Relational Algebra

- It is a theoretical language with operations that work on one or more relations to define another relation without changing the original relation (s).

- Relations are closed under relational algebra operations.

Relational Algebra

- Unary operations
  - Projection
    - The projection operation works on a single relation R and defines a relation that contains a vertical subset of R, extracting the values of specified attributes and eliminating duplicates.
    - **Note:** All the examples in these slides refer to the relations you were given on students records db unless otherwise specified.
    - $\pi_{a1,a2,a3,...an}(R)$
      - Where a1,a2,…,an are attributes and R is a relation.
    - Examples:
      1. Produce a list of all students showing their name, father's name, and sex.
      2. List the rooms by showing their type, number, campus, and capacity.

Relational Algebra

- Selection (or Restriction)
  - The selection operation works on a single relation R and defines a relation that contains only those tuples of R that satisfy the specified condition (predicate).
  - $\sigma_{condition}(R)$
  - **Examples:**
    1. List all students in the department of BAIS.
    2. List all female instructors whose department is BAIS, but are not living in Addis Ababa.
    3. List the lecture halls at the main campus with capacity between 150 and 200 students together with all computer labs.
    4. List the instructors whose date of birth is not entered.
    5. **Display the identification numbers and names of the female instructors with the rank of Full Professor.**

Relational Algebra

- Binary Operations
  - Set Operations
    - Union
      - The Union of two relations R and S defines a relation that contains all the tuples of R, or S, or both R and S, duplicate tuples being eliminated. R and S must be union-compatible.
      - R ∪ S
      - Examples:
        1. Take two relations A and B of your choice that are union compatible and perform the union.
        2. List the Kebeles where Students or Instructors of AAUCC live in Addis Ababa.

Relational Algebra

- Intersection
  - The Intersection operation defines a relation consisting of a set of all tuples that are in both R and S. R and S must be union-compatible.
  - $R \cap S$
  - Examples:
    1. Take two relations A and B of your choice that are union compatible and perform the intersection.
    2. List the Kebeles where Students and Instructors of AAUCC live in Addis Ababa.

Relational Algebra

- Set difference
  - The set difference operation defines a relation consisting of the tuples that are in relation R, but not in S. R and S must be union-compatible.
  - R – S
  - Examples:
    1. Take two relations A and B of your choice that are union compatible and perform A – B and also B – A.
    2. List the Kebeles where Students but not Instructors of AAUCC live in Addis Ababa.

Relational Algebra

- Cartesian product
  - The Cartesian product operation defines a relation that is the concatenation of every tuple of relation R with every tuple of relation S.
  - R x S
  - Examples:
    1. Perform this operation on two relations, say A and B, of your choice.
    2. Register each student in the department of BAIS for every course given by the department of BAIS.
    3. List the names and departments of all students who registered for the course BAIS 322 in the second semester of the academic year 2002.

Relational Algebra

- Join Operations
  - Theta join (θ)
    - The Theta join operation defines a relation that contains tuples satisfying the predicate *F* from the Cartesian product of R and S. The predicate *F* is of the form $R.a_i$ θ $S.b_i$ where θ may be one of the comparison operators (<,≤,>,≥,=, ≠). If the comparison operator is the = sign, then the join operation is called Equijoin.
    - $R \bowtie_F S$
    - Note that: $R \bowtie_F S = \sigma_F (R \times S)$
    - Examples:
      - Take your own example
      - Use example 3 of the previous slide.

Relational Algebra

- Natural join
  - The Natural join is an Equijoin of the two relations R and S over all common attributes x. One occurrence of each common attribute is eliminated from the result.
  - $R \bowtie S$
  - Examples:
    - Take your own example.
    - Use the 2nd example of the previous slide.

Relational Algebra

- Outer join
  - The (left) Outer join is a join in which tuples form R that do no have matching values in the common attributes of S are also included in the result relation. Missing values in the second relation are set to null.
  - $R \rtimes S$
  - Examples:
    1. Take your own example.
    2. Produce a status report on registration of students.
    3. Produce a status report on advisory assignment of instructors.
    4. Produce a status report on room schedules.
  - Assignment:
    - Provide the definition for right outer join.

Relational Algebra

- Semijoin
  - The Semijoin operation defines a relation that contains the tuples of R that participate in the join of R with S.
  - $R \triangleright_F S$
  - Examples:
    - Take your own example.
    - List complete details of all courses which are registered by students of the department of Accounting in the 1st semester of the academic year 2008/9.

Relational Algebra

- Division Operation
  - Division
    - Assume relation R is defined over the attribute set A and relation S is defined over the attribute set B such that B $\subseteq$ A. Let C = A – B. Then the Division operation R $\div$ S is defined as a relation over the attributes C that consists the set of tuples from R that match the combination of every tuple in S.
    - R $\div$ S
    - Examples:
      1. Take two relations R and S for which R $\div$ S can be performed and get R $\div$ S.
      2. Produce the Identification numbers of all students who have registered for all courses given by the department of BAIS.

Exercises

- Refer to Student Records DB schema in specifying the following queries using Relational Algebra.
  1. List the names of courses on which student Abebe Bekele got “A” grades.
  2. What is the name of the instructor who advised student Abebe Bekele in the 1st semester of the academic year 2004?
  3. What grade did student Abebe Bekele got on the course Database Systems I?
  4. List the names of the courses for which student Abebe Bekele registered in the 2nd semester of the academic year 2008.
  5. List the rooms where the course Introduction to management is scheduled in the 3rd period on Wednesdays of the current semester.
  6. Show the names and departments of the instructors who are not assigned to advise students in the current semester.
  7. List the names, ranks, and date of employment of all instructors who are qualified to teach the courses E-Commerce or Database Systems I and II.
  8. Display the course name, course code, and the name of the department offering the course for each course that is prerequisite to the course BAIS 411.