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The Database Language SQL (ii)

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UNION, INTERSECT & EXCEPT

- Set-manipulation constructs for result sets of SQL queries that are *union-compatible*
- Can simplify some complicated SQL queries
- Consider Q5: Find the names of sailors who have reserved a red or a green boat

```
SELECT S1.sname
FROM   Sailors S1, Reserves R1, Boats B1
WHERE  S1.sid=R1.sid
       AND R1.bid=B1.bid
       AND ( B1.color=`red' OR B1.color=`green')
```

Q6: Find the names of sailors who have reserved both a red and a green boat

```
SELECT S1.sname
FROM   Sailors S1, Reserves R1, Boats B1
WHERE  S1.sid=R1.sid
       AND R1.bid=B1.bid
       AND ( B1.color=`red'
             OR AND B1.color=`green')
```

```
SELECT S1.sname
FROM   Sailors S1, Reserves R1, Boats B1,
       Reserves R2, Boats B2
WHERE  S1.sid=R1.sid AND R1.bid=B1.bid
       AND S1.sid=R2.sid AND R2.bid=B2.bid
       AND B1.color=`red' AND B2.color=`green'
```

Q6 with INTERSECT : Find the names of sailors who have reserved both a red and a green boat

```
SELECT S1.sname
FROM   Sailors S1, Reserves R1, Boats B1
WHERE  S1.sid=R1.sid  AND R1.bid=B1.bid
       AND B1.color=`red'

INTERSECT

SELECT S2.sname
FROM   Sailors S2, Reserves R2, Boats B2
WHERE  S2.sid=R2.sid  AND R2.bid=B2.bid
       AND B2.color=`green'
```

Q6 Nested: Find the names of sailors who have reserved both a red and a green boat

```
SELECT S3.sname
FROM   Sailors S3
WHERE  S3.sid IN (
        SELECT S1.sid
        FROM   Sailors S1, Reserves R1, Boats B1
        WHERE  S1.sid=R1.sid  AND R1.bid=B1.bid
                    AND B1.color=`red'
        INTERSECT
        SELECT S2.sid
        FROM   Sailors S2, Reserves R2, Boats B2
        WHERE  S2.sid=R2.sid  AND R2.bid=B2.bid
                    AND B2.color=`green'  )
```

Q5 with UNION : Find the names of sailors who have reserved a red or a green boat

```
SELECT S1.sname
FROM   Sailors S1, Reserves R1, Boats B1
WHERE  S1.sid=R1.sid  AND R1.bid=B1.bid
       AND B1.color=`red'

UNION

SELECT S2.sname
FROM   Sailors S2, Reserves R2, Boats B2
WHERE  S2.sid=R2.sid  AND R2.bid=B2.bid
       AND B2.color=`green'
```

Q19: Find the sids of sailors who have reserved red boats but not green boats

```
SELECT S1.sid
FROM   Sailors S1, Reserves R1, Boats B1
WHERE  S1.sid=R1.sid  AND R1.bid=B1.bid
       AND B1.color=`red'

EXCEPT

SELECT S2.sid
FROM   Sailors S2, Reserves R2, Boats B2
WHERE  S2.sid=R2.sid  AND R2.bid=B2.bid
       AND B2.color=`green'
```

Find the sid of sailors who have reserved exactly one boat

```
SELECT S1.sid
FROM   Sailors S1
EXCEPT
SELECT R1.sid
FROM   Reserves R1, Boats B1, Reserves R2, Boats B2
WHERE  R1.sid=R2.sid  AND R1.bid=B1.bid
          AND R2.bid=B2.bid  AND R1.bid≠R2.bid
```

```
SELECT R3.sid
FROM   Reserves R3
EXCEPT
SELECT R1.sid
FROM   Reserves R1, Boats B1, Reserves R2, Boats B2
WHERE  R1.sid=R2.sid  AND R1.bid=B1.bid
          AND R2.bid=B2.bid  AND R1.bid≠R2.bid
```

Nested Queries

Q1 : Find the names of sailors who have reserved boat 103

```
SELECT S.sname
FROM   Sailors S, Reserves R
WHERE  S.sid=R.sid AND bid=103
```

```
SELECT S.sname
FROM   Sailors S
WHERE  S.sid IN ( SELECT R.sid
                  FROM Reserves R
                  WHERE R.bid=103 )
```

