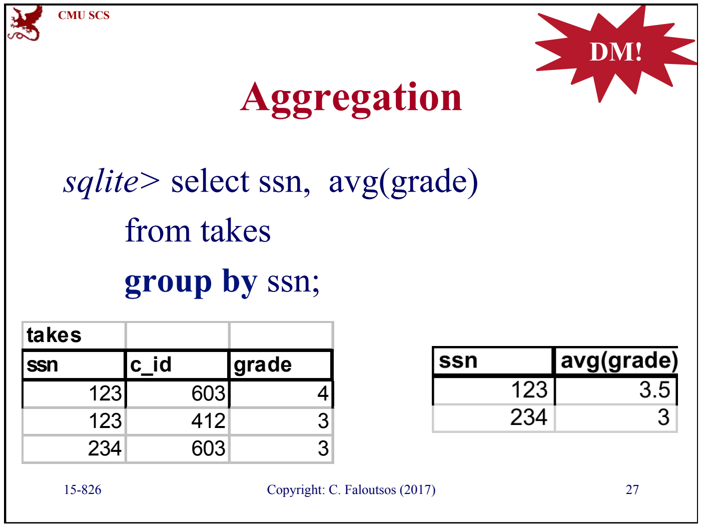
Aggregation

Find ssn and GPA for each student

student	
ssn	name

takes		
ssn	c_id	grade
123	603	4
123	412	3
234	603	3



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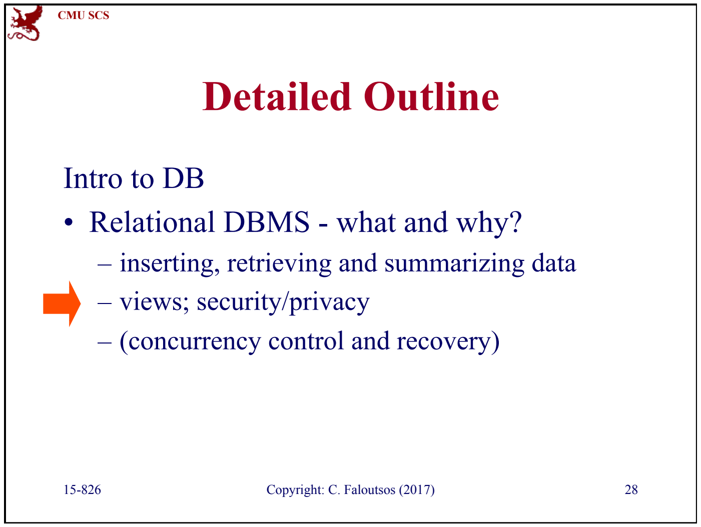
DM!

Aggregation

sqlite> select ssn, avg(grade)
from takes
group by ssn;

takes		
ssn	c_id	grade
123	603	4
123	412	3
234	603	3

ssn	avg(grade)
123	3.5
234	3



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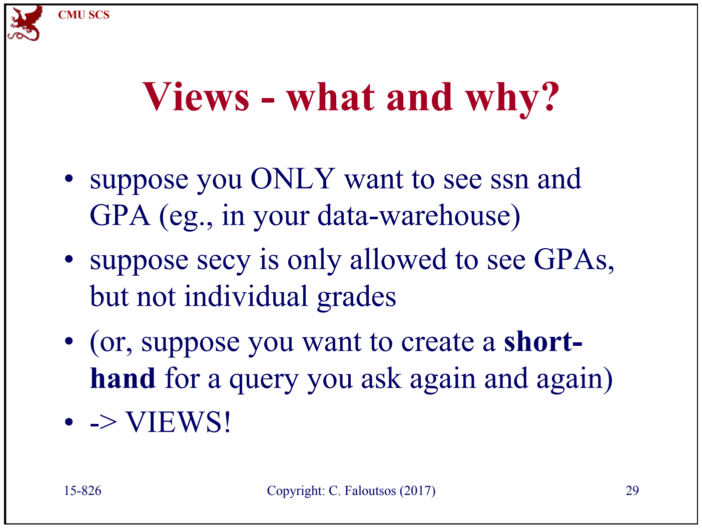
Detailed Outline

