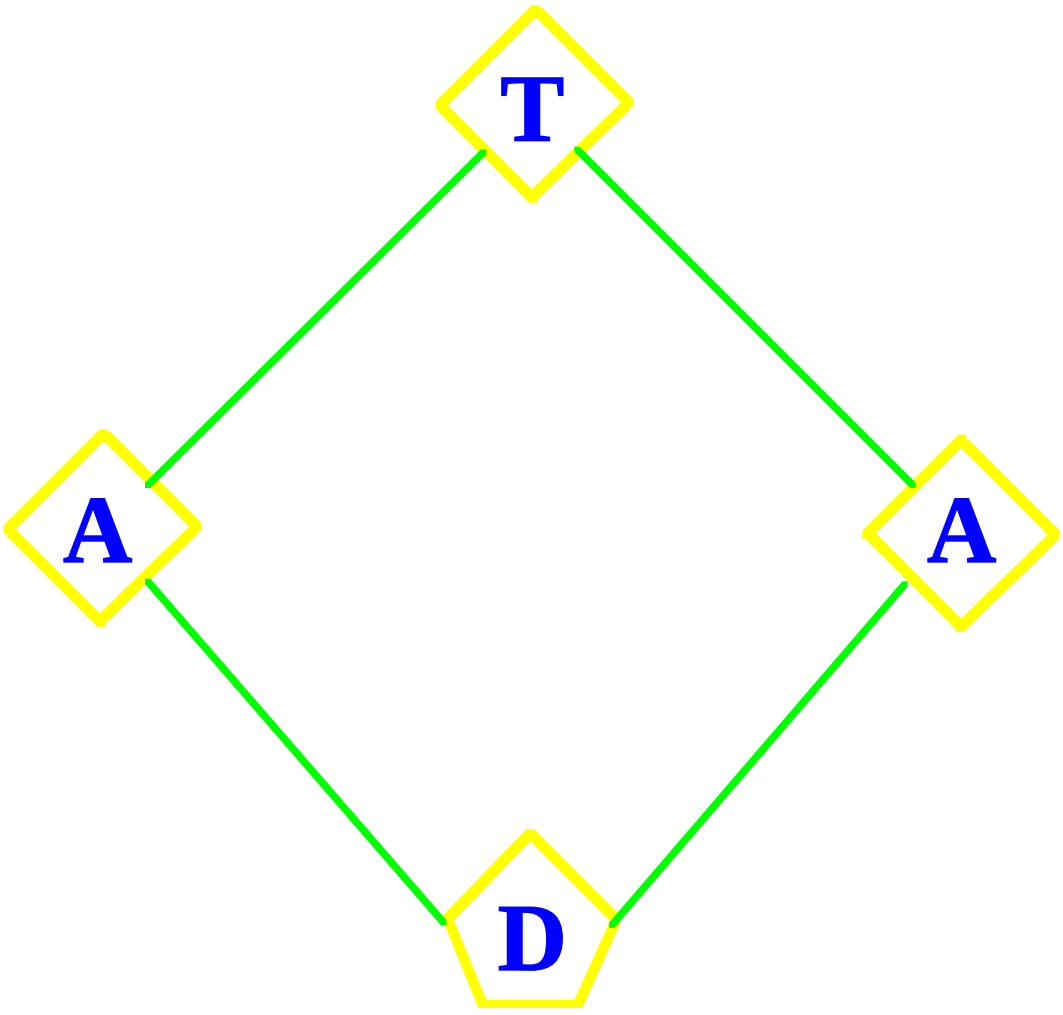
Relational Databases

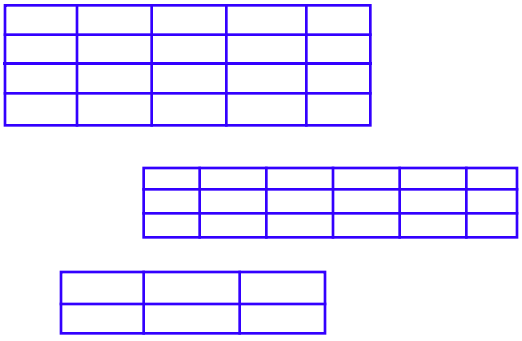
§6.2



A Relational Model for Data Banks

- Name of Johnson's supervisor
- All employees graduated from U of I
- All employees age 25 or younger making $50,000 or more
- Merge Department A and Department B
- Fire Johnson

user



relations (tables)

