# 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> | <B> |
| --- | --- |
| 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

| <A> |
|---|
| 1 |
| 2 |
| 2 |

=?

| <A> |
|---|
| 2 |
| 1 |
| 2 |

=?

| <A> |
|---|
| 1 |
| 2 |

- **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

$\sigma_{C1 \wedge C2}(R) \equiv \sigma_{C_1}(\sigma_{C_2}(R))$ (Decomposable)

$\sigma_{C1 \vee C2}(R) \equiv \boldsymbol{\delta}(\ \sigma_{C_1}(R) \cup \sigma_{C_2}(R)\ )$ (Decomposable)

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

# RA Equivalencies

## Projection

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

# RA Equivalencies

## Cross Product and Join

$R \times (S \times T) \equiv (R \times S) \times T$ (Associative)

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

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

Selection *commutes* with Cross Product, but only if condition **c** references attributes of R exclusively.

# Projection and Cross Product

$$\pi_a(R \times S) \equiv \pi_{a1}(R) \times \pi_{a2}(S)$$

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