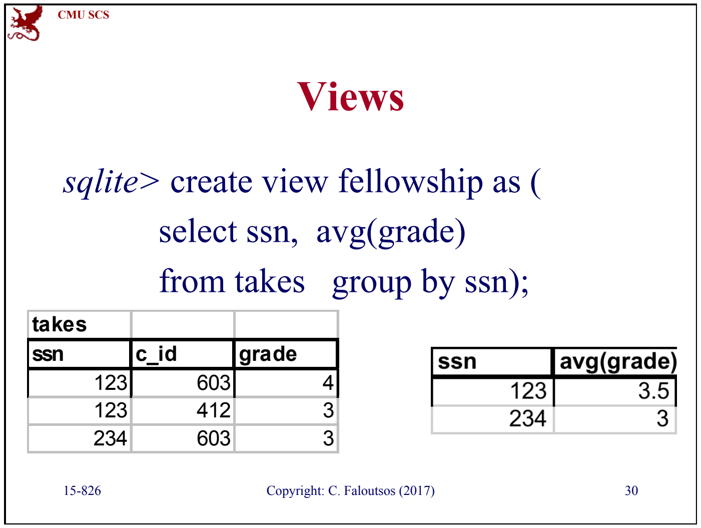
Intro to DB

- Relational DBMS - what and why?
  – inserting, retrieving and summarizing data
  – views; security/privacy
  – (concurrency control and recovery)



Views - what and why?

- suppose you ONLY want to see ssn and GPA (eg., in your data-warehouse)
- suppose secy is only allowed to see GPAs, but not individual grades
- (or, suppose you want to create a **short-hand** for a query you ask again and again)
- -> VIEWS!



Views

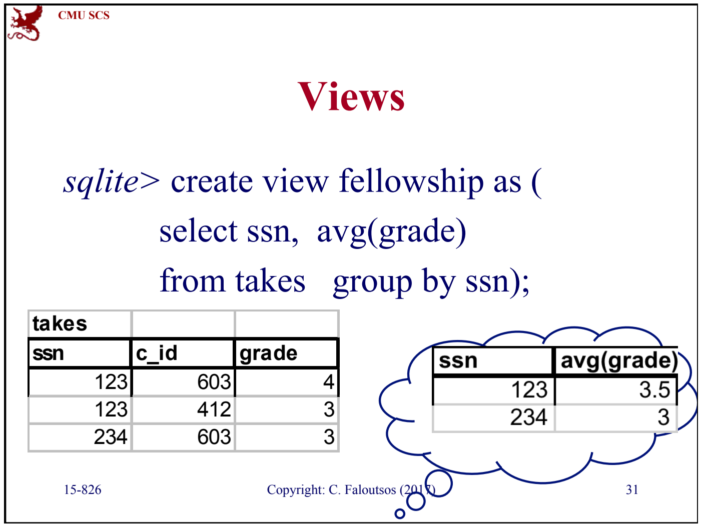
sqlite> create view fellowship as (

select ssn, avg(grade)

from takes group by ssn);

takes		
ssn	c_id	grade
123	603	4
123	412	3
234	603	3

ssn	avg(grade)
123	3.5
234	3



Views

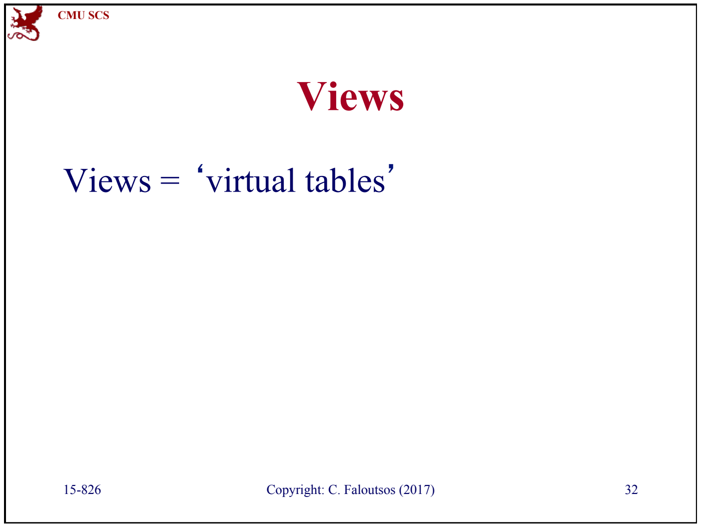
sqlite> create view fellowship as (

select ssn, avg(grade)

from takes group by ssn);