Database

NAME	SSN	DEPT	DATE EMPLOYED	SALARY
WAX	123456789	CS	9-1-72	1,000
WELLS	987654321	AA	1-1-82	287,000
WONG	12222222	CS	1-1-74	5,000

NAME = {WAX, WELLS, …}

SSN = {123456789, 987654321, …}

DEPT = {CS, AA, EE, …}

DATE = {9-1-72, 1-1-82, …}

SALARY = {1,000, 2,000, 3,000, 287,000, …}

$R \subseteq NAME \times SSN \times DEPT \times DATE \times SALARY$

(WAX, 123456789, CS, 9-1-72, 1,000) $\in$ R

(WELLS, 987654321, AA, 1-1-82, 287,000) $\in$ R

Attributes (Fields): NAME, SSN, DEPT, …

Scheme: set of attributes
{NAME, SSN, DEPT, …}

Tuple (Records): (WAX, 123456789, CS, 9-1-72, 1000)

Relation (Table): set of tuples

Database: set of relations

Database: a set of relations

Course	Student ID	Grade
CS 173	1024	A
CS 173	2007	B
EE 260	2007	A

Student ID	Name	Address	Phone
1024	Brown, C.	207 ISR	3-2729
2007	Yi, S.	111 Allen	4-0004

.....

Student ID	Name	Address	Phone	Course	Grade
1024	Brown, C.	207 ISR	3-2729	CS 173	A
2007	Yi, S.	111 Allen	4-0004	CS 173	B
2007	Yi, S.	111 Allen	4-0004	EE 260	A

Operations on Relations

Insert (t, R) : add the tuple t to the relation R

Delete (t, R) : delete the tuple t from the relation R

Delete (x, R) : delete all tuples that match the specification x from the relation R

Relational Operations (Examples)

Course	Day	Hour
CS 173	M	1 PM
CS 173	W	1 PM
CS 173	F	1 PM
EE 260	T	10 AM
EE 260	Th	10 AM
EE 260	F	1 PM

Insert ((CS 173, W, 7 PM),
Course-Day-Hour)

Delete ((EE 260, T, 10 AM),
Course-Day-Hour)

Delete ((EE 260, *, *),
Course-Day-Hour)

Delete ((*, F, 1 PM), Course-Day-Hour)

Lookup (X, R): look up all tuples that match the specification X

Lookup ((*, M, *), Course-Day-Hour)

Keys

Student ID	Name	Address	Phone
1024	Brown	207 ISR	3-2729
2007	Yi	111 Allen	4-0004
2139	Brown	111 Allen	4-0004

For a relation, a key is a set of attributes, such that all tuples in the relation are unique for those attributes.

{Student ID} is a key

{Name, Phone} is a key

{Student ID, Name} is a key

{Address} is not a key

{Address, Phone} is not a key

{Student ID, Name, Address, Phone} is a key

Key selection: an important design issue

Relational Algebra

Operations on a set of relations

R_1, R_2: relations that have the same scheme

$R_1 \cup R_2$

$R_1 \cap R_2$

$R_1 \oplus R_2$

$R_1 - R_2$

Operations (Examples)

Student ID	Name	Phone
1024	Brown	3-2124
2007	Yi	4-0004
2149	King	3-1359

CS 173

Student ID	Name	Phone
1024	Brown	3-2124
2125	Ahu	3-1276
2149	King	3-1359

ECON 101

CS 173 $\cup$ ECON 101: students in either one or both of CS 173 and ECON 101

CS 173 $\cap$ ECON 101

CS 173 $\oplus$ ECON 101

CS 173 - ECON 101

ECON 101 - CS 173

The Selection Operation (Unary)

$\sigma_C(R) = R'$

Select the tuples in the relation R which satisfy the condition C.
These tuples constitute a relation denoted R'.

