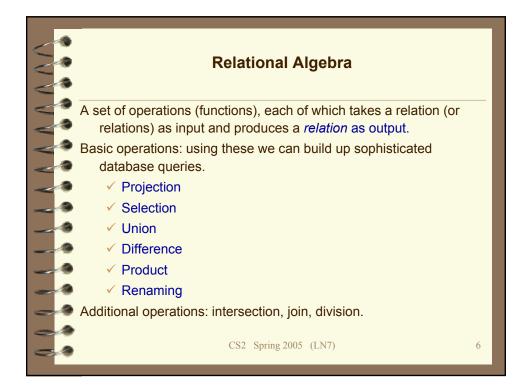
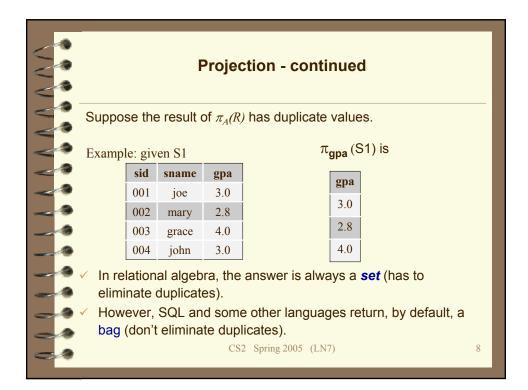
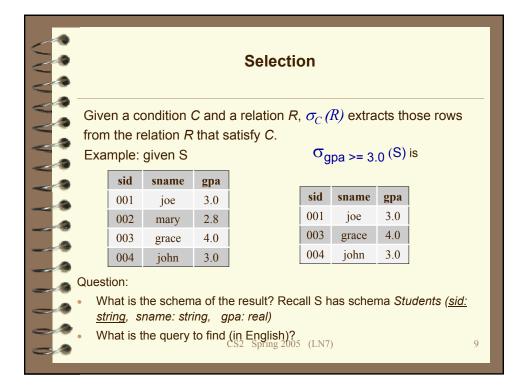


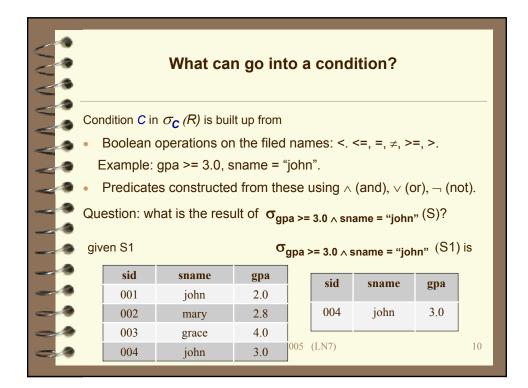
		Example instances							
	S:	S: E:							
	sid	sname	1	gpa	sid	cid	grade		
	001	joe		3.0	001	166	В		
	002	mary	-	2.8	002	CS2	C		
	003	grace		4.0	003	166	А		
	004	john		3.0	003	CS2	А		
	C:	cid	cname	credits	instructor				
- 0		166	math	3	poe				
-		CS2	db	4	fan				
	Question: both John and Joe have a GPA of 3.0. Is S legal? CS2 Spring 2005 (LN7) 5								

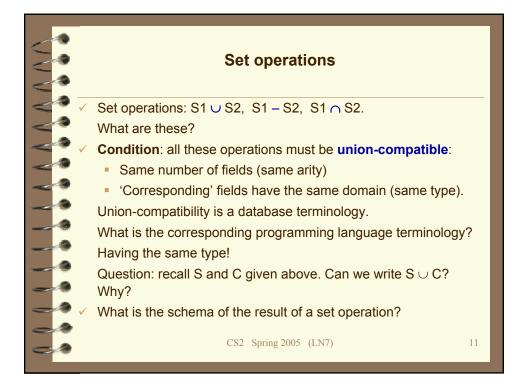


	Projection							
the co	Given a list of column names <i>A</i> and a relation <i>R</i> , $\pi_A(R)$ extracts the columns in A from the relation. Example: given S $\pi_{sid, gpa}(S)$ is							
	sid sname gpa sid gpa							
	001	joe	3.0		001	3.0		
	002	mary	2.8		002	2.8		
	003	grace	4.0		003	4.0		
 Question: What is the schema of the result? Recall S has schema <i>Students</i> (<i>sid: string, sname: string, gpa: real</i>) What is the query (in English)? CS2 Sprmg 2005 (LN7) 							7	

