ICS 321 Fall 2010

The Database Language SQL (iii)

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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

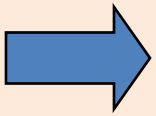
Sailors instance:

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

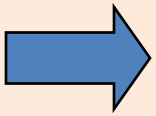
rating	age
7	45.0
1	33.0
8	55.5
8	25.5
10	35.0
7	35.0
10	16.0
9	35.0
3	25.5
3	63.5
3	25.5

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 )
```

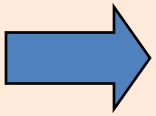
- EVERY: every row in the group must satisfy the attached condition
- ANY: at least one row in the group need to satisfy the condition

Conceptual Evaluation with EVERY

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

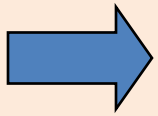
rating	age
7	45.0
1	33.0
8	55.5
8	25.5
10	35.0
7	35.0
10	16.0
9	35.0
3	25.5
3	63.5
3	25.5

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 with age 18, 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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71	zorba	10	16.0
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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