Student ID	Name	Dept	Year	Dorm
1024	Brown	CS	2	Allen
2017	Yi	EE	1	ISR
2337	Brown	CS	1	ISR

Master

$\sigma_{\text{Dept = "CS"}}$(Master) yields

Student ID	Name	Dept	Year	Dorm
1024	Brown	CS	2	Allen
2337	Brown	CS	1	ISR

$\sigma_{\text{Dorm = "ISR"}}$(Master)

$\sigma_{\text{Dept = "CS" and Year = "1"}}$(Master)

The Projection Operation (Unary)

pg.354

Scheme: $\{A_1, A_2, \ldots, A_k\}$

List: $(B_1, B_2, \ldots, B_n)$

$\{B_1, B_2, \ldots, B_n\} \subseteq \{A_1, A_2, \ldots, A_k\}$

$$P_{B_1,B_2,\ldots,B_n}(R)$$

Course	Day	Hour
CS 173	M	10 AM
CS 173	M	2 PM
CS 173	W	10 AM
EE 260	M	2 PM
EE 260	W	2 PM

TIME

Course	Day
CS 173	M
CS 173	W
EE 260	M
EE 260	W

$P_{\text{Course, Day}}$ (TIME)

Hour	Course
10 AM	CS 173
2 PM	CS 173
2 PM	EE 260

$P_{\text{Hour,Course}}$ (TIME)

The Join Operation (Binary)

Course	Day	Hour
CS 173	M	1 PM
CS 173	W	1 PM
CS 173	F	1 PM
EE 260	Tu	9 AM
EE 260	Th	9 AM

R_1

Course	Room
CS 173	1310 DCL
EE 260	151 Everett

R_2

Course	Day	Hour	Room
CS 173	M	1 PM	1310 DCL
CS 173	W	1 PM	1310 DCL
CS 173	F	1 PM	1310 DCL
EE 260	Tu	9 AM	151 Everett
EE 260	Th	9 AM	151 Everett

$$R_1 \underset{\text{Course = Course}}{\bowtie} R_2$$

Join (continued)

$R_1 : \{A_1, A_2, \ldots, A_n\}$

$R_2 : \{B_1, B_2, \ldots, B_m\}$

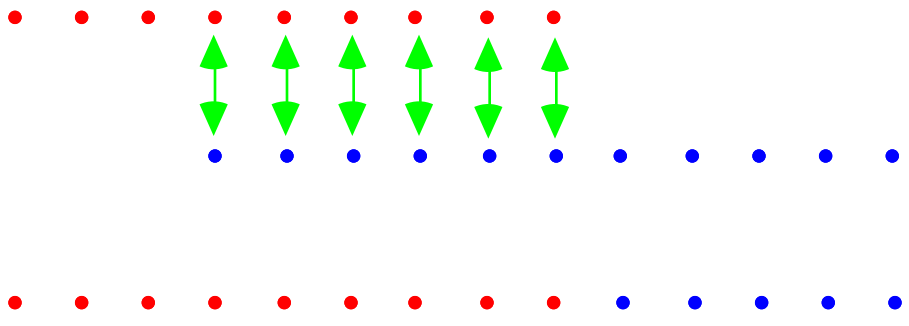
$$R_1 \underset{A_i = B_j}{\bowtie} R_2$$

$\{A_1, A_2, \ldots, A_n, B_1, B_2, \ldots, B_{j-1}, B_{j+1}, \ldots, B_m\}$

$A_1, A_2, \cdots, A_i, \cdots, A_n$

$B_1, B_2, \cdots, B_{j-1}, B_j, B_{j+1}, \cdots, B_m$

Notation in textbook



Join (example)

Name	Age
Brown	26
Yi	51
Cole	26

R_1

Age	Insurance Rate
21	5%
22	5%
…	
26	5%
…	
51	8%

R_2

Name	Age	Insurance Rate
Brown	26	5%
Yi	51	8%
Cole	26	5%

$R_1 \underset{\text{Age = Age}}{\bowtie} R_2$

Join (more example)

Name	Age
Brown	26
Yi	51
Cole	26

R_1

Job	Hours
A	12
B	24
C	26
D	30
E	42

R_2

Name	Age	Job
Brown	26	C
Brown	26	C

$R_1 \underset{\text{Age = Hours}}{\bowtie} R_2$

Meaningless but correct