ICS 321 Spring 2013

# The Database Language SQL (iii)

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# Bag Semantics in SQL

- SELECT-FROM-WHERE statements preserve duplicates by default, unless DISTINCT is given.
- Set operators UNION, INTERSECT, EXCEPT use set semantics by default!
- To use bag semantics: UNION **ALL**, INTERSECT **ALL**, EXCEPT **ALL**.

```
(SELECT title, year
  FROM Movies)
        UNION ALL
(SELECT movieTitle AS title, movieYear AS year
  FROM StarsIn)
```

# Aggregate Operators

- SQL supports 5 aggregation operators on a column, say A,
  1. COUNT ( * ), COUNT ( [DISTINCT] A )
  2. SUM ( [DISTINCT] A )
  3. AVG ( [DISTINCT] A )
  4. MAX ( A )
  5. MIN ( A )

# Aggregation Queries

- Q25: Find the average age of all sailors

```
SELECT AVG(S.age)
FROM   Sailors S
```

- Q28: Count the number of sailors

```
SELECT COUNT (*)
FROM   Sailors S
```

- Find the age of the oldest sailor

```
SELECT MAX (S.age)
FROM   Sailors S
```

# Q27: Find the name and age of the oldest sailor

```
SELECT S.sname, MAX (S.age)
FROM   Sailors S
```

```
SELECT S.sname, S.age
FROM   Sailors S
WHERE S.age = ( SELECT MAX(S2.age)
                FROM Sailors S2 )
```

- If there is an aggregation operator in the SELECT clause, then it can only have aggregation operators unless the query has a GROUP BY clause -- first query is illegal.

# Queries with GROUP BY and HAVING

```
SELECT    [DISTINCT] target-list
FROM      relation-list
WHERE     qualification
GROUP BY  grouping-list
HAVING    group-qualification
```

- The *target-list* contains (i) attribute names (ii) terms with aggregate operations (e.g., MIN (*S.age*)).
  - The list of attribute names in (i) must be a subset of *grouping-list*.
  - Intuitively, each answer tuple corresponds to a *group*, and these attributes must have a single value per group.
  - A *group* is a set of tuples that have the same value for all attributes in *grouping-list*.

# Conceptual Evaluation Strategy with GROUP BY and HAVING

- [Same as before] The cross-product of *relation-list* is computed, tuples that fail *qualification* are discarded, `*unnecessary*' fields are deleted
- The remaining tuples are partitioned into groups by the value of attributes in *grouping-list*.
- The *group-qualification* is then applied to eliminate some groups. Expressions in *group-qualification* must have a *single value per group*!
  - In effect, an attribute in *group-qualification* that is not an argument of an aggregate op also appears in *grouping-list*. (SQL does not exploit primary key semantics here!)
- Aggregations in *target-list* are computed for each group
- One answer tuple is generated per qualifying group

# Q32: Find age of the youngest sailor with age >= 18, for each rating with at least 2 such sailors

```
SELECT  S.rating,
        MIN(S.age) AS minage
FROM  Sailors S
WHERE  S.age >= 18
GROUP BY  S.rating
HAVING  COUNT (*) > 1
```

*Answer relation:*

| rating | minage |
|---|---|
| 3 | 25.5 |
| 7 | 35.0 |
| 8 | 25.5 |

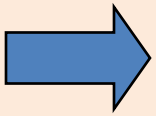
*Sailors instance:*

| sid | sname | rating | age |
|---|---|---|---|
| 22 | dustin | 7 | 45.0 |
| 29 | brutus | 1 | 33.0 |
| 31 | lubber | 8 | 55.5 |
| 32 | andy | 8 | 25.5 |
| 58 | rusty | 10 | 35.0 |
| 64 | horatio | 7 | 35.0 |
| 71 | zorba | 10 | 16.0 |
| 74 | horatio | 9 | 35.0 |
| 85 | art | 3 | 25.5 |
| 95 | bob | 3 | 63.5 |
| 96 | frodo | 3 | 25.5 |

# Conceptual Evaluation for Q32

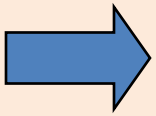
| rating | age |
|---|---|
| 7 | 45.0 |
| 1 | 33.0 |
| 8 | 55.5 |
| 8 | 25.5 |
| 10 | 35.0 |
| 7 | 35.0 |
| 10 | 16.0 |
| 9 | 35.0 |
| 3 | 25.5 |
| 3 | 63.5 |
| 3 | 25.5 |

Partition
or
GROUP BY



| rating | age |
|---|---|
| 3 | 25.5 |
| 3 | 63.5 |
| 3 | 25.5 |
| 7 | 45.0 |
| 7 | 35.0 |
| 8 | 55.5 |
| 8 | 25.5 |

