CSE460/560 DATA MODELS AND QUERY LANGUAGES

Structured Query Language (SQL)

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(Slides Adopted from Jan Chomicki and Ning Deng)

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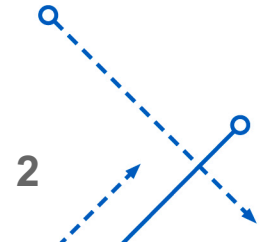
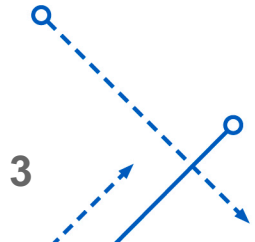
Outline

1. Join
2. Nested Queries
3. Aggregation



Outline

1. **Join**
2. Nested Queries
3. Aggregation



Joins

- R_1 [INNER] JOIN R_2 ON C
  - Where C is a join condition: theta-join
- R_1 NATURAL JOIN R_2
  - Natural join
- Outer Joins
  - Keep tuples in the result even no matching tuples
  - Types
    - R_1 LEFT [OUTER] JOIN R_2 ON C
    - R_1 RIGHT [OUTER] JOIN R_2 ON C
    - R_1 FULL [OUTER] JOIN R_2 ON C

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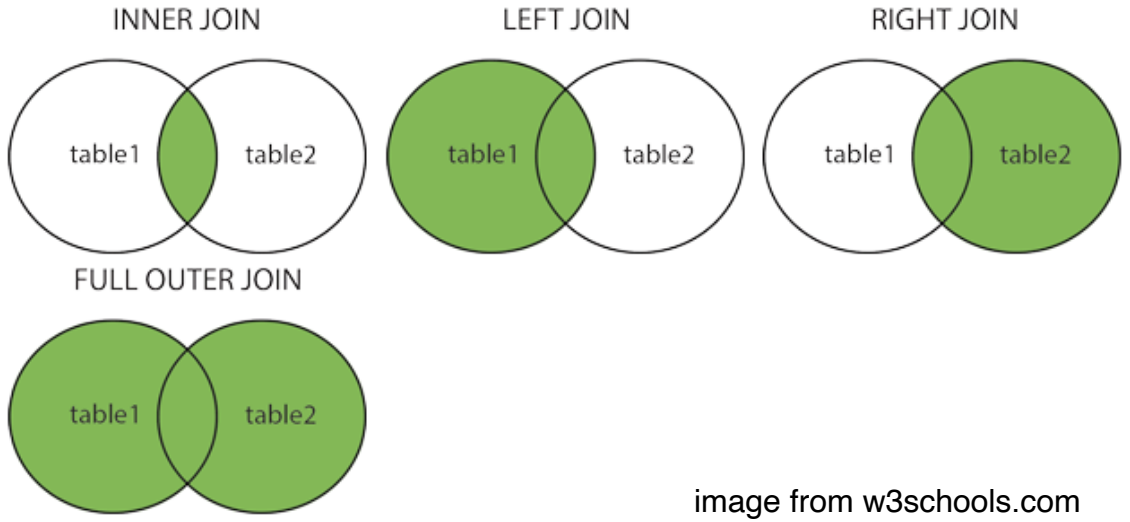

image from w3schools.com

Joins

R1

A	B
a1	b1
a2	b2

R2

B	C
b1	c1
b3	c3

Inner Join

A	R1.B	R2.B	C
a1	b1	b1	c1

Left Join

A	R1.B	R2.B	C
a1	b1	b1	c1
a2	b2	null	null

Right Join

A	R1.B	R2.B	C
a1	b1	b1	c1
null	null	b3	c3

Full Join

A	R1.B	R2.B	C
a1	b1	b1	c1
null	null	b3	c3
a2	b2	null	null

Outline

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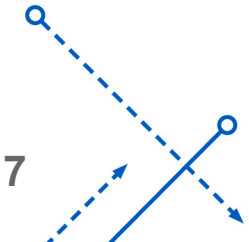

Nested Queries – WHERE-Nesting

- Subquery
  - A query Q can appear as a **subquery** in WHERE clause
    - a IN Q: for set membership $a \in Q$
    - a NOT IN Q: for the negation of set membership $a \notin Q$
    - a θ ANY Q: a is in the relationship θ to some elements of Q
      - $\Theta \in \{=, <, <=, >=, >, <>\}$
    - a θ ALL Q: a is in the relationship θ to all elements of Q
    - EXISTS Q : Q is nonempty
    - NOT EXISTS Q : Q is empty
- Note
  - Subqueries can contain columns from enclosing queries
  - Multiple occurrences of the same column name are disambiguated
    - By choosing the closest enclosing FROM clause

Nested Queries – IN and NOT IN

- Find students who is not a president of any club
  - SELECT S.sid
    FROM Student S
    WHERE S.Firstname IN (
        SELECT C.President
        FROM Club C);

Nested Queries – ANY and ALL

- Students with the highest GPA
  - ```
    SELECT *
    FROM Student S
    WHERE S.GPA >= ALL (
            SELECT S2.GPA
            FROM Student S2
            WHERE S.sid <> S2.Sid
    );
    ```
    ```

Nested Queries – EXISTS and NOT EXISTS

- Students who is a president of one of clubs
  - EXISTS is true if the nested query returns at least one result
  - SELECT S.Firstname
    FROM Student S
    WHERE EXISTS (
        SELECT *
        FROM Club C
        WHERE S.Firstname = C.President);

Nested Queries – FROM-Nesting

- A subquery can also be constructed in the FROM clause
  - SELECT *
    FROM Student S,
    (SELECT C.President
    FROM Club C
    WHERE C.Name='C2') C2President
    WHERE S.Firstname=C2President.President;

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Aggregation

- Instead of return all tuples, the result can be aggregated, respect to some columns
  - COUNT(A): the number of all values in the column A
  - SUM(A): the sum of all values in the column A
  - AVG(A) the average of all values in the column A
  - MAX(A): the maximum value in the column A
  - MIN(A): the minimum value in the column A
- Note
  - DISTINCT A: consider only distinct values of A
  - COUNT(*): counting tuples
  - Aggregate functions are NOT expressible in relational algebra

Aggregate – Counting Tuples

- Counting
  - COUNT(A) and COUNT(*)
  - Returns 0 if it is an empty relation
- Other aggregate functions
  - The result is null (even for SUM)

Aggregate – Grouping

- GROUP BY
  - GROUP BY clause
    - $GROUP\ BY\ A_1, \ldots, A_n$
  - Assembles the tuples in the result of the query into groups
    - with identical values in the columns $A_1, \ldots, A_n$
  - Example
    - SELECT E.ClassID, AVG(E.Grade)
      FROM Enrollment E
      GROUP BY E.ClassId;
- Note: The SELECT list of a query with GROUP BY can contain only
  - The columns mentioned in GROUP BY
    - E.ClassId
  - The result of an aggregate function
    - AVG(E.Grade)

Having

- We can't apply the condition in WHERE clause to the result of GROUP BY
  - Need HAVING
- The clause
  - HAVING C
- Keeps only those groups that satisfy the condition C
- Example
  - SELECT E.ClassId, AVG(E.Grade)
    FROM Enrollment E
    GROUP BY E.ClassId
    HAVING AVG(E.Grade) >3.3

Recommended Reading

Database Systems: The Complete Book
Chapter 6.1 – 6.5