

CMU SCS

# 15-826: Multimedia Databases and Data Mining

Lecture#1: Introduction  
*Christos Faloutsos*  
CMU  
[www.cs.cmu.edu/~christos](http://www.cs.cmu.edu/~christos)

CMU SCS

## Outline

Goal: 'Find **similar** / **interesting** things'

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

15-826 Copyright: C. Faloutsos (2017) 2

CMU SCS

## Problem

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

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

15-826 Copyright: C. Faloutsos (2017) 3

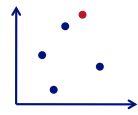
CMU SCS

## 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'?



15-826 Copyright: C. Faloutsos (2017) 4

CMU SCS

## Sample queries

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

15-826 Copyright: C. Faloutsos (2017) 5

CMU SCS

## 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')

15-826 Copyright: C. Faloutsos (2017) 6

CMU SCS

## Problem

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

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

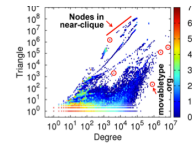
Q1: Examples, for 'interesting'?

15-826 Copyright: C. Faloutsos (2017) 7

CMU SCS

## Sample queries –cont' d

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

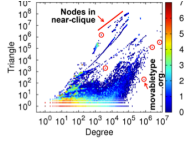


15-826 Copyright: C. Faloutsos (2017) 8

CMU SCS

## Sample queries –cont’ d


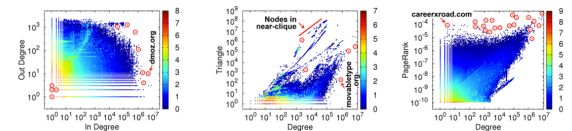
- Rule discovery
  - Clusters (of branches; of sensor data; ...)
  - Forecasting (total sales for next year?)
  - Outliers (eg., unexpected part failures; fraud detection)



15-826 Copyright: C. Faloutsos (2017) 9


CMU SCS

## 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.

CMU SCS

## Outline

Goal: ‘Find similar / interesting things’

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


15-826 Copyright: C. Faloutsos (2017) 11

CMU SCS

## Detailed Outline

- Intro to DB
- ➔ • Relational DBMS - what and why?

15-826 Copyright: C. Faloutsos (2017) 12




CMU SCS

## Detailed Outline

Intro to DB

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


15-826 Copyright: C. Faloutsos (2017) 13



CMU SCS

## What is the goal of rel. DBMSs

15-826 Copyright: C. Faloutsos (2017) 14




CMU SCS

## 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>

15-826 Copyright: C. Faloutsos (2017) 15



CMU SCS

## Main vendors/products

Commercial      Open source

15-826 Copyright: C. Faloutsos (2017) 16

CMU SCS

## Main vendors/products

<u>Commercial</u>	<u>Open source</u>
<ul style="list-style-type: none"> <li>• Oracle</li> <li>• IBM/DB2</li> <li>• MS SQL-server</li> <li>• Sybase</li> <li>• (MS Access,</li> <li>• ...)</li> </ul>	<b>Postgres</b> (UCB) mySQL, sqlite, miniBase (Wisc) (www.sigmod.org)

15-826 Copyright: C. Faloutsos (2017) 17

CMU SCS

## Detailed Outline

Intro to DB

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

15-826 Copyright: C. Faloutsos (2017) 18

CMU SCS

## How do DBs work?

We use **sqlite3** as an example, from  
<http://www.sqlite.org>

15-826 Copyright: C. Faloutsos (2017) 19

CMU SCS

## How do DBs work?

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

student	
ssn	name

15-826 Copyright: C. Faloutsos (2017) 20

CMU SCS

## How do DBs work?

*sqlite*> insert into student  
values (123, "Smith");  
*sqlite*> select \* from  
student;

student	
ssn	name
123	Smith

15-826 Copyright: C. Faloutsos (2017) 21

CMU SCS

## How do DBs work?

*sqlite*> create table takes (  
ssn fixed,  
c\_id char(5),  
grade fixed));

takes		
ssn	c_id	grade

15-826 Copyright: C. Faloutsos (2017) 22

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 23

CMU SCS

## How do DBs work - cont' d

*sqlite*> select name  
from student, takes  
where student.ssn = takes.ssn  
and takes.c\_id = "15826"

15-826 Copyright: C. Faloutsos (2017) 24

CMU SCS

## SQL-DML

General form:

```

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

15-826 Copyright: C. Faloutsos (2017) 25

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 26

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 27

CMU SCS

## Detailed Outline

Intro to DB

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

15-826 Copyright: C. Faloutsos (2017) 28

CMU SCS

## 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!

15-826 Copyright: C. Faloutsos (2017) 29

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 30

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 31

CMU SCS

## Views

Views = 'virtual tables'

15-826 Copyright: C. Faloutsos (2017) 32



CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 33

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 34

CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 35


CMU SCS

## What if slow?

*sqlite*> select \* from irs\_table where ssn='123';

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

15-826 Copyright: C. Faloutsos (2017) 36


CMU SCS 

## 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?

15-826 Copyright: C. Faloutsos (2017) 37

CMU SCS 

## 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

15-826 Copyright: C. Faloutsos (2017) 38

CMU SCS

## What if slow - #2?

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

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

15-826 Copyright: C. Faloutsos (2017) 39

CMU SCS

## 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?

15-826 Copyright: C. Faloutsos (2017) 40

CMU SCS

**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`

15-826 • • • Copyright: C. Faloutsos (2017) 41

CMU SCS

## Long answer:

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

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

CMU SCS

## Conclusions

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

15-826 Copyright: C. Faloutsos (2017) 43


CMU SCS

## 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

15-826 Copyright: C. Faloutsos (2017) 44




CMU SCS

## For more info:

- Sqlite3: [www.sqlite.org](http://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>

15-826 Copyright: C. Faloutsos (2017) 45



CMU SCS

## We assume known:

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

15-826 Copyright: C. Faloutsos (2017) 46