Database Intro

INFO/CSE 100, Autumn 2004

Fluency in Information Technology

http://www.cs.washington.edu/100

Readings and References

- Reading
  - » *Fluency with Information Technology*
    - Chapter 13, Introduction to Database Concepts
- References
  - » *Access Database: Design and Programming*
    - by Steve Roman, published by O'Reilly

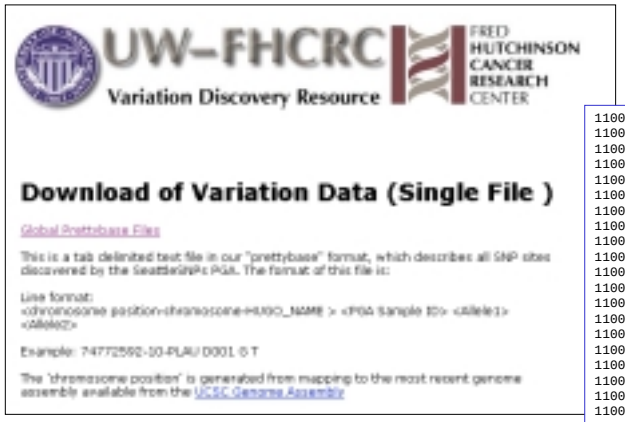
Why Study Databases?

- Some of us want to compute, but all of us want information …
  - Much of the archived information is in tables
  - Databases enhance applications, e.g. Web
  - Once you know how to create databases, you can use them to personal advantage
  - Databases introduce interesting ideas

How to organize the data?

- Before relational databases (the kind we study) there were only "flat files"
  - » Structural information is difficult to express
  - » All processing of information is "special cased"
    - custom programs are needed
  - » Information repeated; difficult to combine
  - » Changes in format of one file means all programs that ever process that file must be changed
    - eg, adding ZIP codes

tab-delimited file example




```
1100322-IL3RA-X      D001   N  N
1100322-IL3RA-X      D002   G  G
1100322-IL3RA-X      D003   G  G
1100322-IL3RA-X      D004   G  G
1100322-IL3RA-X      D005   G  G
1100322-IL3RA-X      D006   G  G
1100322-IL3RA-X      D007   G  G
1100322-IL3RA-X      D008   G  G
1100322-IL3RA-X      D009   A  G
1100322-IL3RA-X      D010   N  N
1100322-IL3RA-X      D011   N  N
1100322-IL3RA-X      D012   N  N
1100322-IL3RA-X      D013   G  G
1100322-IL3RA-X      D014   A  G
1100322-IL3RA-X      D015   N  N
1100322-IL3RA-X      D016   N  N
1100322-IL3RA-X      D033   A  G
1100322-IL3RA-X      D034   A  G
1100322-IL3RA-X      D035   G  G
1100322-IL3RA-X      D036   A  G
1100322-IL3RA-X      D037   A  A
1100322-IL3RA-X      D038   G  G
1100322-IL3RA-X      D039   G  G
1100322-IL3RA-X      D040   G  G
...
```


Unix termcap example

```
# FILE FORMAT:
#
# The version you are looking at may be in any of three formats: master
# (terminfo with OT capabilities), stock terminfo, or termcap.  You can tell
# which by the format given in the header above.
#
# The master format is accepted and generated by the terminfo tools in the
# ncurses suite; it differs from stock (System V-compatible) terminfo only
# in that it admits a group of capabilities (prefixed `OT') equivalent to
# various obsolete termcap capabilities.
...
# ANSI capabilities are broken up into pieces, so that a terminal
# implementing some ANSI subset can use many of them.
ansi+local1:\
        :do=\E[B:le=\E[D:nd=\E[C:up=\E[A:
ansi+local:\
        :DO=\E[%dB:LE=\E[%dD:RI=\E[%dC:UP=\E[%dA:tc=ansi+local1:
ansi+tabs:\
        :bt=\E[Z:ct=\E[2g:st=\EH:ta=^I:
ansi+inittabs:\
        :it#8:tc=ansi+tabs:
```


