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SQL Nested Queries

CS430/630  
Lecture 6

Slides based on “Database Management Systems” 3<sup>rd</sup> ed, Ramakrishnan and Gehrke

# Nested Queries

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- ▶ 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

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# Connecting queries and subqueries

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- ▶ 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

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*Sailors*

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

*Boats*

<u>bid</u>	name	color
101	interlake	red
103	clipper	green

*Reserves*

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



# Subqueries that return a constant

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- ▶ 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=100)
```

- ▶ 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

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- ▶ 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

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```
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

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- ▶ 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

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```
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';
```

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



# Rewriting INTERSECT Queries Using IN

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*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

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- ▶ 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 ...

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# Example Query 1 Answer

*Sailors*

<u>sid</u>	sname	rating	age
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*Boats*

<u>bid</u>	name	color
------------	------	-------

*Reserves*

<u>sid</u>	<u>bid</u>	<u>day</u>
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- Find sids of sailors who've reserved only red boats

SELECT R.sid

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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*

<u>sid</u>	sname	rating	age
------------	-------	--------	-----

*Boats*

<u>bid</u>	name	color
------------	------	-------

*Reserves*

<u>sid</u>	<u>bid</u>	<u>day</u>
------------	------------	------------

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

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

# Example Query 2 Answer

*Sailors*

<u>sid</u>	sname	rating	age
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*Boats*

<u>bid</u>	name	color
------------	------	-------

*Reserves*

<u>sid</u>	<u>bid</u>	<u>day</u>
------------	------------	------------

- 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*

<u>sid</u>	sname	rating	age
------------	-------	--------	-----

*Boats*

<u>bid</u>	name	color
------------	------	-------

*Reserves*

<u>sid</u>	<u>bid</u>	<u>day</u>
------------	------------	------------

- 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)