COS 425: Database and Information Management Systems

Relational model:
Relational algebra

Modeling access

- Have looked at modeling information as data + structure
- Now: how model access to data in relational model?

- Formal specification of access provides:
  - Unambiguous queries
  - Correctness of results
  - Expressiveness of query languages

Queries

- A query is a mapping from a set of relations to a relation
  Query: relations ---→ relation

- Can derive schema of result from schemas of input relations
- Can deduce constraints on resulting relation that must hold for any input relations
- Can identify properties of result relation
Relational query languages

• Two formal relational languages to describe mapping
  – Relational algebra
    • Procedural – lists operations to form query result
  – Relational calculus
    • Declarative – describes results of query
• Equivalent expressiveness
• Each has strong points for usefulness
  – DB system query languages (e.g. SQL)
    take best of both

begin with Relational Algebra

Basic operations of relational algebra:
1. Selection $\sigma$: select a subset of tuples from a relation according to a condition
2. Projection $\pi$: delete unwanted attributes (columns) from tuples of a relation
3. Cross product $\times$: combine all pairs of tuples of two relations by making tuples with all attributes of both
4. Set difference $\cdot$: tuples in first relation and not in second
5. Union $\cup$: tuples in first relation or second relation
6. Renaming $\rho$: to deal with name conflicts

* Set operations: $D_1 \times D_2 \ldots \times D_n$ of two relations must agree

Board examples
Formal definition

- A relational expression is
  - A relation R in the database
  - A constant relation
  - For any relational expressions E₁ and E₂
    - E₁ U E₂
    - E₁ - E₂
    - E₁ X E₂
    - σₚ(E₁) for predicate P on attributes of E₁
    - τₛ(E₁) where S is a subset of attributes of E₁
    - P(Q(L), E₁) where Q is a new relation name and L is a list of (old name → new name) mappings of attributes of E₁

- A query in the relational algebra is
  a relational expression