CS411
Database Systems

06b: SQL-2
Grouping and Aggregation

Why Do We Learn This?

Q: What is “aggregate”?

Aggregations

- SUM, AVG, COUNT, MIN, and MAX can be applied to a column in a SELECT clause to produce that aggregation on the column.
- Also, COUNT(*) counts the number of tuples.

Example: Aggregation

- From Sells(bar, beer, price), find the average price of Bud:

```
SELECT AVG(price)
FROM Sells
WHERE beer = ‘Bud’;
```

Eliminating Duplicates in an Aggregation

- DISTINCT inside an aggregation causes duplicates to be eliminated before the aggregation.
- Example: find the number of different prices charged for Bud:

```
SELECT COUNT(DISTINCT price)
FROM Sells
WHERE beer = ‘Bud’;
```

NULL’s Ignored in Aggregation

- NULL never contributes to a sum, average, or count, and can never be the minimum or maximum of a column.
- But if there are no non-NULL values in a column, then the result of the aggregation is NULL.

Example: Effect of NULL’s

```
SELECT count(*)
FROM Sells
WHERE beer = ‘Bud’;
```

The number of bars that sell Bud.

```
SELECT count(price)
FROM Sells
WHERE beer = ‘Bud’;
```

The number of bars that sell Bud at a known price.

Grouping

- We may follow a SELECT-FROM-WHERE expression by GROUP BY and a list of attributes.
- The relation that results from the SELECT-FROM-WHERE is grouped according to the values of all those attributes, and any aggregation is applied only within each group.

Example: Grouping

- From Sells(bar, beer, price), find the average price for each beer:

```
SELECT beer, AVG(price)
FROM Sells
GROUP BY beer;
```

Example: Grouping

- From Sells(bar, beer, price) and Frequents(drinker, bar), find for each drinker the average price of Bud at the bars they frequent:

```
SELECT drinker, AVG(price)
FROM Frequents, Sells
WHERE beer = 'Bud' AND
        Frequents.bar = Sells.bar
GROUP BY drinker;
```

Compute drinker-bar-price of Bud tuples first, then group by drinker.

Restriction on SELECT Lists With Aggregation

- If any aggregation is used, then each element of the SELECT list must be either:

1. Aggregated, or
2. An attribute on the GROUP BY list.

Q: How about this query?

```
SELECT bar, MIN(price)
FROM Sells
WHERE beer = ‘Bud’;
```

Q: How to do it right, then?

```
SELECT bar, MIN(price)
FROM Sells
WHERE beer = 'Bud';
```

Q: How to do it right?

MySQL impl is problematic!

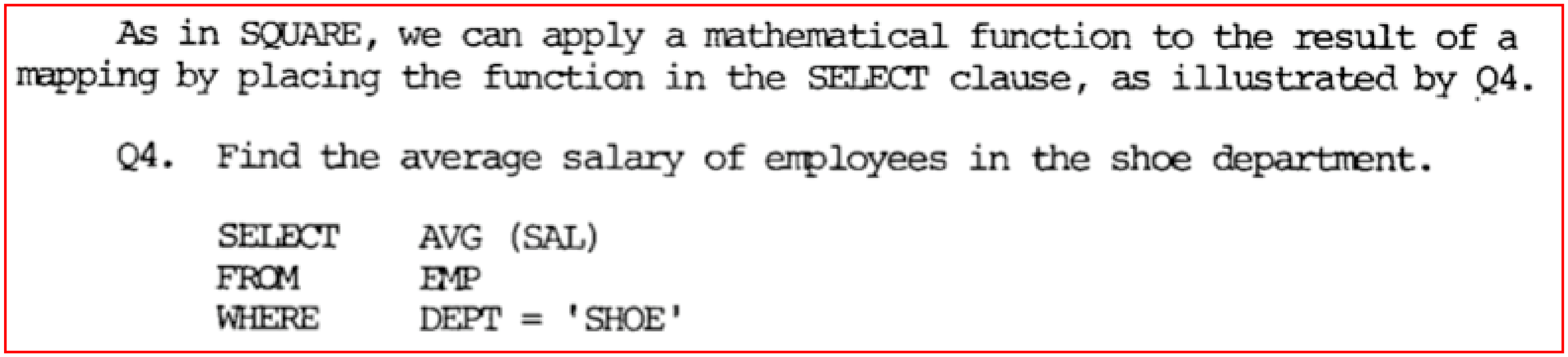
- Select bar, avg(price) from Sells

→ this is NOT OK.