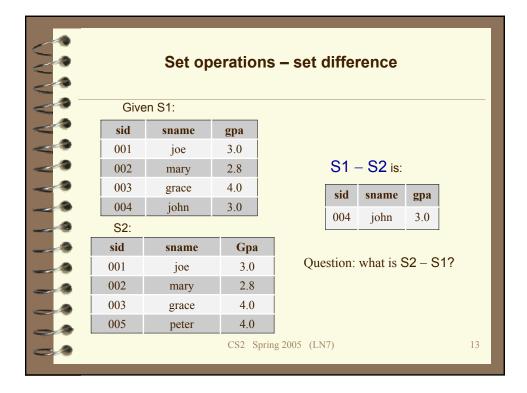


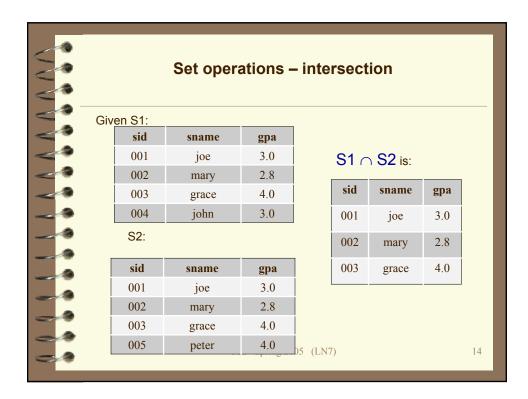


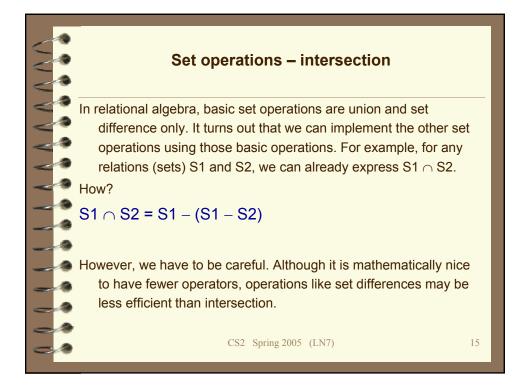




	Set operations – union									
</th <th colspan="9">Given S1: S1 ∪ S2 is:</th>	Given S1: S1 ∪ S2 is:									
<3	sid	sname	gpa	ſ		02 15.				
<2	001	joe	3.0		sid	sname	gpa			
~?	002	mary	2.8		001	joe	3.0			
~	003	grace	4.0		002	mary	2.8			
	004	john	3.0		003	grace	4.0			
3	S2:				004	john	3.0			
	sid	sname	gpa	1 l	005	peter	4.0			
	001	joe	3.0							
	002	mary	2.8							
-3	003	grace	4.0							
-1	005	peter	4.0							
-			CS	2 Spring 200	5 (LN7)			12		

