15-826: Multimedia Databases and Data Mining

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

Outline

Goal: ‘Find similar / interesting things’
• Intro to DB
• Indexing - similarity search
• Data Mining

Problem

Given a large collection of (multimedia) records, find similar/interesting things, ie:
• Allow fast, approximate queries, and
• Find rules/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’)

Sample queries –cont’d

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

Outline

Goal: ‘Find similar / interesting things’

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

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

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>
Why Databases?

- Flexibility
- Data independence (can add new tables; new attributes)
- Data sharing/concurrency control
- Recovery

Why NOT Databases?
Why NOT Databases?

- Price
- additional expertise (SQL/DBA)
- over-kill for small data sets

Main vendors/products

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

Open source
- Postgres (UCB)
- mySQL, mSQL
- miniBase (Wisc)
- Predator (Cornell)
  (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)
- Object-Relational DBMS - what and why?
How do DBs work?

%%sql mydb
sql>create table student (  
    ssn fixed;  
    name char(20) );

<table>
<thead>
<tr>
<th>ssn</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How do DBs work?

sql>insert into student  
values (123, “Smith”);

<table>
<thead>
<tr>
<th>ssn</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>Smith</td>
</tr>
</tbody>
</table>

How do DBs work?

sql>create table takes (  
    ssn fixed,  
    c-id char(5),  
    grade fixed));

<table>
<thead>
<tr>
<th>ssn</th>
<th>c-id</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
How do DBs work - cont’d

More than one tables - joins
Eg., roster (names only) for 15-826

<table>
<thead>
<tr>
<th>student</th>
<th>takes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ssn</td>
<td>ssn</td>
</tr>
<tr>
<td>name</td>
<td>c-id</td>
</tr>
<tr>
<td>grade</td>
<td></td>
</tr>
</tbody>
</table>

sql> select name
    from student, takes
    where student.ssn = takes.ssn
    and takes.c-id = 15-826

How do DBs work - cont’d

SQL-DML

General form:
select a1, a2, ... an
from r1, r2, ... rm
where P
[order by ...]
[group by ...]
[having ...]
### Aggregation

Find ssn and GPA for each student

<table>
<thead>
<tr>
<th>student</th>
<th>takes</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ssn</td>
<td>c-id</td>
<td>grade</td>
</tr>
<tr>
<td>123</td>
<td>603</td>
<td>4</td>
</tr>
<tr>
<td>123</td>
<td>412</td>
<td>3</td>
</tr>
<tr>
<td>234</td>
<td>603</td>
<td>3</td>
</tr>
</tbody>
</table>

```
sql> select ssn, grade from takes;
```

<table>
<thead>
<tr>
<th>takes</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>4</td>
</tr>
<tr>
<td>123</td>
<td>3</td>
</tr>
<tr>
<td>234</td>
<td>3</td>
</tr>
</tbody>
</table>

### Aggregation

```
sql> select ssn, avg(grade) from takes;
```

Wrong
**Aggregation**

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

<table>
<thead>
<tr>
<th>ssn</th>
<th>c-id</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>603</td>
<td>4</td>
</tr>
<tr>
<td>123</td>
<td>412</td>
<td>3</td>
</tr>
<tr>
<td>234</td>
<td>603</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ssn</th>
<th>avg(grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>3.5</td>
</tr>
<tr>
<td>234</td>
<td>3</td>
</tr>
</tbody>
</table>

---

**Detailed Outline**

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

---

**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
- -> VIEWS!
Views

sql> create view fellowship as (  
    select ssn,  avg(grade)  
    from takes  
    group by ssn);

<table>
<thead>
<tr>
<th>ssn</th>
<th>c-id</th>
<th>grade</th>
<th>avg(grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>603</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>123</td>
<td>412</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>234</td>
<td>603</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Views = ‘virtual tables’
Views

```sql
sql> select * from fellowship;
```

<table>
<thead>
<tr>
<th>ssn</th>
<th>c-id</th>
<th>grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>603</td>
<td>4</td>
</tr>
<tr>
<td>123</td>
<td>412</td>
<td>3</td>
</tr>
<tr>
<td>234</td>
<td>603</td>
<td>3</td>
</tr>
</tbody>
</table>

```sql
sql> grant select on fellowship to secy;
```

<table>
<thead>
<tr>
<th>ssn</th>
<th>avg(grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>123</td>
<td>3.5</td>
</tr>
<tr>
<td>234</td>
<td>3</td>
</tr>
</tbody>
</table>

Detailed Outline

Intro to DB
- Relational DBMS - what and why?
  - inserting, retrieving and summarizing data
  - views; security/privacy
  - (concurrency control and recovery)
- Object-Relational DBMS - what and why?
Detailed Outline

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

Why more than RDBMSs?
  • RDBMS: tuples, of numbers + strings
  • What apps need only those?
    – Banks
    – Airlines
    – Retailer stores
    – ...
  • Q: Other apps, with more req’s?
Why more than RDBMS’s

• Q: Other apps, with more req’s?
• A:
  – text
  – multimedia; financial apps/forecasting
  – Geographic Inf. Sys.
  – CAD/CAM
  – Network management

Ideally, we’d like to:

• create a new data type (eg., ‘image’, ‘time-sequence’)
• define functions on it (like (dist(im1, im2))
• be able to ask queries like
  select * from employee
  where dist(employee.face, given-face) <= 10;

OR DBMSs

traditional DBMS + attempts to provide
• user defined data types
• support for large / complex objects
• (inheritance - ISA hierarchies)
SQL-3 proposed extensions

- complex types (sets, lists, multisets)
- inheritance (IS-A hierarchies)
- User Defined Functions (UDFs)

Complex types

e.g.,
```
create type MyDate (   
    day decimal(2),   
    month char(3),   
    year decimal(4)   
);
```

BLObs etc:

- Large objects, e.g., video, images, 3d-MRI scans
- new data types: LOB (=Large OObject)  
  - BLOB: (up to 4Gb; binary: jpeg, mpeg, ...)
  - CLOB: (up to 2Gb; character: english text)
  - NCLOB: (.........; multi-byte characters)
Stored procedures

SQL> create or replace procedure del-st-rec
(s-id number) as
begin
  delete from student
  where s-id = ssn;
end del-st-rec;
SQL> execute del-st-rec ( 123 );

Conclusions

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

Conclusions cont’d

main advantages over flat files & scripts:
• logical + physical data independence (ie., flexibility of adding new attributes, new tables and indices)
• concurrency control and recovery for free
Conclusions cont’d

• OR-DBMS: user-defined data types (eg., images), and U.D. functions.

For more info:

• Microsoft Access: available on ANDREW clusters (PC)
• postgres: www.cs.cmu.edu/~ddash/15415/F07/hws/PostgreSQL_Reader.htm
• Ramakrishna + Gehrke, 3rd edition
• 15-415 web page, eg,
  – www.cs.cmu.edu/~ddash/15415/F07/