AGGREGATION, GROUPING & OUTER JOINS

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Aggregation

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

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Example: Aggregation

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

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

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Eliminating Duplicates in an Aggregation

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- Use DISTINCT inside an aggregation.
- Example: find the number of *different* prices charged for Bud:

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

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NULL's Ignored in Aggregation

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- NULL never contributes to a sum, average, or count, and can never be the minimum or maximum of a column.
- But if all the values in a column are NULL, then the result of the aggregation is NULL.
  - Exception: COUNT of an empty set is 0.

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Example: Effect of NULL's

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Sells(bar, beer, price)

```
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 (i.e., where price is not NULL)

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Example Query

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- Find the age of the youngest employee at each rating level

```
SELECT MIN (age)
FROM Employees
WHERE  rating = i
```

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Grouping

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- 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.

```
SELECT   rating, MIN(age)
FROM       Employees
GROUP BY  rating
```

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Example: Grouping

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

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

beer	AVG(price)
Bud	2.33
Miller	4.55
…	…

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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 all drinker-bar-price triples for Bud.

Then group them by drinker.

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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.

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Illegal Query Example

```
SELECT bar, beer, MIN(price)
FROM Sells
GROUP BY bar
```

- But this query is illegal in SQL.
- Only one tuple output for each bar, no unique way to select which beer to output

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A Closer Look

```
SELECT bar, beer, MIN(price) AS minP
FROM Sells
GROUP BY bar  beer
```

Sells

Bar	Beer	Price
Joe	Bud	3.00
Joe	Miller	4.00
Tom	Bud	3.50
Tom	Miller	4.25
Jane	Bud	3.25
Jane	Miller	4.75
Jane	Coors	4.00

Result

bar	beer	minP
Joe	?	3.00
Tom	?	3.50
Jane	?	3.25

{Bud, Miller, Coors}?

Only one tuple output for each bar, no unique way to select which beer to output

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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.

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Example: HAVING

- From Sells(bar, beer, price) and Beers(name, manf), find the average price of those beers that are either served in at least three bars or are manufactured by Pete's.

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Solution

Sells(bar, beer, price) and Beers(name, manf),

```
SELECT beer, AVG(price)
FROM Sells
GROUP BY beer
HAVING COUNT(bar) >= 3 OR
    beer IN (SELECT name
             FROM Beers
             WHERE manf = 'Pete''s');
```

Beer groups with at least 3 non-NULL bars

Beers manu-factured by Pete's.

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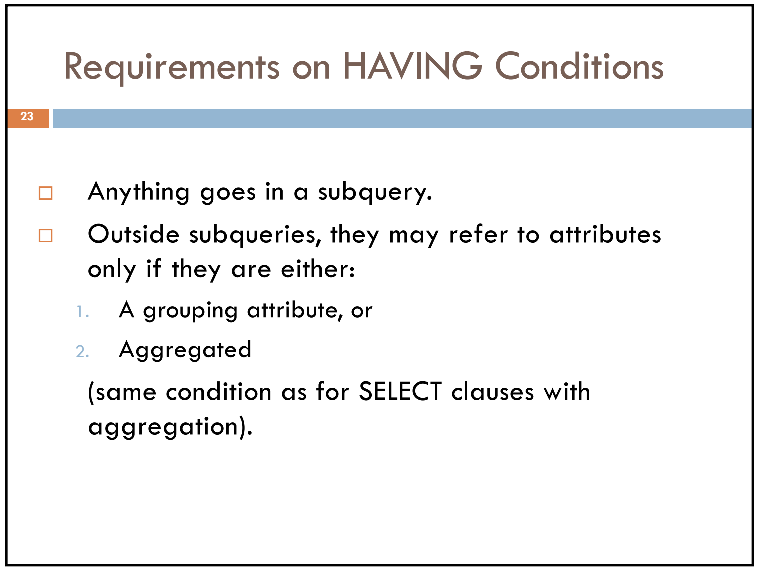

Requirements on HAVING Conditions

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- Anything goes in a subquery.
- Outside subqueries, they may refer to attributes only if they are either:
  1. A grouping attribute, or
  2. Aggregated

  (same condition as for SELECT clauses with aggregation).

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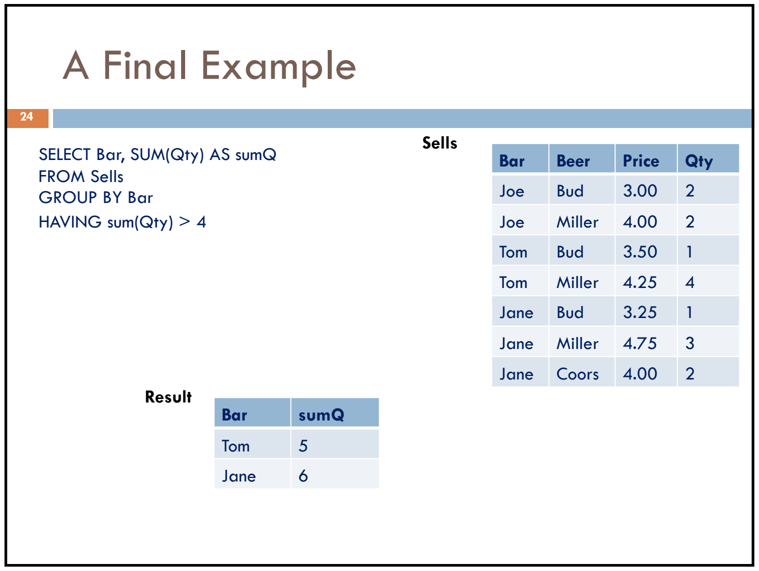

A Final Example

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```
SELECT Bar, SUM(Qty) AS sumQ
FROM Sells
GROUP BY Bar
HAVING sum(Qty) > 4
```

Sells

Bar	Beer	Price	Qty
Joe	Bud	3.00	2
Joe	Miller	4.00	2
Tom	Bud	3.50	1
Tom	Miller	4.25	4
Jane	Bud	3.25	1
Jane	Miller	4.75	3
Jane	Coors	4.00	2

Result

Bar	sumQ
Tom	5
Jane	6

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