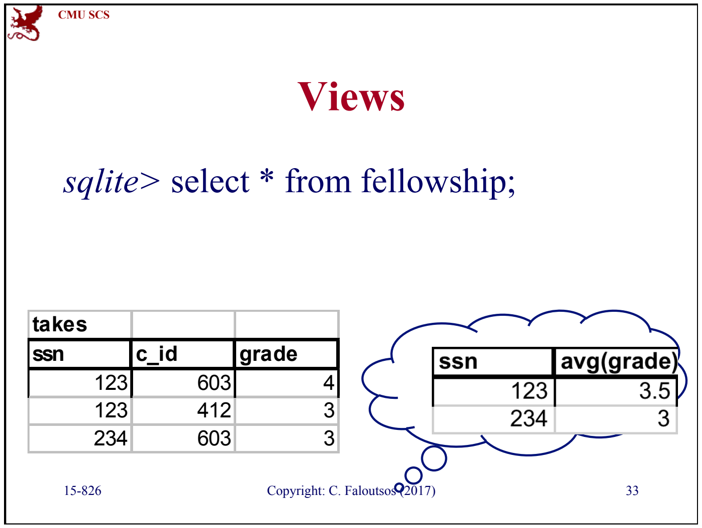
takes		
ssn	c_id	grade
123	603	4
123	412	3
234	603	3

ssn	avg(grade)
123	3.5
234	3



Views

Views = 'virtual tables'



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Views

sqlite> select * from fellowship;

takes		
ssn	c_id	grade
123	603	4
123	412	3
234	603	3

ssn	avg(grade)
123	3.5
234	3

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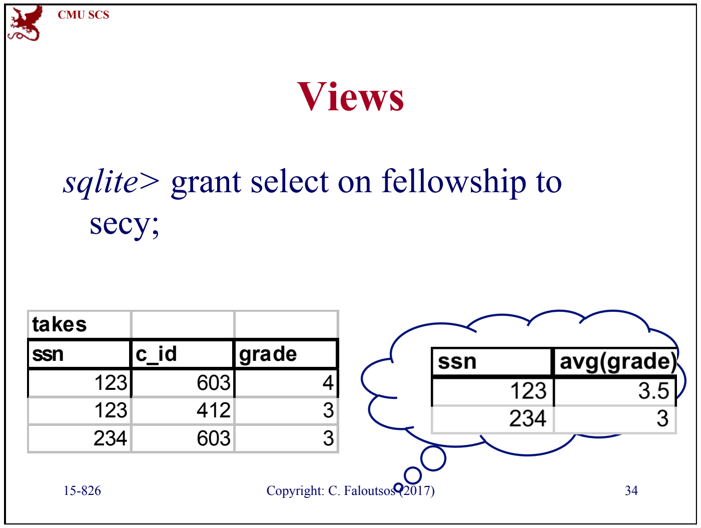

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Views

sqlite> grant select on fellowship to secy;

takes		
ssn	c_id	grade
123	603	4
123	412	3
234	603	3

ssn	avg(grade)
123	3.5
234	3

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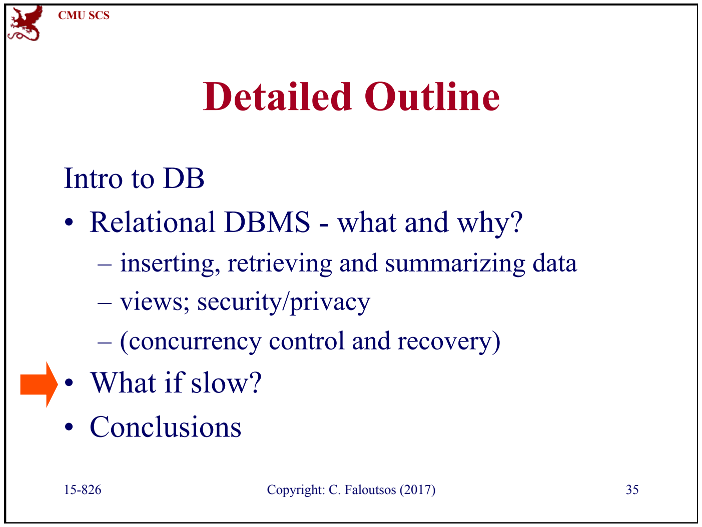