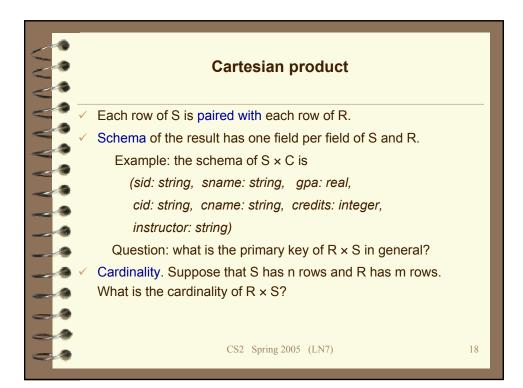


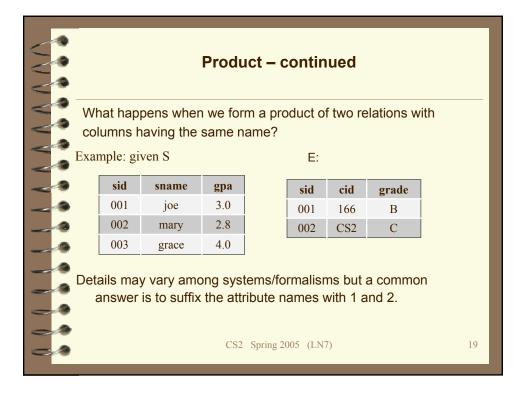




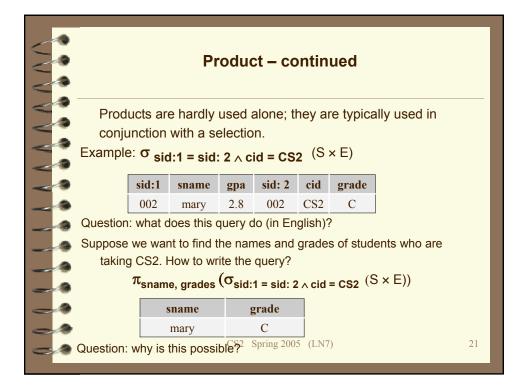
000	Product							
Product <i>R</i> × S connects two relations <i>R</i> and <i>S</i> that are not necessarily union compatible. Example: given S:								
	sid	snam	e gpa					
	001	joe	3.0					
	002	mary	2.8					
	003	grace	4.0					
	C:							
	cid	cname	credits	instructor				
_	166	math	3	poe				
-	CS2	db	4	fan				
2.9			CS2	Spring 2005 ((LN7)	16		

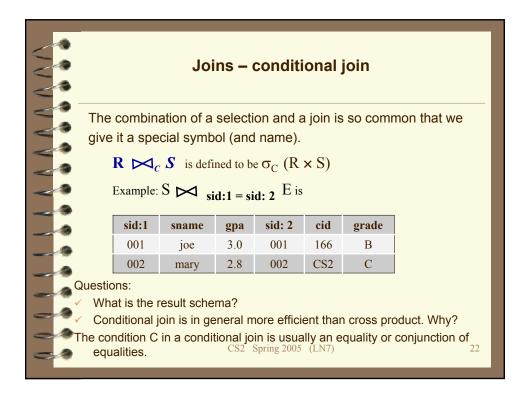
<								
<								
</th <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>								
<		S × C	is:					
	sid	sname	gpa	cid	cname	credits	instructor	
	001	joe	3.0	166	math	3	poe	
	002	mary	2.8	166	math	3	poe	
~	003	grace	4.0	166	math	3	poe	
~~??	001	joe	3.0	CS2	db	4	fan	
	002	mary	2.8	CS2	db	4	fan	
	003	grace	4.0	CS2	db	4	fan	
- 3								-
-								
-			CS2	Spring	2005 (LN7)			17

