

CSE 4/562

Database Systems

Practicum

03/02/2018
(Cancelled class)

The idea is...

- If X and Y are **equivalent**...
- And If Y is **better**...
- **Then replace all Xs with Ys.**

Equivalent Expressions

R

<A>
1
2
2

S

<A>	
2	4
3	5
3	6

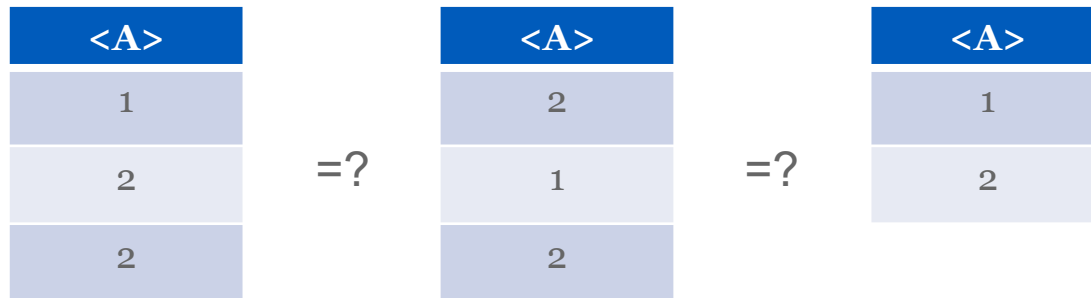
- Is $R=S$?
- Is $R=\pi_A(S)$?
- Is $R=\pi_{A\leftarrow(A-1)}(S)$?
- Is $\pi_{A\leftarrow(A+1)}(R) = \pi_A(S)$?

Equivalent Expressions

Two expressions are equivalent if they produce the same output.

But...

Equivalent Expressions



- **Bag semantics:** The same tuples (order-independent)
- **Set semantics:** The same set of tuples (count-independent)
- **List semantics:** The same tuples (order matters)

RA Equivalencies

Selection

$$\sigma_{C_1 \wedge C_2}(R) \equiv \sigma_{C_1}(\sigma_{C_2}(R)) \quad (\text{Decomposable})$$

$$\sigma_{C_1 \vee C_2}(R) \equiv \delta(\sigma_{C_1}(R) \cup \sigma_{C_2}(R)) \quad (\text{Decomposable})$$

$$\sigma_{C_1}(\sigma_{C_2}(R)) \equiv \sigma_{C_2}(\sigma_{C_1}(R)) \quad (\text{Commutative})$$

RA Equivalencies

Projection

$$\pi_a(\mathbf{R}) \equiv \pi_a(\pi_{a \cup b}(\mathbf{R}))$$

(Idempotent)

RA Equivalencies

Cross Product and Join

$$R \times (S \times T) \equiv (R \times S) \times T \quad (\text{Associative})$$

$$(R \times S) \equiv (S \times R) \quad (\text{Commutative})$$

Selection and Projection

$$\pi_a (\sigma_c(R)) \equiv \sigma_c (\pi_a (R))$$

Selection commutes with projection, but only if attribute set **a** and condition **c** are compatible.

Compatible: **a** must include all columns referenced by **c**

Join

$$\sigma_c(R \times S) \equiv R \bowtie_c S$$

Selection *combines* with Cross Product to form a join as per the definition of Join.

Selection and Cross Product

$$\sigma_{\mathbf{c}}(\mathbf{R} \times \mathbf{S}) \equiv \sigma_{\mathbf{c}}(\mathbf{R}) \times \mathbf{S}$$

Selection commutes with Cross Product, but only if condition \mathbf{c} references attributes of \mathbf{R} exclusively.

Projection and Cross Product

$$\pi_{\mathbf{a}}(\mathbf{R} \times \mathbf{S}) \equiv \pi_{\mathbf{a}_1}(\mathbf{R}) \times \pi_{\mathbf{a}_2}(\mathbf{S})$$

Projection *commutes* (distributes) over Cross Product, where **a1** and **a2** are the attributes in **a** from R and S respectively.

RA Equivalencies

Union and **Intersection** are commutative and associative.

Selection and Projection both commute with both Union and Intersection.

Example

Create different versions of the RA tree for this query and discuss which one is better
(S.C is uniformly distributed and ranges between 1-100)

```
SELECT R.A, T.E  
FROM R, S, T  
WHERE R.B = S.B  
AND S.C < 5  
AND S.D = T.D
```

Tips

- What happens when we execute all joins first
- What happens if we apply $S.C < 5$ on S relation first, and then execute the joins
- Which attributes do you need to read from R, S and T

```
SELECT R.A, T.E  
FROM R, S, T  
WHERE R.B = S.B  
AND S.C < 5  
AND S.D = T.D
```