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Detailed Outline

Intro to DB

- Relational DBMS - what and why?
  - inserting, retrieving and summarizing data
  - views; security/privacy
  - (concurrency control and recovery)
- ➡ What if slow?
- Conclusions

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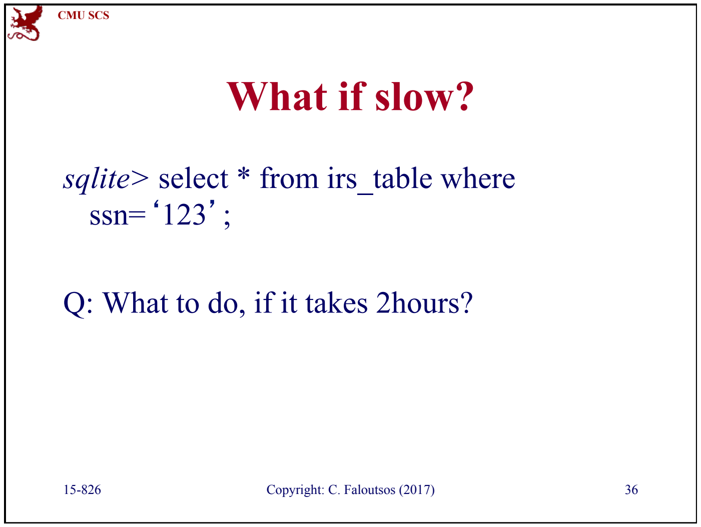

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What if slow?

sqlite> select * from irs_table where ssn= '123' ;

Q: What to do, if it takes 2hours?

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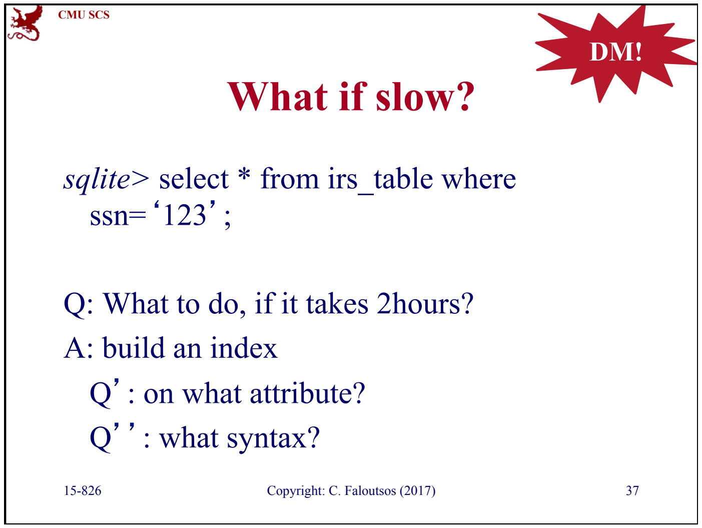

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DM!

What if slow?

```
sqlite> select * from irs_table where
   ssn=‘123’;
```

Q: What to do, if it takes 2hours?

A: build an index

Q’: on what attribute?

Q’’: what syntax?

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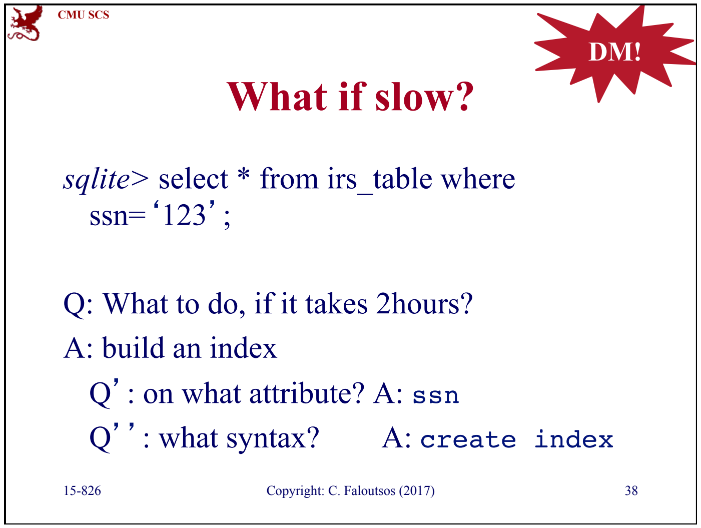

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DM!