Library example

notice the redundancy

ISBN	Title	AuID	AuName	AuPhone	PubID	PubName	PubPhone	Price
1-111-1111-1	C++	4	Roman	444-444-4444	1	Big House	123-456-7890	$29.95
0-00-000000-0	Emma	1	Austen	111-111-1111	1	Big House	123-456-7890	$28.00
0-01-333678-7	Faerie Queene	7	Spenser	777-777-7777	1	Big House	123-456-7890	$13.00
0-01-345678-3	Hamlet	5	Shakespeare	555-555-5555	2	Alpha Press	999-999-9999	$28.00
0-100-45678-9	Iliad	3	Homer	333-333-3333	1	Big House	123-456-7890	$27.00
0-12-345678-6	Jane Eyre	1	Austen	111-111-1111	3	Small House	714-688-0080	$48.00
0-00-777777-7	King Lear	5	Shakespeare	555-555-5555	2	Alpha Press	999-999-9999	$48.00
0-555-55555-8	Macbeth	5	Shakespeare	555-555-5555	2	Alpha Press	999-999-9999	$13.00
0-11-345678-9	Moby Dick	2	Melville	222-222-2222	3	Small House	714-688-0080	$49.00
0-123-33403-3	On Liberty	8	Mill	888-888-8888	1	Big House	123-456-7890	$27.00
0-321-32132-1	Balloon	13	Sleepy	321-321-1111	3	Small House	714-688-0080	$54.00
0-321-32132-1	Balloon	11	Grumpy	321-321-2222	3	Small House	714-688-0080	$54.00
0-321-32132-1	Balloon	12	Grumpy	321-321-8080	3	Small House	714-688-0080	$54.00
0-55-123456-9	Main Street	10	Jones	123-333-3333	3	Small House	714-688-0080	$22.95
0-55-123456-9	Main Street	9	Smith	123-222-2222	3	Small House	714-688-0080	$22.95
0-123-45678-8	Ulysses	6	Joyce	666-666-6666	2	Alpha Press	999-999-9999	$54.00
1-22-33708-8	Visual Basic	4	Roman	444-444-4444	1	Big House	123-456-7890	$21.00

from Access Database book, Steve Roman

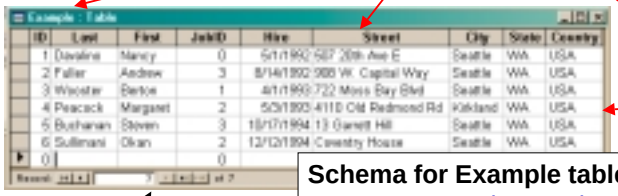
Relational Databases

- Information is stored in tables
  - » Tables store information about *entities*
  - » Entities have characteristics called *attributes*
  - » Each row in a table represents a single entity
    - Each row is a set of attribute values
    - Every row must be unique, identified by a key
  - » Relationships -- associations among the data values are stored

Table structure = schema
Table contents = instance

A Table in a Database

Tables have names, attributes, rows



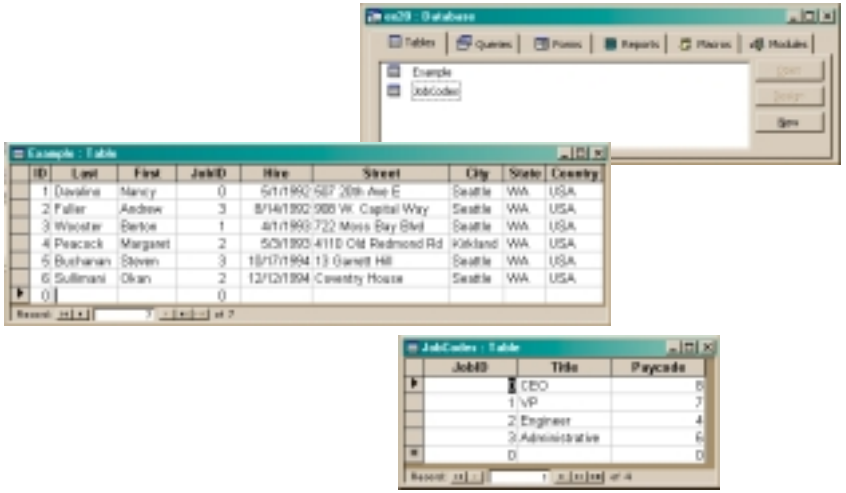
instance

Schema for Example table:

ID	number	unique number(Key)
Last	text	person's last name
First	text	person's first name
JobCode	number	current position
Hire	date	first day on job
...		

schema

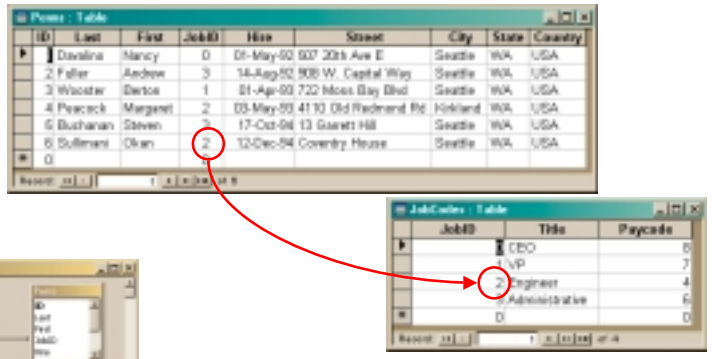
Two tables in a database



Redundancy in a database is Very Bad

- Not every assembly of tables is a good database
- Repeating data is a bad idea
  - » Replicated data can differ in its different locations, e.g. multiple addresses can differ
    - Inconsistent data is worse than no data
  - » Keep a *single copy* of any data
    - if it is needed in multiple places, associate it with a key and store key rather than the data

Relationships between tables



“You can look it up”

- When looking for information, a single item might be the answer, but a table is more likely
  - » Which employees live in Kirkland?
    - Table of employees
  - » Who is taking INFO/CSE 100?
    - Table of students
  - » Whose mile run time ≤ 4:00?
    - Table of runners

