Natural Join

Combine two relations into a single relation.

The tuples are joined if the attributes common to both relations are equal.

instructor ⋈ department

ID	*name*	*dept_name*	*salary*
10101	Srinivasan	Comp. Sci.	65000
12121	Wu	Finance	90000
15151	Mozart	Music	40000
22222	Einstein	Physics	95000
32343	El Said	History	60000
33456	Gold	Physics	87000
45565	Katz	Comp. Sci.	75000
58583	Califieri	History	62000
76543	Singh	Finance	80000
76766	Crick	Biology	72000
83821	Brandt	Comp. Sci.	92000
98345	Kim	Elec. Eng.	80000

⋈

dept_name	*building*	*budget*
Biology	Watson	90000
Comp. Sci.	Taylor	100000
Elec. Eng.	Taylor	85000
Finance	Painter	120000
History	Painter	50000
Music	Packard	80000
Physics	Watson	70000

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15151	Mozart	40000	Music	Packard	80000
22222	Einstein	95000	Physics	Watson	70000
32343	El Said	60000	History	Painter	50000
33456	Gold	87000	Physics	Watson	70000
45565	Katz	75000	Comp. Sci.	Taylor	100000
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76543	Singh	80000	Finance	Painter	120000
76766	Crick	72000	Biology	Watson	90000
83821	Brandt	92000	Comp. Sci.	Taylor	100000
98345	Kim	80000	Elec. Eng.	Taylor	85000

Which common attribute(s) are these relations joined on?

Cartesian Product

This is the *cross product* of two relations.

Q. What is the cross product of {a, b} and {c, d}?

A. {a, b} X {c, d} produces {(a, c), (a, d), (b, c), (b, d)}

The cross product produces all possible pairs of rows of the two relations.

Q. Can you see a problem?

A. If the two relations have attributes in common, how do we tell which relation each attribute is from?

Cartesian Product Example

Relations *r, s*:

A	*B*
α	1
β	2

r

C	*D*	*E*
α	10	a
β	10	a
β	20	b
γ	10	b

s

r x *s*:

A	*B*	*C*	*D*	*E*
α	1	α	10	a
α	1	β	10	a
α	1	β	20	b
α	1	γ	10	b
β	2	α	10	a
β	2	β	10	a
β	2	β	20	b
β	2	γ	10	b

Cartesian Product Common Attributes

Relations *r, s*:

A	B
α	1
β	2

r

B	D	E
α	10	a
β	10	a
β	20	b
γ	10	b

s

r x *s*:

A	r.B	s.B	D	E
α	1	α	10	a
α	1	β	10	a
α	1	β	20	b
α	1	γ	10	b
β	2	α	10	a
β	2	β	10	a
β	2	β	20	b
β	2	γ	10	b

Renaming Attributes

Allows us to refer to a relation, (say E) by more than one name.

$$\rho_x(E)$$

returns the expression *E* under the name *X*

Example.

Relations *r*

A	*B*
a	1
b	2

$r \times \rho_s(r)$

r.A	*r.B*	*s.A*	*s.B*
a	1	a	1
a	1	b	2
b	2	a	1
b	2	b	2

Union

Relations *r, s:*

For $r \cup s$ to be valid.

1. *r, s* must have the *same arity* (same number of attributes)

2. The attribute domains must be *compatible*

i.e, 2nd column of *r* deals with the same type of values as does the 2nd column of *s*.

Q. Did you expect there to be 4 rows?

A	B
α	1
α	2
β	1

r

A	B
α	2
β	3

s

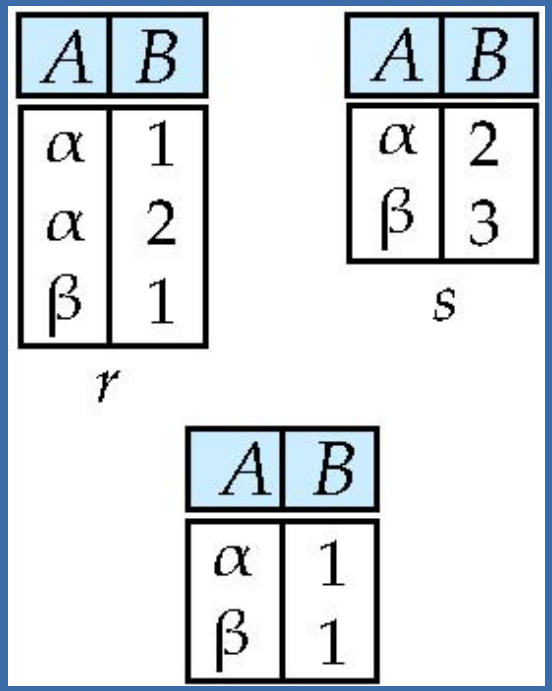
A	B
α	1
α	2
β	1
β	3

r ∪ s:

Difference

What would you expect them to be?

- Relations *r*, *s*:



A	B
α	1
α	2
β	1

r

A	B
α	2
β	3

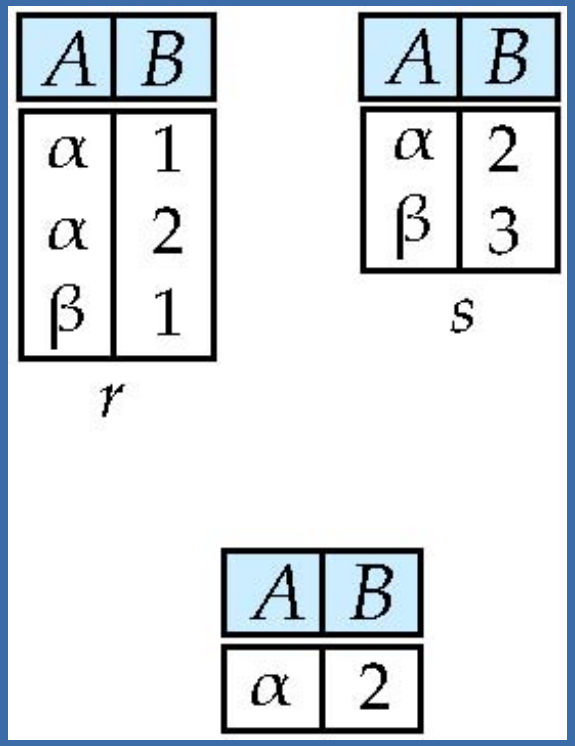
s

- $r - s$:

A	B
α	1
β	1

Intersection

- Relation *r, s*:



A	B
α	1
α	2
β	1

r

A	B
α	2
β	3

s

- $r \cap s$

A	B
α	2

Note: $r \cap s = r - (r - s)$