What if slow?

```
sqlite> select * from irs_table where
   ssn=‘123’;
```

Q: What to do, if it takes 2hours?

A: build an index

Q’: on what attribute? A: `ssn`

Q’’: what syntax? A: `create index`

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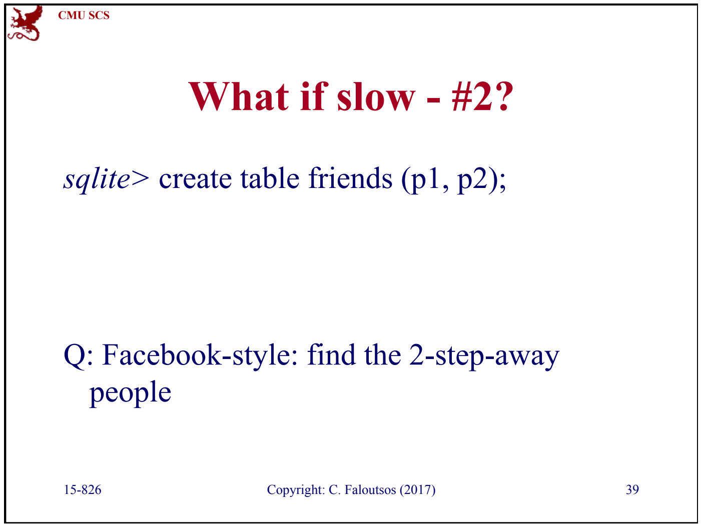

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What if slow - #2?

```
sqlite> create table friends (p1, p2);
```

Q: Facebook-style: find the 2-step-away people

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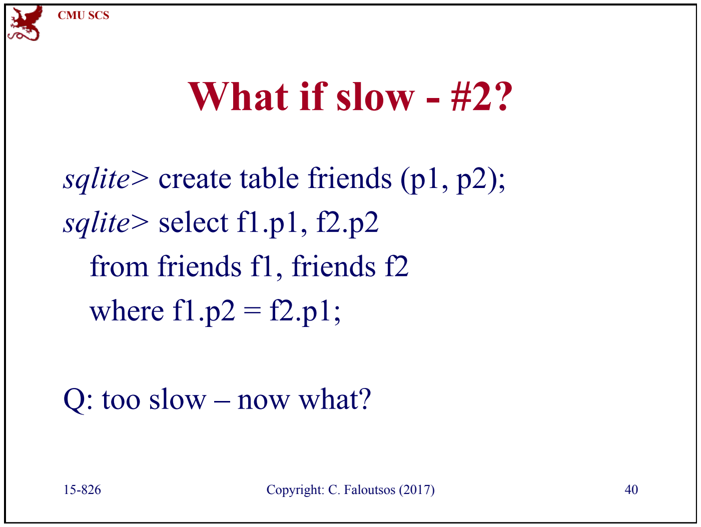

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What if slow - #2?

```
sqlite> create table friends (p1, p2);
sqlite> select f1.p1, f2.p2
   from friends f1, friends f2
   where f1.p2 = f2.p1;
```

Q: too slow – now what?

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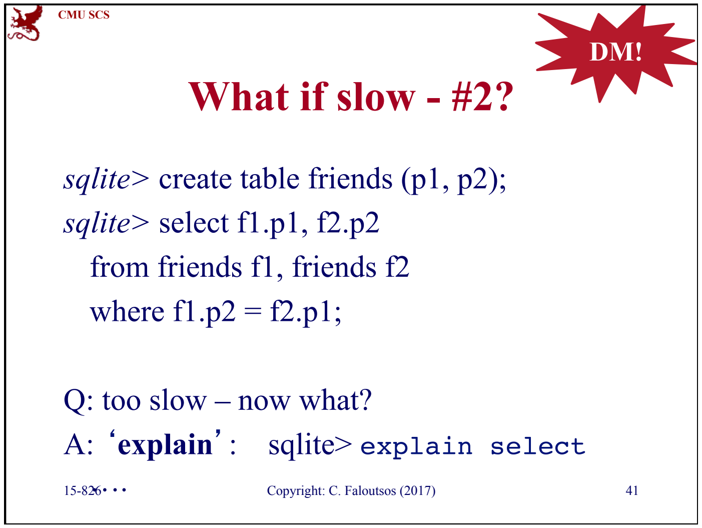

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DM!