Eliminate groups
Using HAVING clause



| rating | minage |
|---|---|
| 3 | 25.5 |
| 7 | 35.0 |
| 8 | 25.5 |

Perform aggregation
on each group

# EVERY and ANY in HAVING clauses

```
SELECT  S.rating, MIN(S.age) AS minage
FROM  Sailors S
WHERE  S.age >= 18
GROUP BY  S.rating
HAVING  COUNT (*) > 1 AND EVERY ( S.age <=60 )
```

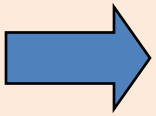
- EVERY: every row in the group must satisfy the attached condition
- ANY: at least one row in the group need to satisfy the condition

# Conceptual Evaluation with EVERY

HAVING COUNT (*) > 1 AND EVERY (S.age <=60)

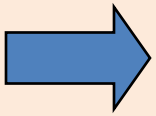
| rating | age |
|---|---|
| 7 | 45.0 |
| 1 | 33.0 |
| 8 | 55.5 |
| 8 | 25.5 |
| 10 | 35.0 |
| 7 | 35.0 |
| 10 | 16.0 |
| 9 | 35.0 |
| 3 | 25.5 |
| 3 | 63.5 |
| 3 | 25.5 |

Partition or GROUP BY



| rating | age |
|---|---|
| 7 | 45.0 |
| 7 | 35.0 |
| 8 | 55.5 |
| 8 | 25.5 |

Eliminate groups Using HAVING clause



| rating | minage |
|---|---|
| 7 | 35.0 |
| 8 | 25.5 |

Perform aggregation on each group

**What is the result of changing EVERY to ANY?**

# Find age of the youngest sailor for each rating with at least 2 sailors between 18 and 60

```
SELECT  S.rating,
        MIN (S.age) AS minage
FROM  Sailors S
WHERE  S.age >= 18 AND S.age <= 60
GROUP BY  S.rating
HAVING  COUNT (*) > 1
```

*Answer relation:*

| rating | minage |
|---|---|
| 3 | 25.5 |
| 7 | 35.0 |
| 8 | 25.5 |

*Sailors instance:*

| sid | sname | rating | age |
|---|---|---|---|
| 22 | dustin | 7 | 45.0 |
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| 74 | horatio | 9 | 35.0 |
| 85 | art | 3 | 25.5 |
| 95 | bob | 3 | 63.5 |
| 96 | frodo | 3 | 25.5 |

# Outer Joins

S1

| sid | sname | rating | age |
|---|---|---|---|
| 22 | Dustin | 7 | 45.0 |
| 31 | Lubber | 8 | 55.0 |
| 58 | Rusty | 10 | 35.0 |

R1

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

- Regular join on sid: Sailor Lubber gets dropped.
- **Outer join**: Sailor rows without a matching Reserves row appear exactly once in the result, with the columns inherited from Reserves taking null values.
- **Left Outer Join** : Sailor rows w/o matching reservations appear in the result, but not vice versa
- **Right Outer Join**: Reservations w/o matching reservations appear in the result, but not vice versa

# Example of outer join

```
SELECT S1.*, R1.*
FROM   Sailors S1 NATURAL OUTER JOIN Reserves R1
```

**S1**

| sid | sname | rating | age |
|---|---|---|---|
| 22 | Dustin | 7 | 45.0 |
| 31 | Lubber | 8 | 55.5 |
| 58 | Rusty | 10 | 35.0 |

**R1**

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

- Note the nulls

**Result**

| sid | sname | rating | age | sid | bid | day |
|---|---|---|---|---|---|---|
| 22 | Dustin | 7 | 45 | 22 | 101 | 10/10/96 |
| 31 | Lubber | 8 | 55.5 | NULL | NULL | NULL |
| 58 | Rusty | 10 | 35.0 | 58 | 103 | 11/12/96 |

# Insertion

```
INSERT INTO R(A1, A2, ...)
        VALUES  (v1, v2, ...);
```

```
INSERT INTO Studio(name)
        SELECT DISTINCT studioname
        FROM Movies
        WHERE studioname NOT IN
                (SELECT name
                FROM Studio);
```

- If inserting results from a query, query must be evaluated prior to actual insertion

# Deletion

```
DELETE FROM R
WHERE  <condition>;
```

```
DELETE FROM StarsIn
WHERE  movieTitle = 'The Maltese Falcon' AND
       MovieYear = 1942 AND
       starName='Sydney Greenstreet';
```

- Deletion specified using a where clause.
- To delete a specific tuple, you need to use the primary key or candidate keys.

# Updates

```
UPDATE R
SET  <new value assignments>
WHERE <condition>;
```

```
UPDATE MovieExec
SET name='Pres. ' || name
WHERE cert# IN (
        SELECT presC#
        FROM Studio );
```

- Tuples to be updated are specified using a where clause.
- To update a specific tuple, you need to use the primary key or candidate keys.