Introduction to Computer Science
Lecture 8: Database Systems

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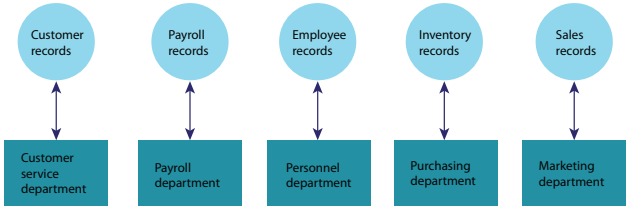
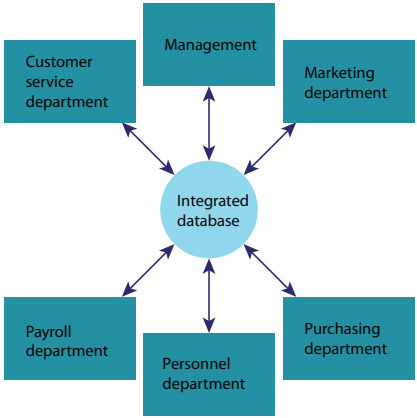
What is Database?

- A collection of data that is multidimensional in the sense that internal links between its entries make the information accessible from a variety of perspectives.
- Contrast to a traditional file systems, called flat file, which is one-dimensional.

File vs. Database



File-oriented



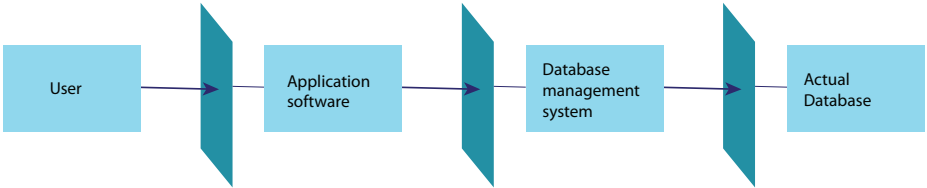
Database-oriented

Schema

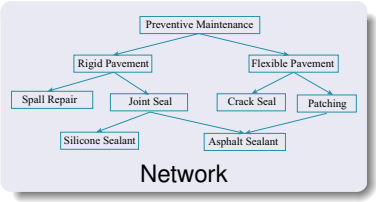
- Schema
  - A description of the structure of an entire database, used by database software to maintain the database.
- Subschema
  - A description of only that portion of the database pertinent to a particular users needs, used to prevent sensitive data from being accessed by unauthorized personnel.

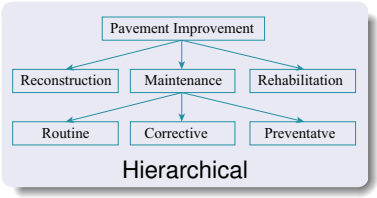
DBMS

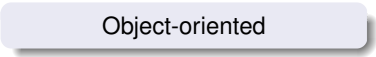
- Two major layers in a database application
  - Application layer
  - Database management layer
- Database Management System (DBMS)
  - A software layer that manipulates a database in response to requests from applications
  - Handling distributed database
  - Achieving data independence

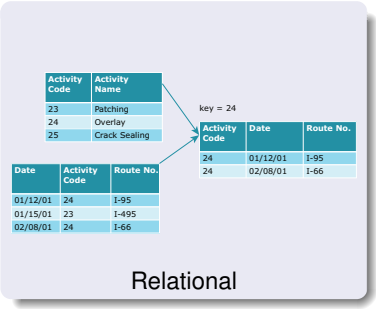


- DBMS translates commands stated in terms of a conceptual view of the database database model.









Relational Database Model

- One relation
  - A rectangular table (relation name = table name)
  - A column: a attribute
  - A row: a tuple

Empl Id	Name	Address	SSN
25X15	Joe E.Baker	33 Nowhere St.	111223333
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555
.	.	.	.
.	.	.	.
.	.	.	.