What if slow - #2?

sqlite> create table friends (p1, p2);

sqlite> select f1.p1, f2.p2
from friends f1, friends f2
where f1.p2 = f2.p1;

Q: too slow – now what?

A: '**explain**': sqlite> `explain select`

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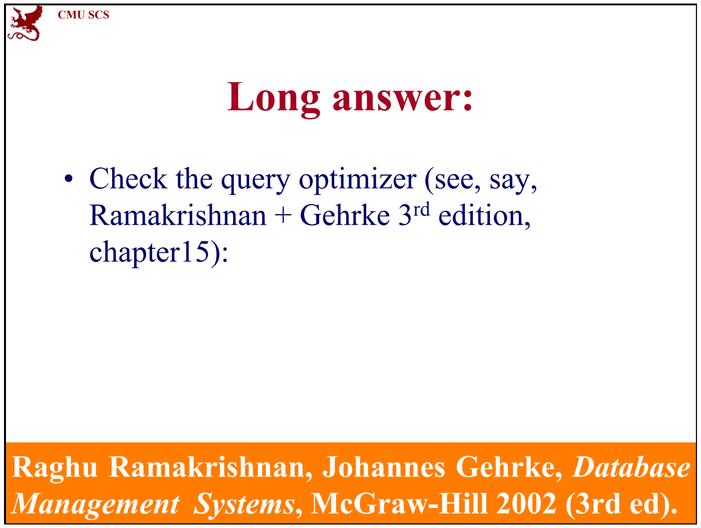

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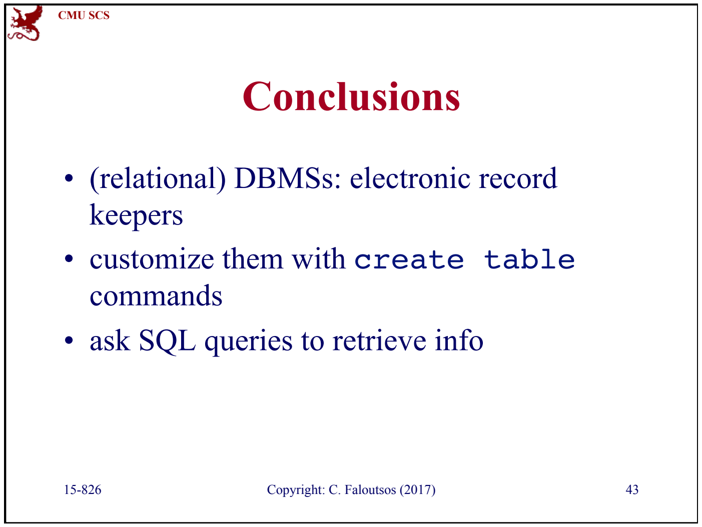
Long answer:

- Check the query optimizer (see, say, Ramakrishnan + Gehrke 3rd edition, chapter15):

Raghu Ramakrishnan, Johannes Gehrke, *Database Management Systems*, McGraw-Hill 2002 (3rd ed).



