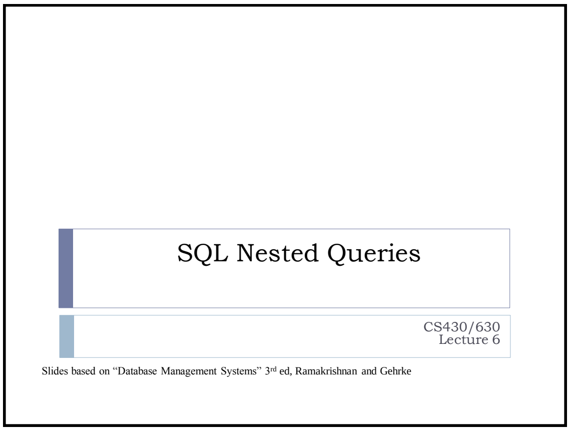
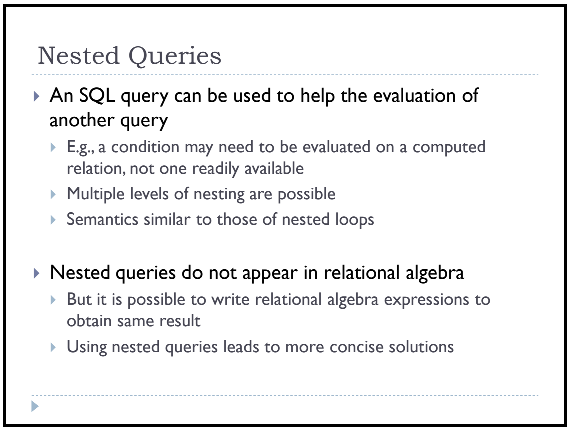


SQL Nested Queries

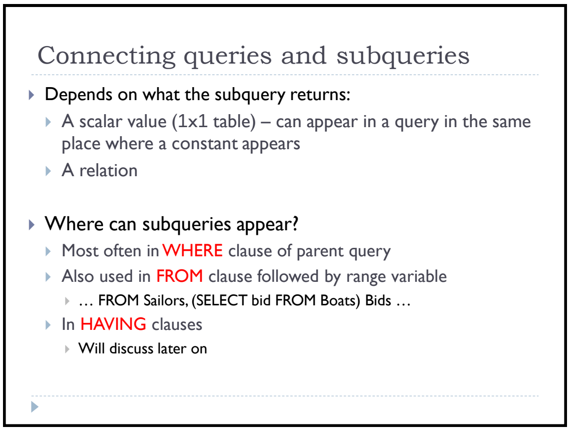
CS430/630
Lecture 6

Slides based on "Database Management Systems" 3rd ed, Ramakrishnan and Gehrke



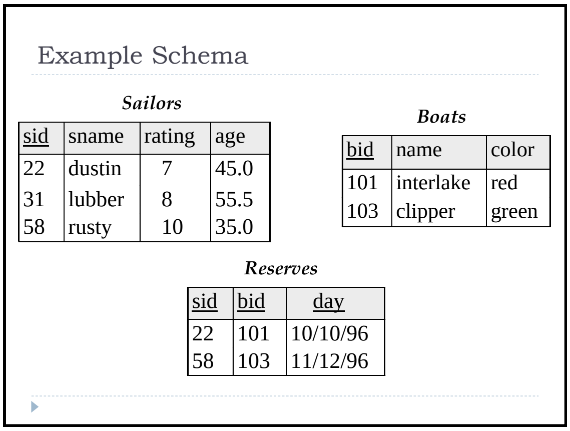
Nested Queries

- An SQL query can be used to help the evaluation of another query
  - E.g., a condition may need to be evaluated on a computed relation, not one readily available
  - Multiple levels of nesting are possible
  - Semantics similar to those of nested loops
- Nested queries do not appear in relational algebra
  - But it is possible to write relational algebra expressions to obtain same result
  - Using nested queries leads to more concise solutions



Connecting queries and subqueries

- Depends on what the subquery returns:
  - A scalar value (1x1 table) – can appear in a query in the same place where a constant appears
  - A relation
- Where can subqueries appear?
  - Most often in WHERE clause of parent query
  - Also used in FROM clause followed by range variable
    - … FROM Sailors, (SELECT bid FROM Boats) Bids …
  - In HAVING clauses
    - Will discuss later on