Query to a database (set of tables) produces a new table

Relational Algebra: Tables From Tables

- There are five basic “algebraic” operations on tables:
  - Select -- pick rows from a table
  - Project -- pick columns from a table
  - Union -- combine two tables w/like columns
  - Difference -- remove one table from another
  - Product -- create “all pairs” from two tables

From this basis, many more complicated operations can be built up

Select Operation

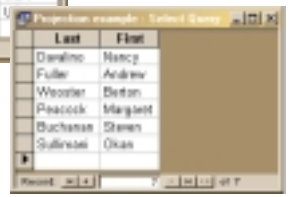
- Select creates a table from the rows of another table meeting a criterion

  Select_from Example **On** Hire < 1993

Project

- Project creates a table from the columns of another table

  Project Last, First **From** Example

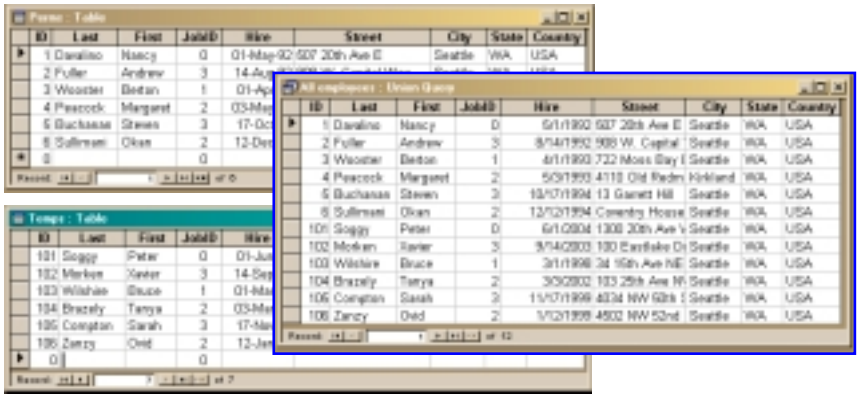


This is a projection from 9 dimensions to 2 dimensions

Union

- Union combines two tables with same attributes

  All employees = perms UNION temps



Difference

- Difference (written like subtraction) removes 1 table's rows from another
  - Eastern = States - WestCoast

States : Table

Name	Capitol	Sight
Washington	Olympia	Mt. Rainier
Oregon	Salem	Crater Lake
California	Sacramento	Golden Gate
Arizona	Phoenix	Grand Canyon
Nevada	Carson City	Las Vegas

WestCoast : Table

Name	Capitol	Sight
Washington	Olympia	Mt. Rainier
Oregon	Salem	Crater Lake
California	Sacramento	Golden Gate

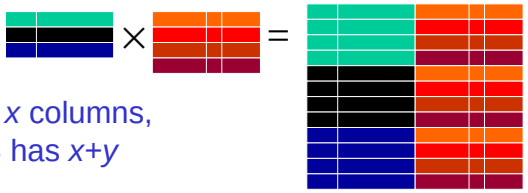
Eastern : Table

Name	Capitol	Sight
Arizona	Phoenix	Grand Canyon
Nevada	Carson City	Las Vegas

Product

- Product (written like multiplication) combines columns and pairs all rows

  Colors = Blues **x** Reds



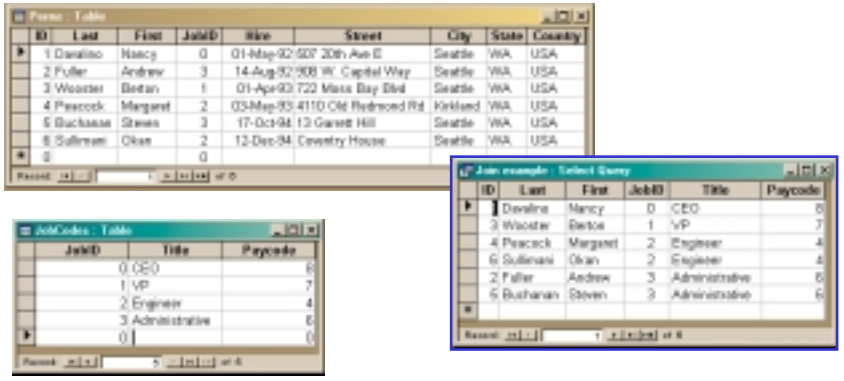
Column Rule: If A has *x* columns, B has *y* columns, A **x** B has *x+y* columns

Row Rule: If A has *m* rows, B has *n* rows A **x** B has *mn* rows

Join

- Join (written like a bow tie) combines rows if common field matches

  Employee List = Perms ⋈ JobCodes



DB Operations

- The five DB Operations can create any table from a given set of tables
  - All modern database systems are built on these relational operations
  - Join is not primitive, but can be built from 5
  - Join, select and project are used most often
  - The operations are not usually used directly, but are used indirectly from other languages

SQL, the DB language we learn, is built on basic 5