Designing a Relational Database

- Starting by designing relations
- Avoid multiple concepts within one relation, why?
  - Can lead to redundant data
  - Deleting a tuple could also delete necessary but unrelated information

Empl Id	Name	Address	SSN	Jib Id	Job Title	Skill Code	Dept	Start Date	Term Date
25X15	Joe E.Baker	33 Nowhere St.	111223333	F5	Floor manager	FM3	Sales	9-1-2007	9-30-2008
25X15	Joe E.Baker	33 Nowhere St.	111223333	D7	Dept. head	K2	Sales	10-1-2008	*
34Y70	Cheryl H. Clark	563 Down-town Ave.	999009999	F5	Floor manager	FM3	Sales	10-1-2007	*
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555	S25X	Secretary	T5	Personnel	3-1-1999	4-30-2006
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555	S25Z	Secretary	T6	Accounting	5-1-2006	*
.	.	.	.	.	.	.	.	.	.

Employee Database with 3 Relations

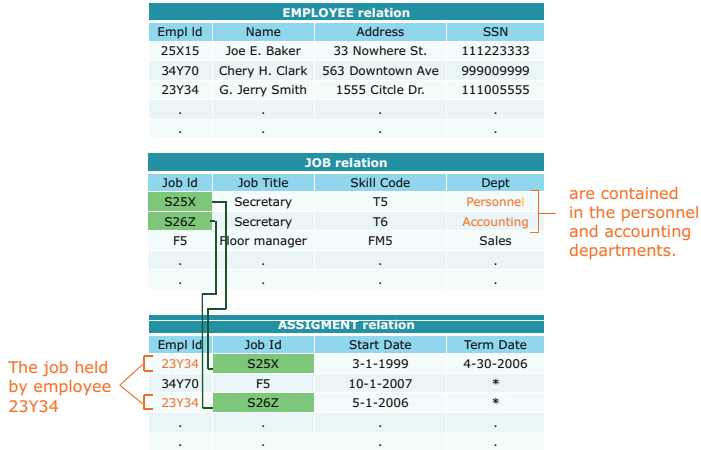
EMPLOYEE relation			
Empl Id	Name	Address	SSN
25X15	Joe E. Baker	33 Nowhere St.	111223333
34Y70	Chery H. Clark	563 Downtown Ave	999009999
23Y34	G. Jerry Smith	1555 Citcle Dr.	111005555
.	.	.	.
.	.	.	.

JOB relation			
Job Id	Job Title	Skill Code	Dept
S25X	Secretary	T5	Personnel
S26Z	Secretary	T6	Accounting
F5	Floor manager	FM5	Sales
.	.	.	.
.	.	.	.

ASSIGMENT relation			
Empl Id	Job Id	Start Date	Term Date

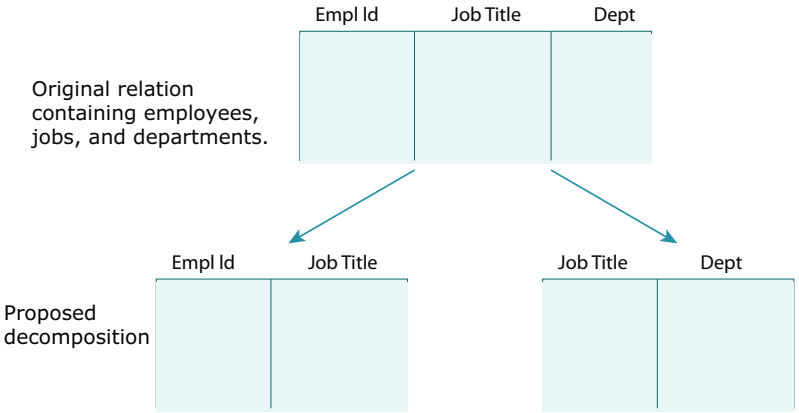
Querying a Database

- Find the departments in which employee 23Y34 has worked.



Relation Decomposition

- Lossless vs. lossy



How to find the department in which a employee works?

Relational Operations

- Select
  - Choose rows
- Project
  - Choose columns
- Join
  - Assemble information from two or more relations

Select

EMPLOYEE relation

Empl Id	Name	Address	SSN
25X15	Joe E.Baker	33 Nowhere St.	111223333
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555
.	.	.	.
.	.	.	.
.	.	.	.

