n-ary Relations and Their Applications

Rosen 8.2

We can have relation between more than just 2 sets

A binary relation involves 2 sets and can be described by a set of pairs
A ternary relation involves 3 sets and can be described by a set of triples
…
An n-ary relation involves n sets and can be described by a set of n-tuples

Relations are used to represent computer databases

Also used to represent constraints!

Let $A_1, A_2, \cdots, A_n$ be sets
An $n-ary$ relation is a subset of the cartesian product $A_1 \times A_2 \times \cdots \times A_n$
The sets $A_1, A_2, \cdots, A_n$ are the *domains* of the relation
The degree of the relation is n

Let R be the relation on $N \times N \times N$ consisting of triples (a,b,c) such that $a < b < c$

Note: N is the set of natural numbers {0,1,2,3,…}

$$R = \{(0,1,2),(0,1,3),\cdots,(0,2,3),(0,2,4),\cdots,(1,2,3),\cdots\}$$

$(2,4,3) \notin R$

The relation has degree 3

The domains of the relation are the set of natural numbers

Note: R could be considered as an extensional representation of the ternary relation a<b<c, assuming domains are finite and really quite small

Let R be the relation on $N \times Z \times N \times Z$ consisting of 4-tuples (a,b,c,d) such that $(a+b \neq c+d) \wedge (a+b+c+d=0)$

Note: N is the set of natural numbers {0,1,2,3,…}
Z is the set of integers {…,-2,-1,0,1,2,…}

$(0,-1,1,0) \in R$
$(5,-11,3,3) \in R$
$(6,6,3,9) \notin R$

The relation has degree 4

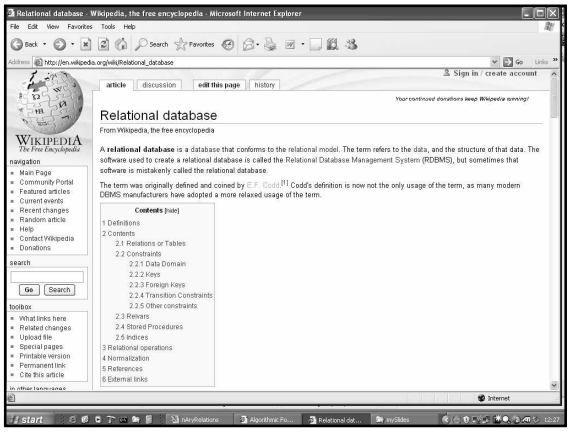
Note: R could be considered as an extensional representation of the ternary relation a<b<c, assuming domains are finite and really quite small

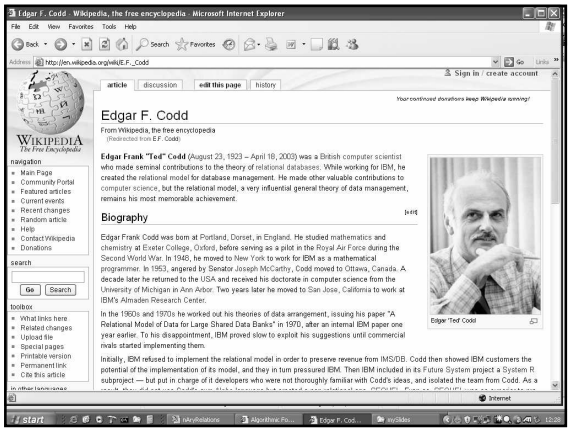
Database is made up of records.
Typical operations on a database are

- find records that satisfy a given criteria
- delete records
- add records
- update records

Some everyday databases
- student records
- health records
- tax information
- telephone directories
- banking records
- …