- Select bar, avg(price) from Sells Group By beer

→ this is OK!

Behind the Scene: First Aggregate Query

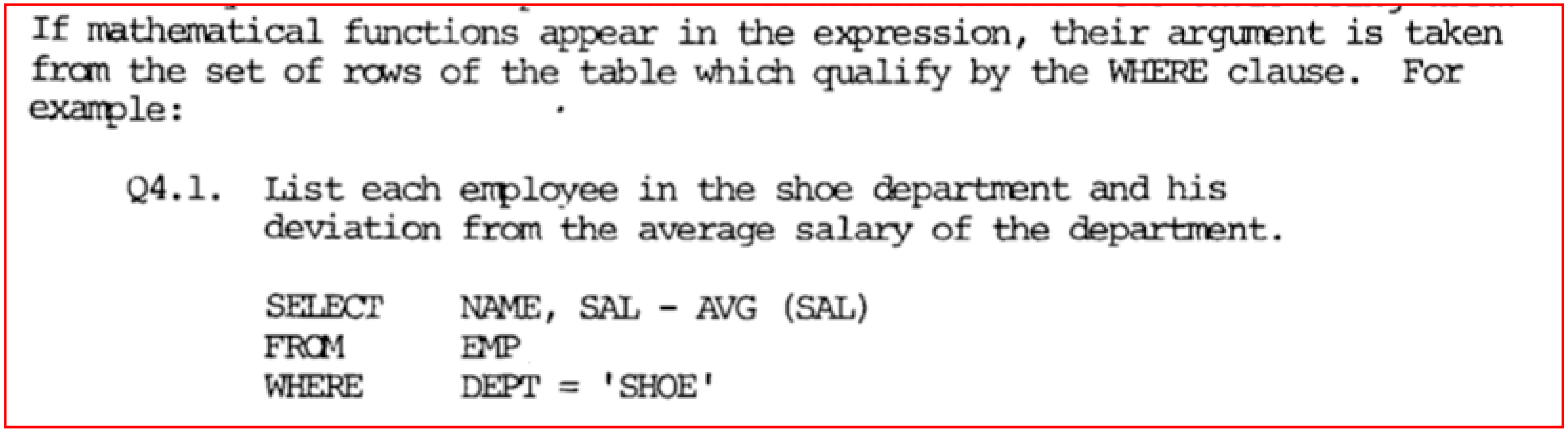


As in SQUARE, we can apply a mathematical function to the result of a mapping by placing the function in the SELECT clause, as illustrated by Q4.

Q4. Find the average salary of employees in the shoe department.

```
SELECT    AVG (SAL)
FROM      EMP
WHERE     DEPT = 'SHOE'
```

Behind the Scene: How about this one?



If mathematical functions appear in the expression, their argument is taken from the set of rows of the table which qualify by the WHERE clause. For example:

Q4.1. List each employee in the shoe department and his deviation from the average salary of the department.

```
SELECT    NAME, SAL - AVG (SAL)
FROM      EMP
WHERE     DEPT = 'SHOE'
```

HAVING Clauses

- HAVING <condition> may follow a GROUP BY clause.
- If so, the condition applies to each group, and groups not satisfying the condition are eliminated.

Requirements on HAVING Conditions

- These conditions may refer to any relation or tuple-variable in the FROM clause.
- They may refer to attributes of those relations, as long as the attribute makes sense within a group; i.e., it is either:
  1. A grouping attribute, or
  2. Aggregated.

Example

```
SELECT beer, AVG(price)
FROM Sells
GROUP BY beer
HAVING COUNT(bar) >= 3 OR beer = ‘michelob’;
```

General form of Grouping and Aggregation

```
SELECT     S
FROM       R1,…,Rn
WHERE      C1
GROUP BY   a1,…,ak
HAVING     C2
```

S = may contain attributes $a_1,\ldots,a_k$ and/or any aggregates but NO OTHER ATTRIBUTES

C1 = is any condition on the attributes in $R_1,\ldots,R_n$

C2 = is any condition on aggregate expressions or grouping attributes

General form of Grouping and Aggregation

```
SELECT   S
FROM     R1,…,Rn
WHERE    C1
GROUP BY a1,…,ak
HAVING   C2
```

Evaluation steps:

1. Compute the FROM-WHERE part, obtain a table with all attributes in $R_1,\ldots,R_n$
2. Group by the attributes $a_1,\ldots,a_k$
3. Compute the aggregates in C2 and keep only groups satisfying C2
4. Compute aggregates in S and return the result