- A *nested query* is a query that has another query, called a *subquery,* embedded within it.
- Subqueries can appear in WHERE, FROM, HAVING clauses

Conceptual Evaluation Strategy for Nested Queries

1. Compute the cross-product of *relation-list*.
   - If there is a subquery, recursively (re-)compute the subquery using this conceptual evaluation strategy
   - Compute the cross-product over the results of the subquery.
2. Discard resulting tuples if they fail *qualifications*.
   - If there is a subquery, recursively (re-)compute the subquery using this conceptual evaluation strategy
   - Evaluate the qualification condition that depends on the subquery
3. Delete attributes that are not in *target-list*.
4. If DISTINCT is specified, eliminate duplicate rows.

Q2: Find the names of sailors who have reserved a red boat

```
SELECT S.sname
FROM   Sailors S
WHERE  S.sid IN ( SELECT R.sid
                  FROM Reserves R
                  WHERE R.bid IN ( SELECT B.bid
                                   FROM Boats B
                                   WHERE B.color=`red' ))
```

- Unravel the nesting from the innermost subquery

Q21: Find the names of sailors who have not reserved a red boat

```
SELECT S.sname
FROM   Sailors S
WHERE  S.sid NOT IN ( SELECT R.sid
                      FROM Reserves R
                      WHERE R.bid IN ( SELECT B.bid
                                       FROM Boats B
                                       WHERE B.color=`red' ))
```

Correlated Nested Queries

Q1: Find the names of sailors who've reserved boat #103

```
SELECT S.sname
FROM   Sailors S
WHERE  EXISTS ( SELECT *
                FROM Reserves R
                WHERE R.bid = 103 AND R.sid=S.sid
```

- EXISTS is another set comparison operator, like *IN*.
- If UNIQUE is used, and * is replaced by R.bid, finds sailors with at most one reservation for boat #103. (UNIQUE checks for duplicate tuples; * denotes all attributes. Why do we have to replace * by R.bid?)
- Illustrates why, in general, subquery must be re-computed for each Sailors tuple.

Set Comparison Operators: ANY

- Q22: Find sailors whose rating is better than some sailor called Horatio.

```
SELECT S1.sid
FROM   Sailors S1
WHERE  S1.rating > ANY ( SELECT S2.rating
                         FROM Sailors S2
                         WHERE S2.name=`Horatio' )
```

- Subquery must return a row that makes the comparison true, in order for S1.rating>ANY to return true

Set Comparison Operators: ALL

- Q23: Find sailors whose rating is better than every sailor.

```
SELECT S1.sid
FROM   Sailors S1
WHERE  S1.rating >= ALL ( SELECT S2.rating
                          FROM Sailors S2)
```

- Subquery must return a row that makes the comparison true, in order for S1.rating>ANY to return true

Rewriting INTERSECT Queries using IN

- Q6: Find sid's of sailors who've reserved both a red and a green boat.

```
SELECT S1.sid
FROM   Sailors S1, Boats B1, Reserves R1
WHERE  S1.sid=R1.sid AND R1.bid=B1.bid
       AND B1.color='red'
       AND S1.sid IN ( SELECT S2.sid
                       FROM Sailors S2, Boats B2,
                            Reserves R2
                       WHERE S2.sid=R2.sid
                             AND R2.bid=B2.bid
                             AND B2.color=`green' )
```

Q9: Find the names of sailors who have reserved all boats

```
SELECT S.sname
FROM   Sailors S
WHERE  NOT EXISTS (( SELECT B.bid
                     FROM Boats B )

                   EXCEPT

                   ( SELECT R.bid
                     FROM Reserves R
                     WHERE R.sid=S.sid ))
```

Q9: Find the names of sailors who have reserved all boats (without EXCEPT)

```
SELECT S.sname
FROM   Sailors S
WHERE  NOT EXISTS ( SELECT B.bid
                    FROM Boats B
                    WHERE NOT EXISTS
                          ( SELECT R.bid
                            FROM Reserves R
                            WHERE R.bid=B.bid
                                  AND R.sid=S.sid ))
```