Databases ***may*** be represented using the relational model





Database made up of *records*; they are *n-tuples*; made up of *fields*

Student record might look as follows

(name,metricNo,faculty,gpa)

gpa is an attribute

(Jones,200401986,Arts,4.9)
(Lee,200408972,Science,3.6)
(Kuhns,200501728,Humanities,5.0)
(Moore,200308327,Science,5.5)

relations (in relDB) also called *tables*

Name	*metricNo*	*Dept*	*GPA*
Ackermann	231455	Computer Science	3.88
Adams	888323	Physics	3.45
Chou	102147	Computer Science	3.49
Goodfriend	453876	Mathematics	3.49
Rao	678543	Mathematics	3.90
Stevens	786576	Psychology	2.99

Attributes: name, metric No, Dept and GPA

Example from the book

Name	*metricNo*	*Dept*	*GPA*
Ackermann	231455	Computer Science	3.88
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primary key:
An attribute/domain/column is a primary key when the value of this attribute uniquely defines tuples
i.e. no two tuples have the same value for that attribute

Name cannot be a primary key, neither can Dept or GPS
metricNo is a primary key

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The current collection of n-tuples (records) in the relation (table) is called ***the extension of the relation***

The permanent aspects of the relation (table) such as the attribute names is called ***the intention of the relation***

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A ***composite key*** is a combination of attributes
That uniquely define tuples

Name	*metricNo*	*Dept*	*GPA*
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Let R be an $n-ary$ relation and C a condition that elements in R must satisfy. The selection operator S_c maps R to the new $n-ary$ relation of all $n-tuples$ from R that satisfy the condition C

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Apply the selection operator S_c
where C is the condition GPA > 3.45

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The *projection* $P_{i_1 i_2 \cdots i_m}$ where $i_1 < i_2 < \cdots < i_m$ maps the $n-tuple$ $(a_1, a_2, \cdots, a_n)$ to the $m-tuple$ $(a_{i_1}, a_{i_2}, \cdots, a_{i_m})$ where $m \le n$

It strips out specific columns

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Apply the projection $P_{1,4}$

Name			*GPA*
Ackermann			3.88
Adams			3.45
Chou			3.49
Goodfriend			3.49
Rao			3.90
Stevens			2.99

Lecturer	*Dept*	*Course*
Cruz	Zoology	335
Cruz	Zoology	412
Faber	Psychology	501
Faber	Psychology	617
Grammer	Physics	544
Grammer	Physics	551
Rosen	Computer Science	518
Rosen	Mathematics	575

Dept	*Course*	*Room*	*Time*
Computer Science	518	N521	14.00
Mathematics	575	N502	15.00
Mathematics	611	N521	16.00
Physics	544	B505	16.00
Psychology	501	A100	15.00
Psychology	617	A110	11.00
Zoology	335	A100	09.00
Zoology	412	A100	08.00

The join operator $J_p(R,S)$ where R and S are $m-ary$ and $n-ary$ relations respectively and $p \le m$ and $p \le n$ delivers a new relation of degree $m+n-p$ such that the first $m-p$ attributes come R and the last $n-p$ attributes come from S where the overlapping p attributes match (see Rosen p.534 Defn 4)

Joins two tables/relations together, matching up on specific attributes

Relational databases | Join | Operations on n-ary relations

Lecturer	*Dept*	*Course*
Cruz	Zoology	335
Cruz	Zoology	412
Faber	Psychology	501
Faber	Psychology	617
Grammer	Physics	544
Grammer	Physics	551
Rosen	Computer Science	518
Rosen	Mathematic s	575

Relation *R*

Dept	*Course*	*Room*	*Time*
Computer Science	518	N521	14.00
Mathematics	575	N502	15.00
Mathematics	611	N521	16.00
Physics	544	B505	16.00
Psychology	501	A100	15.00
Psychology	617	A110	11.00
Zoology	335	A100	09.00
Zoology	412	A100	08.00

Relation *S*

$$J_2(R,S)$$

Lecturer	*Dept*	*Course*	*Room*	*Time*
Cruz	Zoology	335	A100	09.00
Cruz	Zoology	412	A100	08.00
Faber	Psychology	501	A100	15.00
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Explain the previous slide

Explain how what we do differs from what will be presented in IM2