Example Schema

Sailors

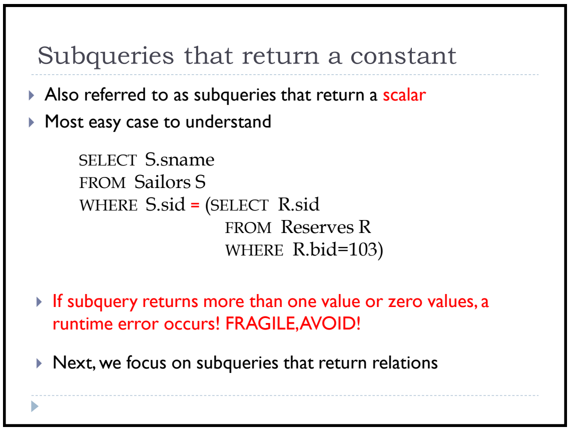
sid	sname	rating	age
22	dustin	7	45.0
31	lubber	8	55.5
58	rusty	10	35.0

Boats

bid	name	color
101	interlake	red
103	clipper	green

Reserves

sid	bid	day
22	101	10/10/96
58	103	11/12/96

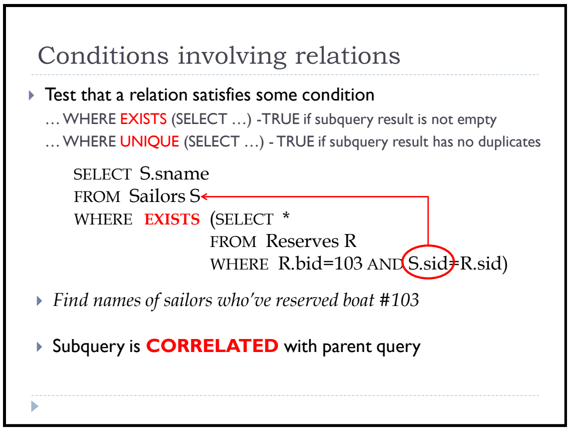


Subqueries that return a constant

- Also referred to as subqueries that return a scalar
- Most easy case to understand

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

- If subquery returns more than one value or zero values, a runtime error occurs! FRAGILE,AVOID!
- Next, we focus on subqueries that return relations



Conditions involving relations

- Test that a relation satisfies some condition

… WHERE EXISTS (SELECT …) -TRUE if subquery result is not empty
… WHERE UNIQUE (SELECT …) - TRUE if subquery result has no duplicates

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

- *Find names of sailors who've reserved boat #103*
- Subquery is **CORRELATED** with parent query

Conditions involving relations and tuples

- Typically have some sort of set operations semantics

  …WHERE field IN (SELECT …)

  … WHERE field op ANY (SELECT …)

  … WHERE field op ALL (SELECT …)

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

- *Find names of sailors who've reserved boat #103*

Conditions involving relations and tuples

- Typically have some sort of set operations semantics

  …WHERE field IN (SELECT …)

  … WHERE field op ANY (SELECT …)

  … WHERE field op ALL (SELECT …)

```
SELECT  S.sname
FROM  Sailors S
WHERE  S.rating > ANY (SELECT  S1.rating
                       FROM  Sailors S1, Reserves R1
                       WHERE  S1.sid=R1.sid AND
                          R1.bid=103)
```

- *Find names of sailors whose rating is higher than the minimum rating among sailors who reserved boat 103*

Conditions involving relations and tuples

- Typically have some sort of set operations semantics

  …WHERE field IN (SELECT …)

  … WHERE field op ANY (SELECT …)

  … WHERE field op ALL (SELECT …)

```
SELECT  S.sname
FROM  Sailors S
WHERE  S.age >= ALL (SELECT  S1.age
                     FROM  Sailors S1)
```

- *Find names of sailors with maximum age*

Subqueries in the FROM clause

```
SELECT  SQ.sname, SQ.bname
FROM ( SELECT S.sname, B.name AS bname
       FROM Sailors S, Boats B, Reserves R
       WHERE S.sid=R.sid and B.bid=R.bid
     ) SQ
WHERE   SQ.bname='interlake';
```

- *Find names of sailors who reserved 'interlake'*

Rewriting INTERSECT Queries Using IN

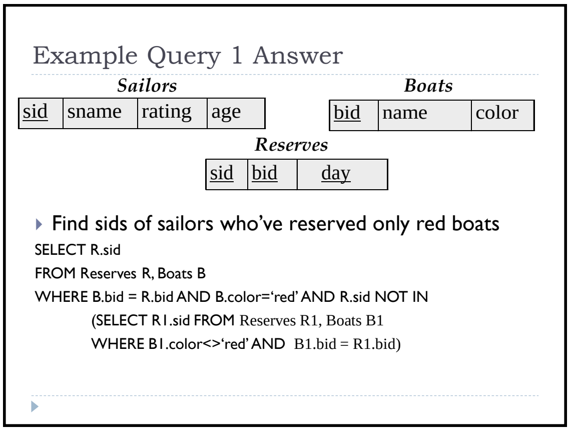
Find sid's of sailors who've reserved both a red and a green boat:

```
SELECT  S.sid
FROM  Sailors S, Boats B, Reserves R
WHERE  S.sid=R.sid AND R.bid=B.bid AND B.color='red'
       AND S.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')
```

- Similarly, EXCEPT queries re-written using NOT IN.