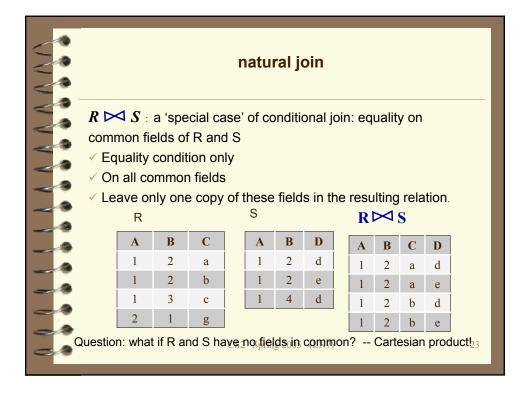




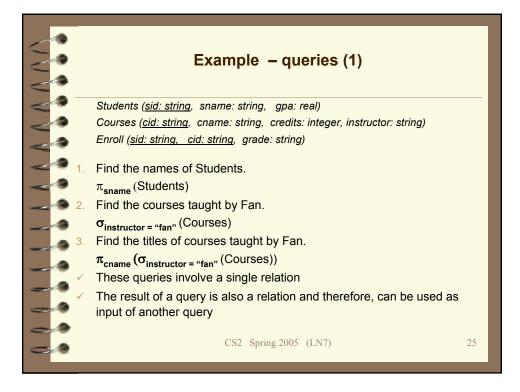
۲							
•							
) —	Example:	SxEis					
)	-						
	sid:1	sname	gpa	sid: 2	cid	grade	
	001	joe	3.0	001	166	В	
	002	mary	2.8	001	166	В	
	003	grace	4.0	001	166	В	
	001	joe	3.0	002	CS2	С	
	002	mary	2.8	002	CS2	С	
	003	grace	4.0	002	CS2	С	
	CS2 Spring 2005 (LN7)						

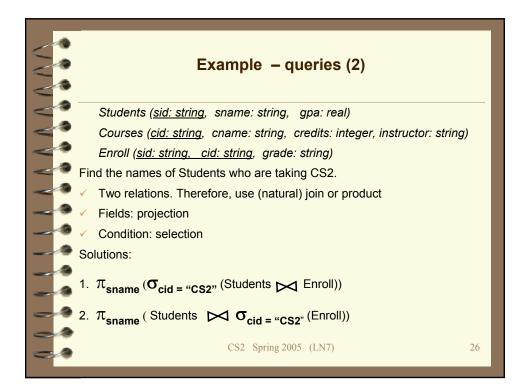


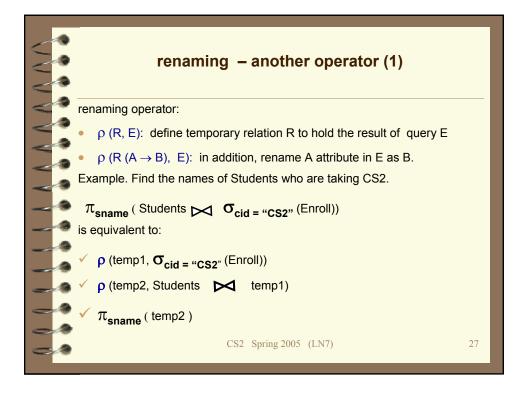


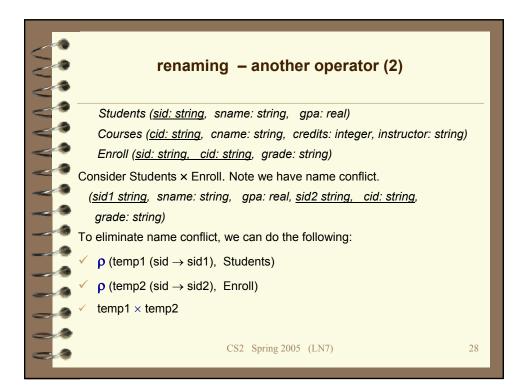


		Example – natural join								
	Exa	mple:	given S	S:	-			E:		
		sid	sname	gpa		[sid	cid	grade	
		001	joe	3.0			SIU 001	166	B	
~?		002	mary	2.8				_	2	
~?		003	grace	4.0		l	002	CS2	C	
		Quest	tion: wh	at is S	► E?			_		
		Answ	er:	sid	sname	gpa	cid	grad	de	
				001	joe	3.0	166	В	3	
				002	mary	2.8	CS2	C		
	Qu	Question: what is S 🖂 C where C is an instance of								
2.13	Со	Courses (cid: string, cname: string, credits: integer, instructor: string) ? CS2 Spring 2005 (LN7) 24								
2/9					052	Spring	2005 (27	