NEW ← SELECT from EMPLOYEE where EmplId = “34Y70”

NEW relation

Empl Id	Name	Address	SSN
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999

Project

EMPLOYEE relation

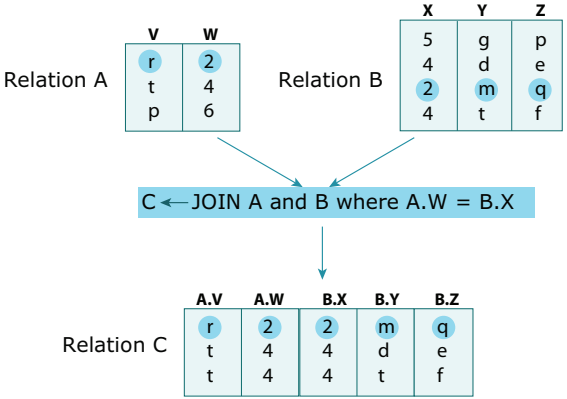
Empl Id	Name	Address	SSN
25X15	Joe E.Baker	33 Nowhere St.	111223333
34Y70	Cheryl H. Clark	563 Downtown Ave.	999009999
23Y34	G. Jerry Smith	1555 Circle Dr.	111005555
.	.	.	.
.	.	.	.
.	.	.	.

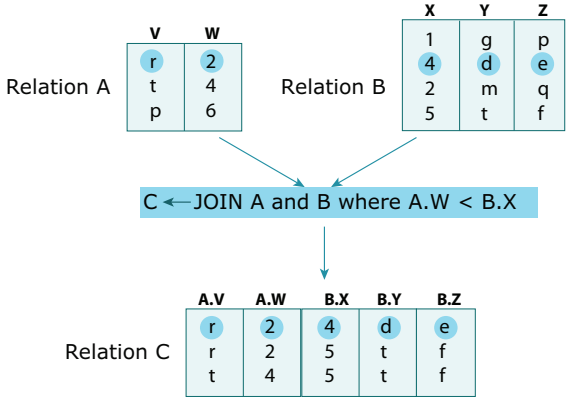
MAIL ← PROJECT Name, Address from EMPLOYEE

MAIL relation

Name	Address
Joe E.Baker	33 Nowhere St.
Cheryl H. Clark	563 Downtown Ave.
G. Jerry Smith	1555 Circle Dr.
.	.
.	.
.	.

Join


Relation A
V W
r 2
t 4
p 6
Relation B
X Y Z
5 g p
4 d e
2 m q
4 t f
C ← JOIN A and B where A.W = B.X
Relation C
A.V A.W B.X B.Y B.Z
r 2 2 m q
t 4 4 d e
t 4 4 t f


Relation A
V W
r 2
t 4
p 6
Relation B
X Y Z
1 g p
4 d e
2 m q
5 t f
C ← JOIN A and B where A.W < B.X
Relation C
A.V A.W B.X B.Y B.Z
r 2 4 d e
r 2 5 t f
t 4 5 t f

SQL

- Structured Query Language
  - Pronounced as “sequel”
- Operations to manipulate tuples
  - insert
  - update
  - delete
  - select

SQL Examples

- ```
  select attribute[, attribute, ...]
  from table[, table, ...]
  where ...
  ```

- ```
  select Dept
  from ASSIGNMENT, JOB
  where ASSIGNMENT.JobID = JOB.JobId
  and ASSIGNMENT.EmplId = '23Y34'
  ```

- ```
  select Name, Address
  from EMPLOYEE
  where Name = 'Cheryl H. Clark'
  ```
  ```

SQL Examples (contd.)

- ```
  insert into EMPLOYEE
  values ('43212', 'Sue A. Burt',
          '33 Fair St.', '444661111')
  ```

- ```
  delete from EMPLOYEE
  where Name = 'G. Jerry Smith'
  ```

- ```
  update EMPLOYEE
  set Address = '1812 Napoleon Ave.'
  where Name = 'Joe E. Baker'
  ```
  ```

MySQL

- Try yourself
  - http://www.mysql.com/downloads/mysql/
- Create a database & grant a user all rights
  - % mysql -u root -p
  - mysql> CREATE DATABASE db_name;
  - mysql> GRANT ALL PRIVILEGES TO user_name;
  - mysql> FLUSH PRIVILEGES;
  - mysql> QUIT;
- Connect to mysql as that user
  - % mysql -u user_name

MySQL (contd.)

- Create tables
  - mysql> USE DATABASE db_name;
  - mysql> CREATE TABLE tbl_name (attr1 type, ...);
- You may also check all DBs, tables, or so on.
  - mysql> SHOW DATABASES;
  - mysql> SHOW TABLES;
  - mysql> SELECT * from tbl_name;
- Connect to mysql as that user
  - % mysql -u user_name