Nested Queries - Review

- Nested queries returning a constant
  - Typically constant is compared with other value in the WHERE clause
  - … WHERE field = (SELECT bid FROM …) …
- Nested queries returning a relation
  - in WHERE clause
    - … WHERE EXISTS|UNIQUE (SELECT bid FROM …) …
    - … WHERE field IN (SELECT bid FROM …) …
    - … WHERE field op ANY|ALL (SELECT bid FROM …) …
  - in FROM clause followed by range variable
    - … FROM Sailors, (SELECT bid FROM Boats) Bids …



Example Query 1 Answer

Sailors

sid	sname	rating	age

Boats

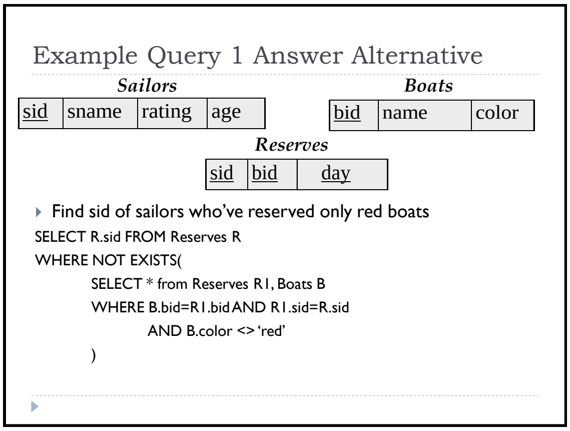
bid	name	color

Reserves

sid	bid	day

- Find sids of sailors who’ve reserved only red boats

```
SELECT R.sid
FROM Reserves R, Boats B
WHERE B.bid = R.bid AND B.color=‘red’ AND R.sid NOT IN
        (SELECT R1.sid FROM Reserves R1, Boats B1
        WHERE B1.color<>‘red’ AND  B1.bid = R1.bid)
```



Example Query 1 Answer Alternative

Sailors

sid	sname	rating	age

Boats

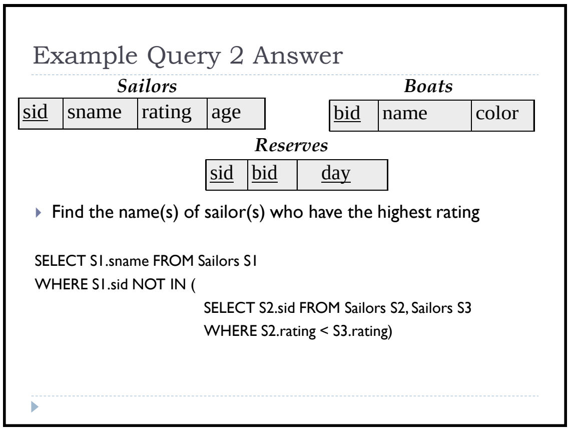
bid	name	color

Reserves

sid	bid	day

- Find sid of sailors who’ve reserved only red boats

```
SELECT R.sid FROM Reserves R
WHERE NOT EXISTS(
        SELECT * from Reserves R1, Boats B
        WHERE B.bid=R1.bid AND R1.sid=R.sid
                AND B.color <> ‘red’
        )
```



Example Query 2 Answer

Sailors

sid	sname	rating	age

Boats

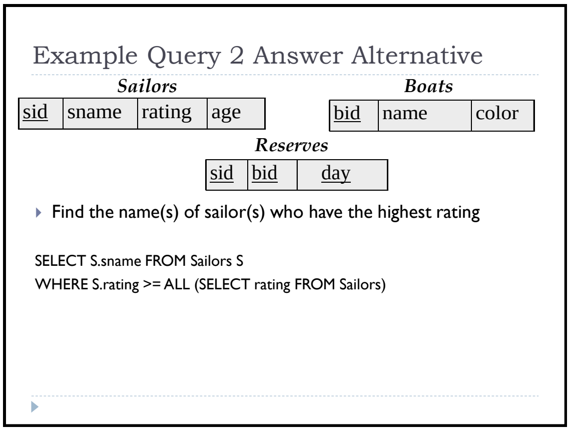
bid	name	color

Reserves

sid	bid	day

- Find the name(s) of sailor(s) who have the highest rating

```
SELECT S1.sname FROM Sailors S1
WHERE S1.sid NOT IN (
                        SELECT S2.sid FROM Sailors S2, Sailors S3
                        WHERE S2.rating < S3.rating)
```



Example Query 2 Answer Alternative

Sailors

sid	sname	rating	age

Boats

bid	name	color

Reserves

sid	bid	day

- Find the name(s) of sailor(s) who have the highest rating

```
SELECT S.sname FROM Sailors S
WHERE S.rating >= ALL (SELECT rating FROM Sailors)
```