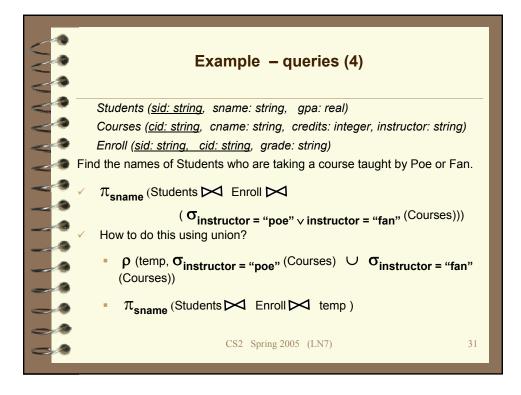






	Example – queries (3)						
</th <th>Students (<u>sid: string</u>, sname: string, gpa: real)</th>	Students (<u>sid: string</u> , sname: string, gpa: real)						
<2	Courses (cid: string, cname: string, credits: integer, instructor: string)						
~?	Enroll (<u>sid: string, cid: string</u> , grade: string)						
~	Find the names of Students who are taking a course taught by Fan.						
	 Information about instructor only available in Courses; so we need an extra join. Solutions: 						
	 π_{sname} (Students nroll nstructor = "fan" (Courses)) Remark. Associative! 						
	$R \bowtie S \bowtie^{F} = (R \bowtie^{F} \checkmark^{F} \bowtie^{F} R)$						
	2. A more efficient solution:						
_	π_{sname} (Students π_{d} (Enroll $\sigma_{\text{instructor}} = \text{"fan"}$ (Courses))))						
- 2	Remark. A query optimizer can find this given the first solution.						
-	CS2 Spring 2005 (LN7) 29						

	Exercises – queries
<^?	Students (sid: string, sname: string, gpa: real)
<	Courses (<u>cid: string</u> , cname: string, credits: integer, instructor: string)
~	Enroll (<u>sid: string, cid: string</u> , grade: string)
~ 1 .	Find the GPAs of Grace.
~~ 2.	Find the ids of the courses being taken by Grace.
 3.	Find the instructors of the courses being taken by Grace.
— 3 4.	Find the names of students who are taking at least one course.
	utions:
— 1.	$\pi_{gpa} (\sigma_{sname = "grace"} Students)$
2 .	$\pi_{cid}((\sigma_{sname = "grace"} \text{ Students }) \longrightarrow \text{ Enroll })$
3.	$\pi_{instructor}$ (Courses \bowtie Enroll \bowtie ($\sigma_{sname = "grace"}$ Students))
– • ^{4.}	π _{sname} (Students CEhrölli) ^{g 2005} (LN7) 30



	Example – queries (5)
	Students (<u>sid: string</u> , sname: string, gpa: real) Courses (<u>cid: string</u> , cname: string, credits: integer, instructor: string) Enroll (<u>sid: string, cid: string</u> , grade: string)
~	Find the ids of Students who are taking a course taught by Poe and a course taught by Fan.
	✓ π_{sid} (Enroll → $\sigma_{instructor = "poe"}$ (Courses)) ∩ π_{sid} (Enroll → $\sigma_{instructor = "fan"}$ (Courses)) ✓ The following is incorrect!
	$ \begin{aligned} \pi_{sid}(\text{ Enroll} \Join (\sigma_{instructor = "poe" \land instructor = "fan"}(\text{Courses}))) \\ \text{Question: Find the names of Students who are taking a course taught by} \\ \text{Poe and a course taught by Fan.} \end{aligned} $
-3	$\pi_{\text{sname}} (\text{Students} \Join \pi_{\text{sid}} (\text{Enroll} \Join \sigma_{\text{instructor}} = \text{"poe"} (\text{Courses})) \cap \pi_{\text{sid}}^2 (\text{Enroll} \Join ^7 \sigma_{\text{instructor}} = \text{"fan"} (\text{Courses}))))^2$

