CS422 Principles of Database Systems
More about Relational Algebra

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Why Study Relational Algebra?

- … when we already know SQL?
- Because we want to know
  - What *basic operations* are needed for a query language like SQL?
    - Design
    - Implementation
  - What the capabilities and limitations of such a language?
  - How to we decide whether two queries are equivalent
    - Query optimization

Notations

$\cup$	UNION
$\cap$	INTERSECTION
–	DIFFERENCE
σ_c	$SELECT_c$
π_L	$PROJ_L$
X	*
$\bowtie$	JOIN
$\bowtie_c$	$JOIN_c$
ρ	RENAME

δ	DELTA
τ	TAU
γ	GAMMA
π_L	$PROJ_L$
$\bowtie^o$	OUTERJOIN
$\bowtie^o_L$	LEFTJOIN
$\bowtie^o_R$	RIGHTJOIN
SUM, AVG, COUNT,MIN,MAX	

Constraints on Relations

- Constraints
  - not null, unique, primary key, references (foreign key) …
- Express constraints using relational algebra
  - $R = \emptyset$
  - $R \subseteq S$

Two Observations

- The two ways of expressing constraints in relational algebra are equivalent
  - $R = \emptyset \Leftrightarrow R \subseteq \emptyset$
  - $R \subseteq S \Leftrightarrow R\text{-}S = \emptyset$
- R and S could be sets or bags

Example

Products (ProdID, Description, Price)
Orders (OrderID, ProdID, Quantity)

Referential Integrity Constraints

- A value of *ProdID* in the *Orders* relation must match a value of *ProdID* in the *Products* relation

Functional Dependency

- { ProdID } → { Description, Price }
- { OrderID, ProdID } → { Quantity }

Other Constraints

- Not NULL
  - *ProdID* in *Products* cannot be null
- Unique
  - *ProdID* in *Products* has to be unique
- Enumeration
  - *Gender* attribute in a relation *R* has to be either "Male" or "Female"

Exercises

- Core Relation Algebra
  - 5.2.1, 5.2.4
- Extended Operators
  - 5.4.1, 5.4.3
- Constraints
  - 5.5.1, 5.5.2

Computer Products DB

Product (maker, model, type)
PC (model, speed, ram, hd, rd, price)
Laptop (model, speed, ram, hd, screen, price)
Printer(model, color, type, price)

model number is assumed to be unique over all manufacturers and product types.

WWII Capital Ships DB

Classes (class, type, county, numGuns, bore, displacement)
Ships (name, class, launched)
Battles (name, date)
Outcomes (ship, battle, result)