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Conclusions

- (relational) DBMSs: electronic record keepers
- customize them with `create table` commands
- ask SQL queries to retrieve info

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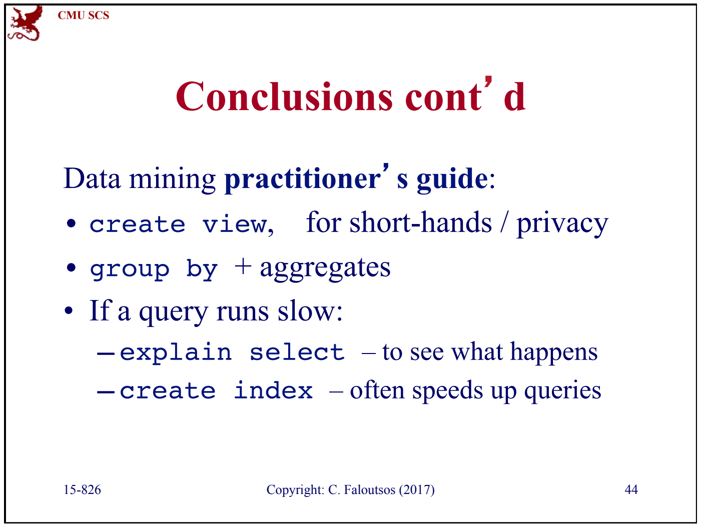

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Conclusions cont'd

Data mining **practitioner's guide**:

- `create view`, for short-hands / privacy
- `group by` + aggregates
- If a query runs slow:
  - `explain select` – to see what happens
  - `create index` – often speeds up queries

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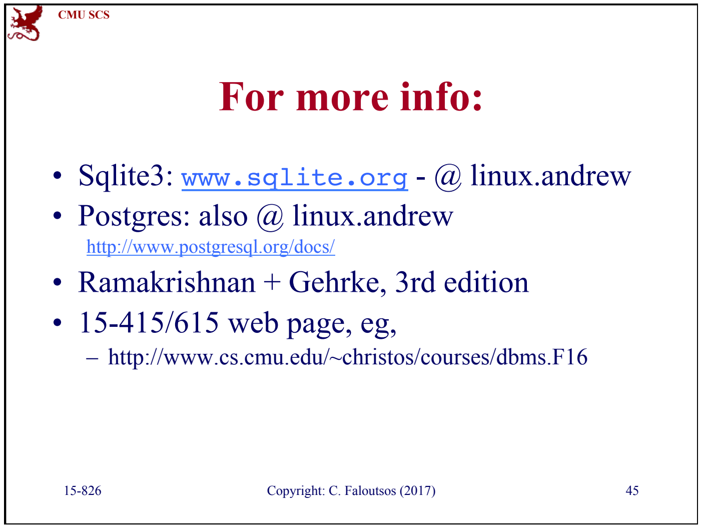

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For more info:

- Sqlite3: www.sqlite.org - @ linux.andrew
- Postgres: also @ linux.andrew
  http://www.postgresql.org/docs/
- Ramakrishnan + Gehrke, 3rd edition
- 15-415/615 web page, eg,
  - http://www.cs.cmu.edu/~christos/courses/dbms.F16

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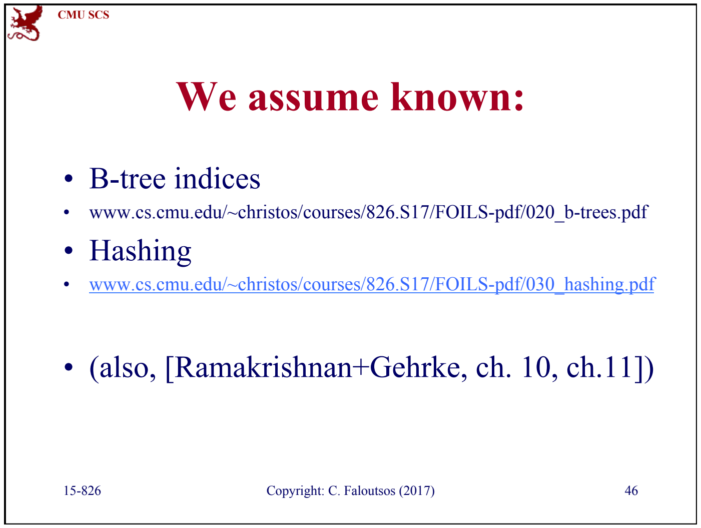

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We assume known:

- B-tree indices
  - www.cs.cmu.edu/~christos/courses/826.S17/FOILS-pdf/020_b-trees.pdf
- Hashing
  - www.cs.cmu.edu/~christos/courses/826.S17/FOILS-pdf/030_hashing.pdf
- (also, [Ramakrishnan+Gehrke, ch. 10, ch.11])

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