Coordinate Systems

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1 Introduction

- Relational Algebra is a basic set of operations for the relational model
- Expressions are compositions of relation algebra operations possible due to closure
- It's used as the model for SQL

2 Select Operator

- Unary operator that returns subset of tuples from a relation given a selection condition
- Denote

$$\sigma_{\text{condition}}(R) \tag{1}$$

- In SQL we can express this as

```
SELECT *
FROM R
WHERE <condition>
```

- Selection cannot produce duplicates (relational model is set-based)
-

$$\sigma_{c_2}(\sigma_{c_1}(R)) = \sigma_{c_1}(\sigma_{c_2}(R)) \tag{2}$$

$$\sigma_{c_2}(\sigma_{c_1}(R)) = \sigma_{c_1 AND c_2}(R) \tag{3}$$

- Define the selectivity as the fraction of tuples selected by the selection condition

3 Project Operator

- Unary operator that keeps specified attributes and discards others
- Denote

$$\pi_{\text{attributes}}(R) \tag{4}$$

- By nature, project returns a set of distinct tuples
- In SQL, we can express this as

```
SELECT DISTINCT <attributes>
FROM R
```

- *Note* $\pi_L(R)$ is only defined if $L \subseteq attr(R)$
-

$$\pi_{L_2}(\pi_{L_1}(R)) = \pi_{L_2}(R) \tag{5}$$

$$\pi_L(\sigma_C(R)) = \sigma_C(\pi_L(R)) \tag{6}$$

- Define the degree as the number of attributes in projected attribute list

4 Set Theory

- Many operators from set theory are also found in relational algebra
- Union and Intersection
- Difference $R - S$ returns the elements in R but not in S (complement of S union complement R)

5 Cross Product

- Binary operator that returns all combinations of elements in A and B
- The resultant has degree equal to the sum of operand degrees and number of tuples equal to the product
- Relations do not have to be union compatible

6 Renaming

- Unary operator that can rename relation, attributes or both
- Denote

$$\rho_{S(B_1,\ldots,B_n)}(R) \tag{7}$$

- eg. Pairing upper years with F!rosh

$$\rho_{Mentor(senior,class)}(\sigma_{year>2}(Student)) \times \sigma_{year=1}(Student) \tag{8}$$

7 Inner Join Operator

- Binary operator that crosses two relations and applies a selection condition
- Denote

$$R \bowtie_{condition} S = \sigma_{condition}(R \times S) \tag{9}$$

learning from https://cs.uwaterloo.ca/~tozsu/courses/CS338/lectures/5%20Rel%20Algebra.pdf