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

<table>
<thead>
<tr>
<th>R</th>
<th>&lt;A&gt;</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>S</th>
<th>&lt;A&gt;</th>
<th>&lt;B&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>4</td>
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<td></td>
<td>3</td>
<td>5</td>
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<td></td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
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

\[ \sigma_{C1 \land C2}(R) \equiv \sigma_{C1}(\sigma_{C2}(R)) \]  
(Decomposable)

\[ \sigma_{C1 \lor C2}(R) \equiv \delta(\sigma_{C1}(R) \cup \sigma_{C2}(R)) \]  
(Decomposable)

\[ \sigma_{C1}(\sigma_{C2}(R)) \equiv \sigma_{C2}(\sigma_{C1}(R)) \]  
(Commutative)
RA Equivalencies

Projection

\[ \pi_a(R) \equiv \pi_a(\pi_{a\cup b}(R)) \quad \text{(Idempotent)} \]
RA Equivalencies

Cross Product and Join

\[ R \times (S \times T) \equiv (R \times S) \times T \]  \hspace{1cm} \text{(Associative)}

\[ (R \times S) \equiv (S \times R) \]  \hspace{1cm} \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

\[ \sigma_c(R \times S) \equiv \sigma_c(R) \times S \]

Selection *commutes* with Cross Product, but only if condition \( c \) references attributes of \( R \) exclusively.
Projection and Cross Product

\[ \pi_a (R \times S) \equiv \pi_{a_1} (R) \times \pi_{a_2} (S) \]

Projection *commutes* (distributes) over Cross Product, where \(a_1\) and \(a_2\) 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 $T$

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